Pak. J. Sci. Ind. Res. 2005 **48**(1) 39-41

Determination of Trace Metals in Silver Cat Fish (*Chryssichthys nigrodigitatus*) Associated with Water and Soil Sediments from Beach-Line Fish Ponds

O. O. Ayejuyo[a*], O. G. Raimi [b] and O. R. Moisili [a]
[a]Chemistry Department, Lagos State University, PMB 1087, Apapa Lagos, Nigeria
[b]Biochemistry Department, Lagos State University, PMB 1087, Apapa Lagos, Nigeria

(received September 29, 2003; revised September 21, 2004; accepted September 30, 2004)

Abstract. Levels of cadmium, lead, zinc, copper and chromium were determined in the head, middle and tail regions of the silver cat fish (*Chryssichthys nigrodigitatus*). Water and sediments from three neighbouring man-made fresh water ponds were also analyzed using atomic absorption spectrophotometer. The mean concentration of these metals were found to be more in the soil, followed by the water and then the fish. The highest concentrations of zinc between 33.05-33.19 μg/ml and 39.72-40.13 μg/g, were found in the water and soil, respectively. Chromium concentration in water and soil ranged from 0.220-0.254 μg/ml and 0.335-0.347 μg/g, respectively. In the fish parts, zinc and chromium were found to be more in the head with values ranging from 19.05-19.23 μg/g and 0.210-0.215 μg/g, respectively. Cadmium, copper and lead were found to be more in the middle region, having values ranging from 0.260-0.261 μg/g, 4.60-4.62 μg/g and 0.320-0.321 μg/g, respectively. All metals investigated were consistently low in the fish tail. There was no significant difference in the mean concentration of all the metals in the three ponds at $p \leq 0.05$, while the distribution of the metals in the fish parts and between the fish and the water was significantly different at $p \leq 0.05$.

Keywords: trace metals, silver cat fish, soil sediments, atomic absorption spectrophotometer, *Chryssichthys nigrodigitatus*

Introduction

The advancement in technology and the growth in population have led to high levels of industrialization and urbanization which in turn have led to environmental pollution arising from the indiscriminate discharge of industrial effluents. These effluents may contain most common heavy metals, such as Hg, Zn, Cu, Co, Sb, Cd, Pb and Cr (Ibok *et al.*, 1989). It has been pointed out that industrial manufacturers may endanger public health by discharging toxic substances, including heavy metals into water, which may cause taste and odour problems, contaminating irrigated food crops, and killing fishes and other natural life in rivers (Oni, 1987). Water pollution by heavy metals has become a health hazard in recent years (Sastry and Tyaji, 1982), while human activities have increased the quantity and distribution of heavy metals in the atmosphere, on land, in rivers, lakes, and the seas (Warren, 1981). The extent of this widespread, but generally diffused contamination, has caused a great concern about its possible effects on plants, animals and human beings. Heavy metals are common components of natural waters, though some are essential for living organisms, these may be toxic when present beyond tolerant limits (Lehninger *et al.,* 1993; Volesky, 1990). Generally, these metals remain for a long time in seafoods, and through a series of reaction mechanisms accumulate in them. These are subsequentely transported in large concentrations through the food chain to animals or human beings when consumed.

*Author for correspondence; E-mail: walex_3k@yahoo.com

Description of site. The beach-line fishponds in Lagos, Nigeria are constructed in such a way that the Ojo river is allowed to flow freely in and out of the ponds. The ponds have been in existence for more than 10 years and the harvested fish are sold to the nearby consumers. The river is open to the sea at the south-east (Bar-beach) and also at the south-west (Ceme-beach) through Badagry, Lagos. Human activities such as dumping of refuse, sewage discharge, excavation of soil and the discharge of industrial waste into the river have increased over the years. The data of this work will be helpful in determining the level of pollutants entering into the ponds through this river.

Materials and Methods

Description of the ponds. The ponds are square-shaped, each with a dimension of approximately 20 by 20 m by 1.3 m deep.

Sampling. ***Collection of fish.*** Fish samples of the same species were collected from three ponds (P1, P2 and P3) by hand-net. Later, each specimen was cut into three parts, head, trunk and tail, with a plastic knife and then stored at 4 °C prior to analysis.

Collection of water. The water samples were collected in plastic containers, acidified with 0.01N HNO_3 for preservation

(Holm *et al.*, 1995) and stored in polyethylene bottles prior to analysis.

Collection of the soil. Samples of bottom soil of the ponds were collected by soil sampler (Adeniyi, 1996), air-dried and kept in polyethylene bags prior to analysis.

Digestion. ***Water.*** The water samples were digested using the method of Holm *et al.* (1995).

Soil. Five g of sieved, air dried soil sample was digested with 2 N HNO_3 as described by Adeniyi (1996) and Abdul-Rida (1996).

Fish. The defrozen fish samples were rinsed with deionized water and each fish part was dried at 105 °C for 20 h and blended. 2 g of the blended fish part was weighed and digested by following the method described by Ibok *et al.* (1989).

Instrumentation. Zinc, lead, copper, chromium and cadmium were determined in the three samples (water, sediments and fish parts) using Perkin Elmer and Oak Brown atomic absorption spectrophotometer. The instrument settings and operational conditions were done in accordance with the manufacturer's specifications.

Statistical analysis. The results obtained were subjected to ANOVA to compare the mean levels of the metals in the three ponds and fish parts.

Results and Discussion

The results of this study are shown in Table 1, which indicate the presence of heavy metals in all the fish parts (head, middle region and tail). Presence of metals in fish has been described as an indication of the level of metal pollution of the water from which the fish was caught (Atta *et al.*, 1997). Lead, iron and copper was found to be highly concentrated in fish organs showing some likely evidence of bioaccumulation (Adeyeye, 1994). Among all the metals determined, zinc was found to be in the highest concentration with an average of 39.95 μg/g and 33.10 μg/ml in the soil and water, respectively in all the three ponds, followed by copper with 7.05 μg/g and 8.50 μg/ml, and chromium 0.34 μg/g and 0.24 μg/ml in the soil and water, respectively (Table 1). These results are in agreement with the results of Ibok *et al.* (1989) in which zinc, lead and copper were found to be more in the streams investigated. The high level of zinc and copper in the present study could be due to the discharge of untreated industrial wastewaters and human activities, including smelting of iron around the Ojo River, and subsequently in the receiving ponds. The average values of these metals are far above the United States Environmental Protection Agency (USEPA) recommended maximum limit values in drinking water (Table 2).

Table 2. US Public health services drinking water standards*

Metals	Cd	Cr	Cu	Pb	Zn
Recommended limit (ppm)	0.02	0.05	1.0	0.05	5.0

*USEPA (1976)

In the fish parts, zinc concentration ranged from 19.05-19.23 μg/g in the head, 18.18-18.20 μg/g in the middle region and 17.19-17.21 μg/g in the tail (Table 1). Concentrated copper was found in the middle region with values ranging from 4.60-4.62 μg/g followed by the head with a range of 3.00-3.15 μg/g. Lead was also found to be more in the middle region with a range of 0.320-0.321 μg/g followed by cadmium with concentration level of 0.260-0.261 μg/g, while the chromium range of 0.208-0.215 μg/g was the highest in the head. The high levels of these metals in the head are as a result of the gills, which help in respiration and filtration of water. This

Table 1. Mean metal concentrations in fish (μg/g), soil (μg/g) and water (μg/ml) in the three ponds, P1, P2, P3

	Cd			Pb			Zn			Cu			Cr		
Samples	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3
Head	0.202 ± 0.01	0.205 ± 0.01	0.203 ± 0.01	0.300 ± 0.03	0.290 ± 0.02	0.295 ± 0.03	19.23 ± 0.09	19.05 ± 0.09	19.20 ± 0.10	3.00 ± 0.25	3.09 ± 0.25	3.15 ± 0.27	0.210 ± 0.01	0.215 ± 0.01	0.208 ± 0.01
Middle	0.261 ± 0.01	0.260 ± 0.01	0.261 ± 0.01	0.320 ± 0.04	0.321 ± 0.05	0.321 ± 0.05	18.20 ± 0.21	18.20 ± 0.22	18.18 ± 0.21	4.60 ± 0.11	4.62 ± 0.12	4.62 ± 0.12	0.190 ± 0.01	0.191 ± 0.01	0.191 ± 0.01
Tail	0.177 ± 0.01	0.178 ± 0.02	0.176 ± 0.01	0.273 ± 0.07	0.275 ± 0.06	0.276 ± 0.06	17.19 ± 0.21	17.20 ± 0.21	17.21 ± 0.22	2.73 ± 0.01	2.75 ± 0.02	2.74 ± 0.02	0.160 ± 0.01	0.160 ± 0.01	0.162 ± 0.01
Water	0.660	0.669	0.670	2.900	3.090	3.040	33.05	33.19	33.06	8.50	8.48	8.48	0.243	0.254	0.220
Soil	0.730	0.710	0.721	3.140	3.250	3.200	40.13	39.72	40.00	7.05	7.05	7.05	0.335	0.335	0.347

±: standard deviation

result agrees with the findings of Ayejuyo *et al.* (2003) in which zinc was found in the highest amount in the gills of *Clarias lazera* as compared with all the other body parts studied. In the present study, the gills were not separated from the head. Relatively high amount of metals were found in the middle portion. Visceral muscles are found within the middle portion of the fish and these muscles are known to concentrate toxic metals (Atta *et al.*, 1997). The concentration of the metals determined in the fish parts followed the order Zn > Cu > Pb > Cd > Cr. Fish head has become a delicacy (Okoye, 1991) and the highest levels of zinc and copper are recorded in the head and the middle portions of the fish analyzed. The presence of these metals in all the samples may be taken as an indicator of pollution of the ponds and the Ojo River water, which freely flows in and out of the ponds (Fig. 1). These metals are known to be toxic to fishes and other aquatic animals and also to humans, who subsequently consume them.

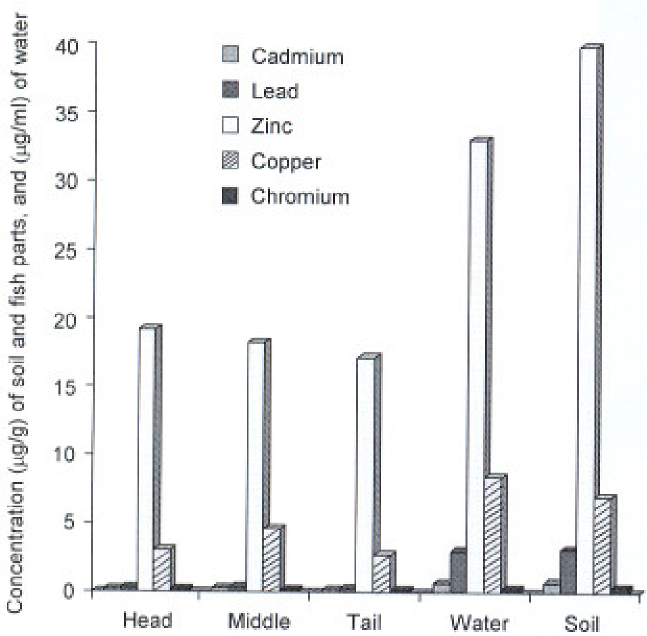

Fig. 1. Histogram of mean metal distribution in samples from the three ponds.

Conclusion

Since Nigerians depend on the fish caught locally to supplement their protein requirement, the research on levels of heavy metals in fish including their sources could be seen as one bold step towards preserving the Nigerian natural habitat. Therefore, human activities such as dumping of refuse, digging of sand and discharging of industrial effluents into rivers and streams should be discontinued in order to make fishes and other aquatic animals safe in rivers and for their subsequent human consumption.

Acknowledgement

The authors would like to acknowledge the assistance of Mr. M. A. Lawal and Mr. Babatope, both of the Federal Institute of Industrial Research, Oshodi (FIIRO), Lagos, Nigeria.

References

Abdul-Rida, M. M. A. 1996. Concentration and growth of earthworms and plants in polluted (Cd, Cu, Fe, Pd and Zn) and non-polluted soils: interactions between soil-earthworm. *Soil Biol. Biochem.* **28:** 1029-1035.

Adeniyi, A. A. 1996. Determination of cadmium, copper, iron, lead, manganese and zinc in waterleaf (*Talinum triangulare*) in dumpsites. *Environ. Int.* **22:** 259-262.

Adeyeye, E. I. 1994. Determination of trace heavy metals in *Illisha african* fish and in associated water and soil sediments from some fish pond. *J. Int. Environ. Studies* **45:** 231-238.

Atta, M. B., El-Sebaie, L. A., Naoman, M. A., Kassab, H. F. 1997. The effect of cooking on the contents of heavy metals in fish (*Tilapia nilotica*). *Food Chem.* **58:** 1-4.

Ayejuyo, O. O., Olowu, R. A., Megwa, K. C., Denloye, A. A. B., Owodeinde, F. G. 2003. Trace metals in *Clarias lazera*, water and sediments from Majidun River, Ikorodu, Nigeria. *Res. Commun. Fisheries* **1:** 27-31.

Holm, P. E., Christensen, T. H., Tjell, J. C., McGrath, S. P. 1995. Heavy metals in the environment. *J. Environ. Qual.* **24:** 183-190.

Ibok, U. J., Udosen, E. D., Udoidiong, O. M. 1989. Heavy metals in fishes from some streams in Ikot Ekpene Area of Nigeria. *J. Niger. Tech. Res.* **1:** 61-68.

Lehninger, A. L., Nelson, D. L., Cox, M. M. 1993. *Principles of Biochemistry*, 2nd edition, Worth Publishers, New York, USA.

Okoye, B. C. O. 1991. Heavy metals and organisms in Lagos Lagoon. *J. Int. Environ. Studies* **37:** 285-292.

Oni, O. O. 1987. Water quality surveillance and treatment. *National Water Bull.* **2:** 15.

Sastry, K. V., Tyaji, S. 1982. Toxic effects of chromium in a fresh teleost fish, *Channa punctatus*. *Toxicol. Lett.* **11:** 17-21.

USEPA. 1976. *Quality Criteria for Water*, p. 481, United States Environmental Protection Agency, Washington DC, USA.

Volesky, B. 1990. Removal and recovery of heavy metals by biosorption. In: *Biosorption of Heavy Metals*, B. Volesky (ed.), pp. 7-43, CRC Press, Boca Raton, Florida, USA.

Warren, L. J. 1981. Contamination of sediments by lead, zinc and cadmium: a review. *Environ. Pollut.* (series B) **2:** 401-436.