

HEAVY METAL RESIDUES IN SOME FRESH EGYPTIAN FISHES

NOHA, R. M. ABD-EL-FATAH and GHADA, S.E. SALEM

Food Hygiene department Animal Health Research Institute-Dokki- Giza

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SUMMARY

A total of one hundred and twenty fresh fish samples were randomly collected from Giza and Cairo markets (60 of each; 20 of *Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed*) to estimate the concentration of Mercury(Hg), lead(Pb), cadmium(Cd), and zinc(Zn). Residues in flesh of the above mentioned fresh water fishes were estimated by using Atomic Absorption Spectrophotometer (AAS).

The obtained results indicated that the mean values \pm S.E of Hg in examined *Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed* were (2.2 \pm 0.26 and 2.1 \pm 0.92, 2.01 \pm 0.71 and 1.1 \pm 0.88, 0.115 \pm 0.015 and 0.021 \pm 0.042 ppm) in Giza and Cairo Governorates respectively. Also Pb residues were (1.015 \pm 0.5 and 1.1 \pm 0.84, 1.8 \pm 0.61 and 1.9 \pm 1.01, 1.12 \pm 0.13 and 0.321 \pm 0.14 ppm) respectively. While the Cd values were (0.85 \pm 0.11 and 1.09 \pm 0.416, 3.1 \pm 0.72 and 2 \pm 0.92, 2.51 \pm 1.51 and 0.62 \pm 0.32 ppm) respectively. Concerning Zn

values, they were (12.72 \pm 1.21 and 10.2 \pm 0.51, 12.05 \pm 1.15 and 10.7 \pm 0.63, 11.02 \pm 0.5 and 10.86 \pm 0.119 ppm) respectively.

The obtained data were evaluated according to the permissible limits of FAO/WHO (1992) and E.S.S No.2360 issued by Egyptian Organization for Standardization and Quality Control (EOSQC) (1993). The public health significance and suggested precautions for minimizing the level of such heavy metals in food were discussed.

INTRODUCTION

Fish had long been regarded as a desirable and nutritional source of high quality protein and generous supply of minerals and vitamins. In recent years, the attention of the public has been focused on the possible danger of heavy metal poisoning in human due to consumption of contaminated fish. Water pollution by heavy metals results from pouring of the effluent of sewage and various fac-

tores in the Nile, as well as agricultural drainage waters and fish absorb heavy metals from such water through gills, skin and digestive tract. (Cappon, 1987; Shakweer, 1998)

Heavy metals are recognized as accumulative toxic substances due to low elimination rates from the body. Most of these pollutants are toxic and cause serious health hazard to man depending on their levels of contamination (Frag et al; 2000).

Hg, Pb and Cd are considered as toxic elements due to their competition with the essential metal for binding sites and also their interference with sulphydryl groups and structural protein (Ahmed et al., 1993), and it is tran located through the food chain to human, and the nature of its toxicity depends on the chemical form of the element, the dosage, the rout, the frequency and duration of administration (Gough and Shacklette, 1976; Underwood , 1977). Pb causes renal failure and liver damage (Emmerson, 1973), moreover Hg and Cd injurie the kidney and cause impaired kidney function, poor reproductive capacity, hypertension, tumors and hepatic dysfunction. While Zn is considered to be an essential element for metabolic activities of living organisms and it is found in the vertebrate body second to iron in its quantity, also it is a cofactor for number of enzymes as carbonic anhydrase and carboxy peptidase phosphatase (Khangarot and Ray 1987) although its toxic effect takes place when fish exposed to higher levels of contamination than normal (Goyer ,1986). Moreover (Luckey and Venugopal, 1977)

stated that Zn in large concentration causes nephritis and anuria.

The purpose of the present study is to determine concentrations of mercury, lead, cadmium, and zinc in flesh of *Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed* sold in Cairo and Giza Governorates to ensure their safety for human consumption.

MATERIALS AND METHODS

I-Collection of samples:

The present study was carried out on one hundred and twenty fresh water fish samples they were randomly collected from Giza and Cairo markets *Tilapis nilotica*, *Mugil cephalus* and *Bagrus bayed*) to estimate the concentration of Hg , Pb , Cd, and Zn residues using Atomic Absorption Spectrophotometer . All samples were kept separated in clean polyethylene bags and transferred to the laboratory for digestion and analysis.

II- Washing procedure: (El- Mawaff, 1995):

All equipment must be washed and cleaned using deionized water to avoid chemical contamination with trace elements or heavy metals.

III- Sample preparation: (Tüzen et al., 1998):

Flesh of the fish samples were digested using a mixture of HNO₃:H₂SO₄:HClO₄ (4:1:1) V: V: V (20 ml per 2-4g sample) and heating at 80°C for 3hrs. After cooling, 20ml demineralized water

were added. The digest was heated again up to 150°C for 4 hrs and brought to a volume of 25 ml with demineralized water.

VI- Hg, Pb, Cd and Zn standard solution:

The stock standard solutions of the elements (1000 mg/L) were obtained from Merck, Darmstadt, Germany. Working standard solutions for each element were prepared fresh daily.

V-Determination of the concentrations of Hg, Pb, Cd and Zn:

This was carried out by using AI (1200) AURO-RA Atomic Absorption Spectrophotometer. The maximum absorbance was obtained by adjusting the cathode lamps at specific slits and wavelengths as shown in table (1).

RESULTS AND DISCUSSION

Pollution of the environment is one of the most important problem facing human in this century. It includes pollution of water, air and land, but the costs of water pollution have been probably even more difficult to estimate than the costs of air and land pollution (Katyayal and stock, 1993).

Hg is an extremely toxic metal in all its forms, major sources of mercury are the chalk like and electric generating industry (Goyer et al., 1989). Long term exposure of Hg can cause Minmata disease which is manifested by weakness of muscle, loss of vision, impairment of cerebral function; coma and death may occur (Matida et al. 1972). Hg also passes through human placenta causing chromosomal aberrations, neurological damage and teratogenicity of the fetus (Ely, 1970, Koss and Long, 1976, Sorensen, 1991). The recommended human weekly intake of Hg is 0.0033 mg/kg body weight ((EOSQC(No., 2360,

Table (1): Specification of spectrophotometer cathode lamps.

Metal	Wavelength	Slit width
Mercury	253.7	0.5
Lead	217.0	0.7
Cadmium	228.8	0.7
Zinc	319.9	0.7

Table (2) Hg, Pb, Cd and Zn (ppm*) in fresh water fish in Giza governorate (n=20 of each)

Type of fish	Mercury (Hg)			Lead (Pb)			Cadmium (Cd)			Zinc (Zn)		
	Min	Max	Mean ±SE	Min	Max	Mean ±SE	Min	Max	Mean ±SE	Min	Max	Mean ±SE
Tilapia nilotica	1.6	2.8	2.2 ±0.26	0.9	1.13	1.015 ±0.5	0.62	1.08	0.85 ±0.11	20.41	13.52	12.72 ±1.21
Mugil cephalus	2.4	3.1	2.01 ±0.71	0.15	2.4	1.8 ±0.61	2.7	4.5	3.1 ±0.72	21.92	12.4	12.05 ±1.15
Bagrus bayed	0.08	0.15	0.115 ±0.015	0.02	2.45	1.12 ±0.13	2.7	2.88	2.51 ±1.5	20.21	12.6	11.02 ±0.5

Table (3) Hg, Pb, Cd and Zn (ppm*) in fresh water fish in Cairo governorate (n=20 of each)

Type of fish	Mercury (Hg)			Lead (Pb)			Cadmium (Cd)			Zinc (Zn)		
	Min	Max	Mean ±SE	Min	Max	Mean ±SE	Min	Max	Mean ±SE	Min	Max	Mean ±SE
Tilapia nilotica	2.1	3.94	2.1 ±0.92	1.7	2.4	1.1 ±0.84	0.79	1.63	1.09 ±0.416	11.93	21.55	10.2 ±0.51
Nugil cephalus	0.95	1.81	1.1 ±0.88	0.06	4.10	1.9 ±1.01	0.1	2.7	2.0 ±0.92	12.1	20.35	10.7 ±0.63
Bagrus bayed	0.01	0.05	0.021 ±0.042	0.62	1.942	0.321 ±0.14	0.15	1.21	0.62 ±0.32	11.91	20.015	10.86 ±0.119

* ppm=mg/k

1993) and 0.3 ppm/week that is not include more than 0.2 ppm of methyl alcohol WHO (1976).

In tables (2,3) the mean values of residual content of Hg in *Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed* in Giza and Cairo was (2.2 ± 0.26 and 2.1 ± 0.92 , 2.01 ± 0.71 and 1.1 ± 0.088 , 0.115 ± 0.015 and 0.021 ± 0.042 ppm) respectively.

The obtained results were higher than those published by Gajeweska and Naberzyski (1977), USEPA (1982), UNEP (1987), and Gado and El_Medany (2003) who estimated Hg level 0.731ppm in *Oreochromis niloticus* at Kafr El-Sheikh governorate, while lower figures were recorded by Zhou and Wong (2000) who reported Hg concentration in fish collected from pearl River Delta by 17.5-26.7 μ /g, but nearly similar to Tarrig et al. (1994) who reported maximum concentration of Hg in fresh water fish in Pakistan to be 2.301 ppm, Abd-El-Aziz (1996) examined *Tilapia nilotica* in Gharbia Governorate and reported Hg level 2.037ppm and Saleh et al. (1998) reported that Hg concentration in *Tilapia zilli* of Wadi El-Rayan lakes ranged from 2.3 to 3.8 μ /gram.

These results were higher than recommended levels for fish by "EOSQC" NO., 2360(1993) (0.5mg/kg) as methyl mercury., FAO/WHO (1992) (0.5ppm) and FDA (1984) (0.5ppm). While Hg residues were within the permissible

limits in *Bagrus bayed* samples collected from Cairo Governorate.

High Hg levels may be due to high affinity of Hg to fish muscle (Lovett et al., 1972). Hg in muscle appears in form of methyl mercury which is lipid soluble, easily absorbed and distributed through biological system. (Manahan, 1989)

It is obvious that Pb is a major environmental pollutant and it had been incriminated as a cause of accidental poisoning in domestic animals more than any other substance. It accumulates in the body because its low rate of elimination.. Both inorganic and organic Pb compounds are highly toxic and its distribution in tissue depends on the mode of administration and chemical form of the poison.

Pb has been widely used and hazardous exposure to it is quite common through mining, smelting dealing with or using lead containing products.

The classical symptoms of Pb poisoning are colic, anemia and encephalopathy (Chisaolm, 1973). On the other hand, oral manifestation of Pb poisoning includes ulcerative stomatitis, blue gingival lead line and grey spots on buccal mucosa (Bryson, 1989).

The maximum provisional weekly intake from lead Pb for human is 0.05mg/kg body weight

"EOSQC" No., 2360, 1993) and 3 mg/person or 0.05 mg/kg body weight WHO (1972), while Casareit and Doull (1975) reported that the human daily intake of Pb 0.3 mg. Meanwhile, Goyer and Clarkson (2001) reported that dietary intake of Pb was decreased since 1940, as the intake was 4000 to 500 µg/day of American population as the update level is 20 µg/day.

Analytical results of examined fresh water fish (*Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed*) in table (2,3) the mean value of Pb residues were 1.015±0.5 and *Bagrus bayed* in table (2,3) the mean value of Pb residues were (2,3) the mean value of Pb residues were 1.015±0.5 and 0.321±0.14 ppm in Giza and Cairo Governorates respectively.

The tabulated data were higher than results published by Cappon (1987) and El-Nabawi et al. (1987) who recorded that the level of Pb was 0.52 µg/gram in muscle tissue of *Tilapia nilotica*, Abdel-Aziz (1996) reported that *Tilapia nilotica* in Gharbia Governorate contained 0.628 ppm Pb, Soliman and Galab (2001) established that *Tilapia* fish in Manzala lake were contaminated with Pb ranging from 0.5 to 0.7ppm, also Gado and El-Midany (2003) reported Pb residue 0.499 ppm in *Oreochromis niloticus* at Kafr El-Sheikh governorate. But lower than those values recorded by Abou-Donia (1990) (1.662ppm) and Oechlenschlaeger (1990) who stated the mean value of Pb in fish filets in Germany by 11, 22, 16, 25 and 26 mg/kg respectively, while nearly similar results were reported by Shakwer (1998) who recorded Pb level 9.7 ppm in *Oreochromis niloticus* in Mariut lake.

The obtained results were higher than the permissible limits recommended by (EOSQC (1993) (0.1mg/kg) and FAO/WHO (1992) (0.5ppm). High Pb levels in the present study may be due to industrial and agricultural discharges throughout the environment which are the primary source of Pb contamination in fish.

Commission of The European Communities (1978) stated that the usual sources of Cd arises mainly from tobacco smoke industry, or agricultural contamination, the polluted drinking water with Cd produced from plastic and galvanized pipes. Cd is toxic in any chemical form and its ingestion may result in acute gastroenteritis which characterized by sudden onset of vomiting, diarrhea and abdominal pain, death may occur due to renal failure (Buculer et al., 1986).

The results achieved in tables (2, 3) revealed that the mean values of Cd in examined fresh water fish (*Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed*) collected from Giza and Cairo were (0.85±0.11 and 1.09±0.416, 3.1±0.72 and 2.0±0.92, 2.51±1.51 and 0.62±0.32) ppm respectively.

The highest mean value of Cd residue was found in examined Mugil cephalus samples collected from Giza governorate, while the lowest value was found in Bagrus bayed collected from Cairo governorate although this low mean value of Cd was higher than the permissible limits (0.1 mg/kg) in fresh (1993) and frozen fish and those recommended by FAO/WHO (1992) (0.05ppm). The maximum provisional tolerable weekly intake from Cd for human is 0.0067-0.0083mg/kgbody weight ((EOSQC (No., 2360, 1993). Also Goyer and Clarkson (2001) reported that the total daily intake of Cd from food, water and air in North American and Europe varies from 10 to 40 µg/day.

The obtained results were nearly similar to Ochsenschlaeger (1990), Tariq et al. (1991) and Nasser et al. (1996). While were higher than those obtained by Hassan and Youssef (1985) who found that the mean concentration of Cd residues in *Tilapia nilotica* was 0.39 ppm, also, Sheo et al., (1991) reported the mean value of Cd residue in fresh water fish collected from Korea ranged from 0.0139 to 0.052 ppm. Mohamed (1993) reported that the mean concentration of Cd in *Tilapia* located in river Nile at Assiut were 0.293 to 0.589 ppm, Abd-El-Aziz (1996) examined *Tilapia nilotica* in Gharbia governorate and found Cd value was 0.054 ppm and Gado and El-Midany (2003) recorded Cd level in *Oreochromis niloticus* in Kafr El-Sheikh governorate was 0.462 ppm.

Zn is essential micronutrient, one of the most abundant biological trace metals and indispensable elements in growth and reproduction of animals and man. Zn is also an essential trace element for animal, being involved in protein synthesis and as a constituent of many metalloenzymes. Its requirement in animal is generally 35-45µg/g for all domestic species (Underwood, 1977): Zn salts are toxic only in very large doses (Hawk, 1979).

From the obvious results in tables (2,3) the mean concentration of Zn in examined fresh water fish (*Tilapia nilotica*, *Mugil cephalus* and *Bagrus bayed*) was 12.72±1.21 and 10.2±0.51, 12.05±1.15 and 10.7±0.63, 11.02±0.5 and 10.86±0.11 ppm in Giza and Cairo Governorates respectively.

Higher results were obtained by Villarel-Trevino (1986) who reported that the mean value of Zn in 4 species of fresh water fish ranged from 15.33 to 17.62 ppm, Sheo et al. (1991) determined the level of Zn (from 8.68 to 15.214 ppm) in 4 species of fresh water fish collected from Yeoung San river, Korea, Knkle et al., (1997) estimated the mean concentration of Zn (from 40.7 to 85.1 µg/g in fresh fish samples at Gila river, Soon and Ae (1997) Nahung (2000) calculated the concentration of Zn (172.4 ppm) in *Mugil cephalus*, and Canli and Galic (2003).

But lower results were recorded by Shakweer (1998) who examined *Oreochromis niloticus* in Mariut lake for Zn residue which estimated as 6.13 ppm and Gado and El-Midany (2003) reported Zn level (0.685 ppm) in *Oreochromis niloticus* in Kafr El-Sheikh governorate.

The obtained results were within the permissible limits when compared with those reported by Goyer and Clarkson (2001) who mentioned that the average daily intake for Americans is approximately 12 to 15 mg, mostly from food, while ("EOSQC" , 1993) stated the maximum provisional daily intake of Zn in food from 0.3-0.1 mg/kg body weight.

The variation of Hg, Cd, Pb and Zn concentrations in the present study with those recorded by other investigators is logic due to the differences in size of examined fish, season, analytical procedures locality of harvesting as well as environmental pollution. It is necessary to minimize the use of phosphate and sludge for land fertilization as possible and discharges of industrial and agriculture wastes into water must be controlled and proper recycling of industrial wastes is essential. Also programs and regular analysis should be performed for current monitoring of heavy metals in food, air and water in order to have an accurate view about the actual problem and the level of contamination in our environment as a trial to decrease and overcome it .

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