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Assessment of Heavy Metals in Water and Fish from Ibrahim Adamu Lake, Jigawa, Nigeria

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ABSTRACT

The study was conducted to assess the levels of heavy metals in water and the flesh of tilapia (*Oreochromics niloticus*). Water and tilapia were sampled for a period of 12 months from October, 2003 to September, 2004. Water and muscle tissue were analyzed for Cu, Cr, Pb and Zn using flame atomic absorption spectrophotometer. The assessment showed Cr (3.35 mg L^{-1}), Cu (0.75 mg L^{-1}) Pb (0.81 mg L^{-1}) in water while Cr (2.27 mg kg^{-1}) and Pb (0.27 mg kg^{-1}) were found to be high in the tissue samples and were above the values recommended by WHO and the Food Agricultural Organization of the United Nations and therefore, not safe for human consumption.

Key words: Pollution, heavy metals, Ibrahim Adamu Lake, standard limits

INTRODUCTION

Contamination of freshwater bodies with a different variety of pollutants has been a problem over the last decades because of the damage caused to aquatic life (Canli *et al*., 1998). Aquatic systems are very sensitive to heavy metal pollutants. Pollution of heavy metal in aquatic ecosystem is growing at an alarming rate (Malik *et al*., 2010).

The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent, atmospheric deposition, mining, erosion and runoff from agricultural fields (Ambedkar and Muniyan, 2011).

Metals are not biodegradable and their presence in the food chain through a number of pathways becomes accumulated in different organs of animals (Staniskiene *et al*., 2006; Korai *et al*., 2008). Increase in pollution, urbanization, industrialization and agricultural practices have further aggravated the situation (Giguere *et al*., 2004; Gupta *et al*., 2009). The accumulation could also depend on the concentration of the metals and exposure period (Nyirenda *et al*., 2011).

Heavy metals can accumulate toxic concentration and cause damage. They have a great chance of moving up the food chain and cause public health hazards depending on their relative levels (Mansour and Sidk, 2002).

Heavy metals such as Cu, Pb, Zn and Cr have been associated with waste water and sewage (Mucheweti *et al*., 2006) and are known to be toxic at high concentration (Rana *et al*., 2007).

The aim of this study is to assess the levels of these metals in water and in the flesh of the fish (*Oreochromis niloticus*) collected from Ibrahim Adamu Lake, Jigawa State, Nigeria.

MATERIALS AND METHODS

Study area: Ibrahim Adamu Lake is located in Kazaure town of Jigawa state, 735 km from the state capital Dutse on 13° along the line of latitude. The lake was constructed

in 1974 with the primary aim of supplying water to the town, irrigation, fisheries and secondary aim of recreation and wildlife conservation.

Collection of fish sample: Fish species were caught by artisanal fishermen using different fishing gears viz., traps, cast nets of "2-10" mesh and hooks. The caught fish were iced packed in order to maintain freshness and brought to the Research Laboratory immediately at Bayero University, Kano. The fish (*O. niloticus*) was identified at a glance by the characteristic pattern of dark and light bands crossing the caudal fin.

Analysis of metals in water: Water samples for heavy metals analysis were collected in I L bottles pre-rinsed with distilled water. A 0.25 L of the water sample was transferred into a 500 cm^3 beaker. It was filtered and evaporated to dryness. The residue was redissolved in 0.1 M nitric acid in a 100 cm^3 volumetric flask ready for analysis after labeling (Ayodele and Abubakar, 1998). Aqueous stock solutions were prepared for Cr, Cu, Zn and Pb, using the appropriate salts. Five working standard solutions were prepared for each metal by serial dilution of stock solutions. These and blank solutions were aspirated into flame Atomic Absorption Spectrophotometer. A calibration curve of absorption versus concentration was prepared for each metal and used for the determination of the metal concentrations in the samples using standard calibration plot.

Analysis of metals in fish tissue: Ice packed fish was dissected to remove the flesh. The flesh was dried to constant weight in an oven at 105°C. A method described by Ayodele and Abubakar (1998) was used to digest the sample. Dried tissue was ground in a ceramic mortar and sieved through 20 μm mesh. A 1.0 g of the dry powdered sample was digested in 10 cm^3 concentrated nitric acid. The resulting solution was evaporated to dryness and the residue was re-dissolved in 0.1 M HNO_3. The metal concentrations were determined by Flame Atomic Absorption Spectrophotometer (Buckmodel 210).

RESULTS

In the water sample, the mean concentration of metal Zn, Cr, Cu and Pb were 1.64, 3.35, 0.75 and 0.81 mg L^{-1}, respectively (Table 1). The concentration of chromium was the highest followed by copper.

The mean values of metals in fish tissue were 0.87, 2.77, 0.30 and 0.27 mg kg^{-1} (Table 2). The mean values were compared with permissible limits.

DISCUSSION

The research area, Ibrahim Adamu is centre to human and livestock communities of Kazaure local government area of Jigawa state, therefore, the analysis of the water and fish from the lake becomes very important from public health perspectives. The level of heavy metals in the fish flesh is of interest because of potential risk to humans (Ashraf, 2005; Barbieri *et al.*, 2010).

The mean concentration of Zn in the water and tissue samples were below the FAO/WHO limits of 5.0 mg L^{-1} and 5.0 mg kg^{-1} desirable for Zn in drinking water and fish tissue, respectively. Copper as an essential element that promotes the activity of certain enzymes in human body, however, when ingested in large quantity may be toxic to man and may pose danger to the community. The mean concentration of copper recorded in water was higher than in tissue when compared with the permissible limits (Table 1 and 2). This could be attributed to human activities taking place. Lawani and Alawode (1987) reported a mean value of 5.89 mg L^{-1} for Cu.

Table 1: Mean heavy metals concentration in water from Ibrahim Adamu Lake

Metals	Mean concentration (mg L^{-1}) (present study)	Nauen (1983)
Zn	1.64	5.00
Cr	3.35*	0.05
Cu	0.75*	0.05
Pb	0.81*	0.01

*Levels higher than permissible limits

Table 2: Mean heavy metals concentration in tissue from Ibrahim Adamu Lake

Metals	Mean concentration (mg kg^{-1}) (present study)	Nauen (1983)
Zn	0.87	5.00
Cr	2.77*	1.00
Cu	0.30	3.00
Pb	0.27*	0.21

*Levels higher than permissible limits

The mean concentration of chromium (3.35 and 2.77 mg kg^{-1}) was above the limit for both water and fish tissue when compared with values of 0.05 mg L^{-1} and 1.00 mg kg^{-1} by FAO/WHO. Eneji *et al*. (2011) reported high concentration of chromium in Tilapia from River Benue which they said was attributed to bioavailability, intrinsic fish processes and trophic structure variation.

Lead poisoning is ranked as the most common environmental health hazard even at low concentrations. The mean concentrations of lead obtained were high considering the acute toxicity of the metal. The values in the study 0.81 mg L^{-1} and 0.27 mg kg^{-1} were high compared with the safe limits set by FAO/WHO.

CONCLUSION

The result from the study gave important information on the levels of the four metals and the fish were capable of concentrating these metals in their tissue from the water showing the same trend in humans that feed on the fish depending on the consumption by consumers. It is recommended that resources be put in place by the state government to continuously reduce to the minimum the method of the lake pollution.

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