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Determination of Heavy Metals in Fish Tissues and Water from White Nile Khartoum City - Sudan

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Abstract

The aim of this study is to determine levels of some heavy metals contaminating White Nile water and their bioaccumulation in various organs of Tilapia species (*Oreochromisniloticus).* Water and fish samples were taken from two stations in Khartoum city, both of them located on the White Nile River.The first station is Adobaseen Brigade area near the sewage bonds exit and the second station is Jebal awllia dam. Lead (Pb), cadmium (Cd) and copper (Cu) were analyzed quantitatively using Perking Elmer Atomic Absorption Spectrophotometer. The water of the first station contain high level of lead concentration ranging from 0.140 ± 0.02 mg/L compare to the second station Pb range 0.037 ± 0.01 mg/L. Cd concentration in the first station water ranges of 0.049± 0.012 while in the second station ranges between0.0110 ± 0.002 mg/L. Copper concentration in the first station was 0.040±0.009 while in the second station was 0.0151±0.002.Studies on thedifferent parts (muscle, liver gills, and kidney) of the fish revealed higher concentration ranges between0.602 to 0.576mg/g dw in the gills followed by liver ranges between 0.519_0 203mg/g dw, and 0.409_0.307 mg/g dw in kidney while the muscle recorded low level ranges between 0.307_0.247mg/g dw Pb. The highest concentration ranges between0.455_0.188 mg/g Cd was detected in the gills, lowestconcentration with a value ranges between0.113_0.121 mg/g dw in the muscle. Also results indicated highest concentration ranges between 0.874 to 702mg/g dw cu was detected in the gills followedby range between 0.673_0.358 mg/g dw. In the kidney range is between 0.603 and 0.457 mg/g dw, and 0.418 to 0.369 mg/g dw in liver and muscle respectively. The results indicated that Adobaseen station contained the highest concentrationof all the detected heavy metals, except (Pb) in liver and (Cu) in gills. Muscle tissues appeared to be the least preferred site for the bioaccumulation of metals as the lowest metalconcentration. This suggests that the fish samples could be used to monitor Pb, Cd and Cu pollution levels in the White Nile River.

Keywords

Heavy Metals, White Nile, Tilapia Species

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1. Introduction

Environmental pollution is a worldwide problem and heavy metals belonging to the most important pollutants. The progress of industries has led to increased emission of pollutants into ecosystems.

Metals tend to accumulate in water and move up through the food chain. So, studies to quantify the level of heavy metals in environment and determine potentially hazardous levels for human are necessary.

Heavy metals have relatively high atomic weight are toxic at low concentrations. They do not degrade or are not destroyed; they generally do not breakdown into less harmful constituents. They accumulate where they are released. As trace elements, some heavy metals (e.g. copper, selenium, zinc etc.)are essential to maintain the metabolism of human

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body. However, at higherconcentrations they can lead to poisoning (Bendico and Lavilla 2003). Someheavy metals like mercury, cadmium and lead are highly toxic in nature. Thetoxic actions of trace elements or heavy metals occur due to bioaccumulationand biomagnifications of the elements in the tissues of living organisms. Withthe increased urbanization and industrialization; there has been a rapidincrease in the municipal waste water (sewage water and industrial effluents) which in turn has intensified the environmental pollution (Boyle et al. 2004).

Heavy metals such as cadmium, lead, cupper and more specifically mercury are potentially harmful to most organisms even in very low concentrations andhave been reported as hazardous environmental Pollutants able to accumulate along the aquatic food chain with severe risk for animal and human health.

Toxic heavy metal contamination mostly occurred in aquaculture farms and frequently occurs in groundwater, rivers, estuaries, wetland and coastal areas. Of particular concern are the highly toxic non-nutrient elements such as mercury (Hg), lead (Pb), and cadmium (Cd).

The presences of pollutants have been associated with decreased fertility and other reproductive abnormalities in birds, fish, shell fish and mammals and also altered immune function. Heavy metals like mercury and cadmium are known to accumulate in marine organisms and cause rapid genetic changes (Nimmo et al. 1978, Nevo et al. 1986).

Pollution of rivers causes the degradation of biodiversity. Heavy metalscontamination creates problem in those species, especially the fishes whichsurvive in polluted rivers and this problem is directed toward the health damageof human, the consumers of fishes. The study area White Nile River is one of the main local sources of food fishes for Khartoum city. The river is polluted bysewage bonds.

The objective ofthe present study was to determine the concentration level of some importantheavy metals in fishes and water in order to know the level ofpollution in White Nile River.

2. Material and Methods

2.1. Sampling

Surface water samples from the two stations were collected in ultra clean sampling bottles (200 ml)

Samples of fish named tilapia species (*Oreochromisniloticus*) was caught from the twostations using gill nets, which were left over night in the river by local fishermen.The samples wereprepared step by step according to the recommended procedures by AOAC (AOAC 2002).

2.2. Procedures

2.2.1. Preparation and Analysis of Water Samples

The water dedicated for the metal analysis were acidified immediately when they reached the laboratory by adding 1 ml of 50% nitric acid to each bottle. Pb, Cd and Cu, were determined by using Perkin Elmer Atomic Absorption Spectrophotometer.

2.2.2. Preparation and Analysis of Fish Samples

The fishes were weighed by a spring balance in the field and anelectric balance in laboratory according to weight range. After the dissection ofthe collected fishes, the gills, liver, muscle and kidney were separated using a plastic knife and were taken separately in a petri-dish and weighed by using an electricbalance and then taken into polybags separately. The polybags were sealed andtaken into an icebox. Approximately 2.0 gm of each sample were weighed and burned in the furnace at 550 ^{o}C for 90 min. The obtained ash was dissolved in 5 ml concentrated nitric acid and made up to 25 ml volume. The elements Pb, Cd and Cu were analyzed using Atomic Absorption Spectrophotometer and the results were given as mg/g dw.

2.3. Statistical Analysis

Data were analyzed by statistical software SPSS ver. 16.

3. Results

Results of heavy metal concentrations in water of White Nile at the tow stations are presented in Table 1 and Table 2 presents concentrations of heavy metals in fresh Nile tilapia tissues. Table 3 present the Permissible or threshold limits various heavy metals.

Table 1. Heavy metal concentrations in water of the tow stations in White Nile.

Stations parameters	Adobseen	Jabal awllia	Occurrence%	
			D	J
Pb	0.140±0.029	0.037±0.061	84%	60%
Cd	0.0492±0.012	0.0110±0.002	80%	57%
Cu	0.040±0.009	0.0151±0.002	80%	67%

Table 2. Heavy metal concentration in the Adobasseen station and Jabal awllia station in the White Nile River.

Stations parameters	Adobasseen	Jabal awllia	Occurrence%	
			D	J
Pb on muscle	0.247±0.2	0.307±0.48	67%	67%
Pb on liver	0.203±0.17	0.519±0.59	74%	77%
Pb on gills	0.576±0.34	0.602±0.61	84%	70%
Pb on kidney	0.307±0.20	0.409±0.33	80%	70%
Cd on muscle	0.121±0.15	0.113±0.27	70%	54%
Cd on liver	0.146±0.22	0.295±0.41	80%	64%
Cd on gills	0.188±0.22	0.455±0.35	84%	67%
Cd on kidney	0.376±0.53	0.274±0.31	67%	64%
Cu on muscle	0.369±0.29	0.418±0.44	70%	60%
Cu on liver	0.457±0.43	0.603±0.61	84%	74%
Cu on gills	0.702±0.47	0.874±0.47	64%	80%
Cu on kidney	0.358±0.35	0.673±0.58	77%	70%

Significant at (P<0.01).

Table 3. Permissible limits of for various heavy metals.

Metal	Permissible	Country and reference
Copper	1.00 ppm	WHO (1984)
	20.0 ppm	South Africa (Foodstuffs, cosmetics and disinfectants Act. No. 54 of 1972)
	20.0 mg/g	Spain: Boletin Official del Estado (1991)
Lead	0.05 ppm	WHO (1984)
	0.1 mg/kg	Egypt "E.O.S.Q.C. (1993)
	0.5 ppm	FAO/WHO (1992)
	5.0 mg/g	Spain: Boletin Official del Estado (1991)
Cadmium	0.005 ppm	WHO (1984)
	0.05 ppm	FAO/WHO (1992)
	0.1 mg/kg	Egypt "E.O.S.Q.C. (1993)
	1.0 pg/g	Spain: Boletin Official del Estado (1991)

4. Discussion

Mean copper concentration in water of Adubaseen and Jebal awlia station was0.040±0.009ppm, 0.0151±0.002 respectively and the maximum permissiblelimits recommended by WHO (1984) is 0.05ppm, while in fish muscle in Adubaseen and jebal awlia station was 0.369±0.29ppm, 0.418±0.44 respectively. The recordedresults of copper concentrations in fish muscle were lower than the permissible limits intended by Foodstuffs, Cosmetics and Disinfectants (1972) [20.0 ppm] and Boletin Official del Estado (1991) in Spain [20.0 µg g–1] and Schumacher and Domingo (1996).

It is shown from Table.1 that the lead concentration in in water of dubaseen and jebal awlia station was exceed thepermissible limit recommended by E.Q.S.Q.C. (1993).

This result was nearly higher than those reported by Seddek*et al*. (1996) and Marouf and Dawoud (2006), they recorded levels ranged from 0.42 to 0.74 ppm.

High levels of lead may be attributed to presenceof industrial and agricultural discharges, direct sewage bonds discharge, motor boattraffics and also from mine and smelting operations.

Lead is non-essential element and higherconcentrations can occur in aquatic organisms close toAnthropogenic sources. It is toxic even at lowconcentrations and has no known function inbiochemical processes (Burden et al., 1998). It isknown to inhibit active transport mechanisms, Involving ATP, to depress cellular oxidation reductionreactions and to inhibit protein synthesis (Waldorn and Stofen 1974)

Mean cadmium concentration in water of Adubaseen and Jebal awlia station was 0.0492±0.012ppm and0.0110±0.002ppm respectively the maximum ermissible limits recommended by WHO (1984) is 0.005ppm, while in fish muscle of dubaseen and jebal awlia station was0.121±0.15 ppmand. 0.113±0.27 ppm respectively The recordedresults of cadmium concentrations in fish muscle were lowerthan the permissible limits intended by Boletin Official del Estado (1991) in Spain [l.0 µg g– 1], FAO/WHO(1992) [0.05 ppm] and Egyptian Organization forStandardization and Quality Control "E.O.S.Q.C".[0.1mg kg–1]. This result is below the results obtained by Egbal O. Ahmed *et., al* who reported that the cadmium concentrations in water and fish were 0.353 ± 0.037 to 0.326 ± 0.028 mg/L. and 0.348 ± 0.018 mg/g dw respectively.

Cd is used in Nickel- Cadmium rechargeable batteries and for planting, also used in some paints, Plastic and ceramic

(WHO 1973). All these activities are found in Khartoum city industrial areas and discharged in the White Nile throw sewage bonds

Elements from water are taken by fish through gills and the gastrointestinal tract, where they can be accumulated in inner organs, leading to pathological changes (Alabaster, 1994)

In order to determine the level of contamination of fish inner organs, concentrations of HMs were analyzed in fish gills, liver, muscle and kidney. The gill is an important site for the entry of HMs that provokes lesions and gills damage (Bols, 2001)

In our results the higher recorded concentration was in the gills followed by the liver, kidney and finally the muscles.

The concentration level of heavy metals in the gills could be attributed to the fact that water alwayspasses through mouth and gills when the water is filtered, this is correlated with the findings of (FAO, 1975)

5. Conclusion

- In our results the higher recorded concentration was in the gills followed by the liver, kidney and finally the muscles.
- Adobaseen station which is located at the sewage bonds exit has the highest concentration of all detected metal compare with the second station.
- The observed heavy metals concentrations in fish and water were below the recommended limits.
- The investigation showed elevating levels of heavy metals in environment. Thus, a serious notification to industrial and manmade pollution, which can lead to ecosystem and food chain contamination.

Recommendations

- The general research environment in fisheries sector must be improved, through technical support; instruments availability, trained technicians, and laboratories equipments and collaboration
- Raise the environmental awareness of the community, through mass media, and in schools and universities.
- Environmental laws must be enforced and applied effectively, to protect the environment.

References

[1] Alabaster, J.S. and D.R. LLOY, 1994.Water quality criteria for fresh waterfish. Moscow, pp: 25.

[2] BENDICHO, C. and LAVILLA, I. 2003. Ultrasound-assisted metal extractions. Encyclopedia of Separation Science 3: 4421-4426.

[3] BoletinOficial Del Estado (1991). Separates delBoletinOficial del Estado Espanol No. 195. Gaceta de Madrid, P: 27154. In: Schumacher, M. and Domingo, J. L. (1996).

[4] Bols, N.C., J.L. Brubacher, R.C. Ganassin, L.E.J. Lee, 2001.Ecotoxicology and innate immunity in fish. Dev. Comp. Immunol., 25(8): 853-873

[5] BOYLE, J.F., ROSE, N.L., APPELBY, P.G. and BRIKS, H.J.B. 2004. Recent Environmental Change and Human Impact on Svalbard: The Lake-Sediment Geochemical Record. Journal of Paleolimnology 31: 515-530.

[6] Burden VM, Sandheinrich CA, Caldwell A. 1998 Effects of lead on the growth and alpha amino levulinic acid dehydrates activity of juvenile rainbow trout, Oncorhynchusmykiss. Environmental Pollution 101: 285-289.

[7] Egbal O. Ahmed, Determination of Cadmium and Lead in Fish Tissues and Water from Khartoum City Sudan Research Journal of Fisheries and Hydrobiology, 5(1): 39-43, 2010

[8] Egyptian Organization for Standardization and Quality Control (EOSQC). 1993. Maximum residue limits for heavy metals in food. Ministry of Industry.No. 2360/1993.PP. 5.

[9] FAO, 1975. Biological effects of pollution, reports and studies Vol. 3 No 187, pollution and fisheries. Rome, Italy

[10] FAO/WHO (1992) Food Monitoring and Assessment Programmed, WHO, Geneva 5, UNEP, Nairobi. 52. Report of the Third Meeting of the GEMS/Food

[11] Marouf HA, Dawoud AS. 2006. Evaluation of heavy metals content in fresh water Crayfish in Damietta. Journal l of Veterinary Medical Association, Egypt 66:217-225.

[12] Nevo E, Noy R, Lavie B, Beiles A, Muchtar S.1986.Genetic diversity and resistance to marine pollution. Biological Journal of the Linnean Society 29: 139-144.

[13] Nimmo DR, Rigby RA, Bahner LH, Sheppard JM. 1978. The acute and chronic effects of cadmium on the estuarine mysid Mysidopsisbahia. Bulletin of Environmental Contamination and Toxicology 19: 80–85.

[14] Seddek AS, Salem DA, El-Sawi NM, Zaky ZM. 1996. Cadmium, lead, nickel, copper, manganese and flourine levels in River Nile fish. Assiut Veterinary Medical Journal, Egypt 35: 95-102.

[15] Waldorn HA, Stofen S. 1974. Sub-clinical lead poisoning. Academic Press, New York, pp: 1-224

[16] World Health Organization (WHO). 1984. Guidelines for drinking water quality. WHO, Geneva, No.111.

[17] World Health Organization, 1973.The hazard to health and ecology effects of present substance in the environmental ICP/CEP, 101(3).