MONITORING OF HEAVY METAL RESIDUES IN SOME FRESHWATER FISHES IN GIZA GOVERNORATE

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Abstract

Five Nile fishes namely *Oreochromis niloticus, Bagrus bayad,* Synodontis (Schall or niloticus), *Clarias lazera* and *Mugil cephalus* were collected from fish resources in Giza Governorate. Samples from each were weighed and muscles were digested and analyzed for lead, cadmium, copper and zinc. The levels of Pb residues were 0.02, 0.03, 0.02, 0.06 and 0.14 ppm in *Oreochromis niloticus, B. bayad,* Synodontis sp., *Cl. lazera* and *Mugil cephalus,* respectively. The levels of Cd residues were 0.10, 0.13, 0.18, 0.24 and 0.29 ppm, in *Oreochromis niloticus, B. bayad,* Synodontis sp., *Cl. lazera* and *Mugil cephalus,* respectively. The levels of Cu residues were 0.04, 0.06, 0.03, 0.03 and 0.03 ppm, in *Oreochromis niloticus, B. bayad,* Synodontis sp., *Cl. lazera* and *Mugil cephalus,* respectively. The levels of Zn residues were 0.22, 0.42, 0.16, 0.27 and 0.75 ppm in *Oreochromis niloticus, B. bayad,* Synodontis sp., *Cl. lazera* and *Mugil cephalus,* respectively. The results indicated an increased bioaccumulation of heavy metals in *Clarias lazera* sp. and *Mugil cephalus* sp with lead and cadmium compared with other three species, in addition to zinc in Mugil sp. The results are discussed with other previous reports and their hazardous health effects.

INTRODUCTION

Water pollution is a very critical environmental problem facing public health authorities. Industrial pollution of surface water, especially with heavy metals is among the most important health significance for man and animals consuming such water.

Heavy metals and their salts constitute the most widely distributed group of highly toxic and long-retained pollutants. They are commonly found in effluents discharging from metal processing factories and mining products. Chemical and sewage sludge effluents have higher levels of heavy metals that might cause pollution potential to freshwater resources.

On the contrary of most pollutants, heavy metals are not biodegradable or very slowly degraded, and they undergo ecological cycling in which natural water are the main pathway. Thus, heavy metals have a great ecological significance due to their cumulative toxic behaviour and harmful effect on aquatic life (Draz *et al.*, 1993).

Heavy metals have a higher tendency to be incorporated into food chains and might become accumulated in tissues and organs of fish and other aquatic organisms in concentrations higher than those in water, and this represents serious health hazards to human consumers (Draz *et al.*, 1993). Fish might be considered as a biological indicator of the degree of heavy metals pollution in water resources.

The present study was conducted to determine the heavy metal contamination of different types of fishes at the region of Giza Governorate.

MATERIALS AND METHODS

Five Nile fishes, *Oreochromis niloticus*, *Bagrus bayad*, Synodontis, (Schall or niloticus), *Clarias lazera* and *Mugil cephalus* were collected from some freshwater resources in Giza Governorate. The analysis of fish muscles was carried out by dry ashing procedure (Analytical Methods for Atomic Absorption Spectrophotometer, 1982). Fish muscles were excised and placed into crucible, then dried at 135°C for 2 hours. Dried samples were placed into muffle furnace and dry, ashed at 500°C for 12 hours. Ashed materials were cooled to room temperature and dissolved by 2 ml conc. HNO3, then, evaporated on warm hot plate till dryness. The ashed materials were placed again into the muffle furnace at 500°C for 1 hour. After cooling, the nitric acid treatment was repeated to obtain clean practically carbon free ash. Ashed materials were dissolved in 10 ml of 1 N HCl on a hot plate. The dissolved sample was made up to volume (25 ml) with 1 N HCl. Quantitative determination of heavy metals in fish samples was carried out using Air, Acetylene flame Atomic Absorption Spectrophotometer (UNICAM 696 AA spectrophotometer) for determination of lead, (Pb), cadmium (Cd), Copper (Cu) and zinc (Zn) levels in examined fish samples.

RESULTS AND DISCUSSION

The recorded results of lead concentrations in fish muscles (0.02 ± 0.002 ppm) collected from G_1 *O. niloticus* were within the permissible limits intended by MAFF (1979) in England, Julshamn (1983) in New Zealand, Boletin Official del Estado (1991) in Spain, FAO/WHO (1992) and Egyptian Organization for Standarization and Quality Control EOSQC (1993) in Egypt. The same recorded in different fish samples in G_2 (Bagrus bayad) (0.03 ± 0.005 ppm), G_3 (Synodontis) (0.02 ± 0.005 ppm), G_4 (*Clarias lazera*) (0.06 ± 0.01 ppm) but increased than the permissible limit, in G_2 *Mugil cephalus* fish samples (0.14 ± 0.009 ppm) in which higher than the EOSQC (1993) in Egypt (Table, 2). Low lead levels in muscles of *O. niloticus* sp. were reported in many areas in Egypt such as reported by El-Nowafi (1998), it is concluded that low lead levels may be attributed to the collection of fish samples from areas far from industrial discharges. In addition, Seddek *et al.* (1996) recorded higher lead level in *C. lazera* (0.45 ± 0.01 ppm), *B. bayad* (0.12 ± 0.01 ppm) and Synodontis sp. schall (0.64 ± 0.2 ppm) and Abd El-Kader *et al.* (1993) where lead levels in Mugil sp. ranged from 0.29 ± 0.42 µg / gm wet weight attributed to possible pollution through agricultural and industrial resources at Assuit Governotrate.

The cadmium concentration in fish samples (muscles) collected from *O. niloticus* (0.10 ± 0.004 ppm) were within the permissible limits intended by EOSQC (1993) and Boletin Official del Estado (1991) in Spain, but increased than the permissible limits of FAO/WHO (1992) which is 0.05 (ppm), the contrary high levels were recorded in different fish samples in G_2 Bagrus Bayad (0.13 ± 0.004 ppm) and G_3 (Synodonitis) 0.18 ± 0.004 ppm, *Clarias lazera* (0.24 ± 0.004 ppm) and *Mugil cephalus* (0.29 ± 0.006 ppm).

They exceed than the permissible limit intended by FAO/WHO (1992) which is 0.05 ppm and that intended by EOSQC (1993) which is 0.1mg/kg, but within the permissible limit intended by Boletin Ofiicial del Estado (1991), in Spain which is (1.0 µg / g) (Table, 2).

The obtained results of cadmium concentrations in fishes nearly agreed with the levels detected by Abd El-Nasser *et al.* (1996) where cadmium showed its highest concentration in muscles of *O. niloticus* 0.070 and 0.045 ppm in winter and (0.150 and

0.049 ppm) in summer, and disagreed with Abd El-Kader *et al.* (1993) results in muscles of *Clarias lazera* in Assuit (0.560 and 0.290 ppm) in winter, and (0.189 and 0.127 ppm) in summer disagreed with Seddek *et al.* (1996) who recorded fluctutating concentration of cadmium in muscular tissue in levels of 0.26 ± 0.01 ppm in *O. niloticus*, (0.33 ± 0.01 ppm) in *C. lazera*, (0.33 ± 0.02 ppm) Synodontis schall and (0.39 ± 0.02 ppm) in *B. bayed.* Abd El-Kader *et al.* (1993) recorded that cadmium levels in Mugil species ranged from 0.03 - 0.05 μg/g wet weight. From the obtained findings low concentration of cadmium in fish muscles may be attributed to the low cadmium level in water and/or the short time of exposure to cadmium. The obtained data of copper concentration in fishes of different groups (Table 1) 0.04 ± 0.005, 0.06 ± 0.01, 0.03 ± 0.001, 0.03 ± 0.004 and 0.03 ± 0.003 ppm were under the maximum permissible levels recommended by Food Stuffs Cosmetics and Disinfectants (1972) and Boletin Oficial del Estado (1991) which is 20.0 ppm. Higher Copper values than our recorded results in Table 1 were estimated by Seddek *et al.* (1996) in five Nile fishes *Oreochromis niloticus*, *Clarias lazera*, Synodontis sp. schall and *Bagrus bayad* collected from fish resources. The calculated level of copper was 4.22, 5.55, 3.78 and 1.68 ppm, respectively. The recorded low level of Copper in Mugil species fish disagreed with that detected by Abd Elkader (1993) where the detected copper level in the examined fish samples in Mugil species lies between 0.58 and 0.97 μg/g wet weight. Copper is essential metal in a number of enzymes. Copper discharged into the water can enter the food chain, be bioaccumulated by fish, and hence, becomes a threat to man. In addition, Daoud *et al.* (1999) recorded higher copper levels in examined fish samples (*O. niloticus*) from three industrial polluted areas in Egypt where level of Copper ranged between 7.040, 0.330 and 2.714 ppm from Helwan, Kaha and Kafr El-Zayat, respectively. From the obtained findings, it is achieved that copper bioaccumulation in fishes was not so remarkable.

The recorded levels of zinc concentration in different groups of fish species G_1, G_2, G_3 and G_4. 0.22 ± 0.05, 0.42 ± 0.06, 0.16 ± 0.02 and 0.27 ± 0.03 ppm (Table 1) were under the maximum permissible levels recommended by Food Stuffs, Cosmotics and Disinfectants (1972) and Food Standard Committee FSC in Eromosele *et al.* (1995) which is 50 ppm. The recorded low level of zinc in *O. niloticus* sp. disagreed with Daoud *et al.* (1999) reported higher zinc levels in examined fish samples *O. niloti-*

cus sp. The recorded zinc levels were 13.656, 8.903 and 10.367 ppm, respectively attributed to environmental pollution in these areas in Egypt.

The recorded levels of zinc in examined fish samples Mugil sp. (0.75±0.21 ppm) disagreed with Abd El-Kader *et al.* (1992) where zinc in the examined fish samples Mugil sp. ranged from 4.47 to 7.30 μg/g wet weight with an average 5.55 ± 0.43 μg/g wet weight. Zinc is one of the most abundant essential trace elements in human body. The toxic dose is likely to be higher, however, the discharged zinc in water can be bioaccumulated by fish and the metabolism of human especially children may be affected.

The obtained results of copper and zinc coincided with Clark (1989) who stated that, although fish from areas known to be contaminated contain higher concentration of copper and zinc than those from uncontaminated, copper and zinc do not generally accumulate in food chains and do not make any hazard toxicity to man.

In conclusion, the variation of Pb, Cd, Cu and Zn concentration between the results here and other levels recorded by previous investigators may be attributed to the different fish species, localities, time of sample collection, the analytical procedures as well as the degree of environmental pollution.

Table 1. Heavy metal concentrations ppm in fish samples from different areas in Giza Governorate (n = 10).

Samples	Lead	Cadmium	Copper	Zinc
Oreochromis niloticus	0.02 ± 0.002^{A}	0.10 ± 0.004^{A}	0.04 ± 0.005^{A}	0.22 ± 0.05^{A}
Bagrus bayad	0.03 ± 0.005^{B}	0.13 ± 0.004^{aB}	0.06 ± 0.01^{aB}	0.42 ± 0.06^{B}
Synodontis sp.	0.02 ± 0.005^{C}	0.18 ± 0.004^{abc}	0.03 ± 0.001^{bc}	0.16 ± 0.02^{C}
Clarias lazera	0.06 ± 0.01^{abcD}	0.24 ± 0.004^{abcD}	0.03 ± 0.004^{b}	0.27 ± 0.03^{D}
Mugil cephalus	0.14 ± 0.009^{abcd}	0.29 ± 0.006^{abcd}	0.03 ± 0.003^{b}	0.75 ± 0.21^{abcd}
F- Calculated	6.9854#	11.2654#	9.6845#	7.9854#

Significantly different using F-test at $P < 0.05$

Aa, Bb, Cc, Dd significantly difference against capital litter using LSD at $P < 0.05$

Table 2. Recommended international levels of heavy metals in fishes.

Metal	Reference	Permissible limits	Country and References
Lead (Pb)	WHO (1984)	0.1 mg/kg	Egypt: Egyptian Organization for Standardization and quality Control "E.O.S.Q.C." (1993).
		0.5 ppm	FAO/WHO (1992).
		2.0 mg/kg	England: MAFF (1979).
		4.0 µg/g	New Zealand, In: Julshamn (1983).
		5.0 µg/g	Spain: Boletin Oficial del Estado (1991). In: Schuhmacher and Domingo (1996).
Cadmium (Cd)	WHO (1984)	0.05 ppm	FAO/WHO (1992).
		0.1 mg/kg	Egypt: "E.O.S.Q.C." (1993).
		1.0 µg/g	Spain: Boletin Oficial del Estado (1991). In: Schuhmacher and Domingo (1996).
Copper (Cu)	WHO (1984)	20.0 ppm	Food Stuffs, Cosmetics and Disinfectants (1972).
		20.0 µg/g	Spain: Boletin Oficial del Estado (1991). In: Schuhmacher and Domingo (1996).
Zinc (Zn)	WHO (1984)	50.0 ppm	Food Stuffs, Cosmetics and Disinfectants (1972).
		50.0 mg/kg	England: Food Standard Committee "FSC" In: Eromosele *et al* . (1995).

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أستبيان مستويات المعادن الثقيلة فى بعض أسماك المياه العذبة فى محافظة الجيزة

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تعد معادن الرصاص والكادميوم والنحاس والزنك من أهم الملوثات التى نشأت وواكبت التطور الصناعى مما دفعنا الى تحديد مستويات هذه العناصر فى خمسة انواع مختلفة من الاسماك بنهر النيل هى: البلطى وقشر البياض والشال والقرموط والبورى. وكانت نسبة العناصر بالترتيب ٠,٠٢، ٠,٠٣، ٠,٠٢، ٠,٠٦، ٠,١٤ جزء فى المليون، ٠,١٠، ٠,١٣، ٠,١٨، ٠,٢٤، ٠,٢٩ جزء فى المليون، ٠,٠٤، ٠,٠٦، ٠,٠٣، ٠,٠٣، ٠,٠٣ جزء فى المليون، ٠,٢٢، ٠,٤٢، ٠,١٦، ٠,٢٧، ٠,٧٥ جزء فى المليون. كما اثبتت النتائج أن اعلى نسبة تلوث بالرصاص والكادميوم كانت فى أسماك القرموط والبورى بالمقارنة بالمجاميع الثلاثة وكذلك أعلى نسبة تلوث بالنحاس فى اسماك البورى.

تم مناقشة النتائج ومقارنتها بالحدود المسموح بها من قبل منظمة الصحة العالمية. وأوصى الباحثون بضرورة منع أى مصدر تلوث للمياه حيث أن المياه تعد مصدراً هاماً لوصول هذه الملوثات الى الانسان والحيوان.