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RESIDUAL ANALYSIS OF SOME HEAVY METALS IN WATER AND *OREOCHROMIS NILOTICUS* FISH FROM POLLUTED AREAS.

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SUMMARY

A total of 30 water samples were collected from three industrial localities in Egypt (Helwan "El-Marazek Bridge", Kaha and Kafr El-Zayat). Ten water samples were collected from each locality near by and at various distances from the outlet of the local industrial establishments. At the same time, 60 *Oreochromis niloticus (O. niloticus)* fishes (20 fishes from each locality) were obtained from the same localities of water samples during the period of summer season in 1998. Lead, cadmium, mercury, copper and zinc levels were determined in both water samples and fish flesh by using Atomic Absorption Spectrophotometer. Moreover, the effect of some heat treatments (frying and roasting) on mercury residues in fish flesh was studied. From the obtained data, it was detected that the highest values of lead, mercury, copper and zinc were found in water samples collected from Kafr El-Zayat, while cadium was detected at its highest level in water samples collected from Kaha district. On the other hand, it was observed that the highest values of heavy metal residues in fish samples were found in Helwan, while mercury was detected at its highest level in fish samples collected from Kafr El-Zayat. Moreover, it was found that frying had a stronger effect than roasting in decreasing the residual level of mercury in fish samples. The obtained data indicated a correlation between accumulation of heavy metals in fishes and its concentrations in water. Public health importance and the hazardous toxic effects of these heavy metals as well as the suggestive recommendations to minimize water and fish pollution with these heavy metals were discussed.

INTRODUCTION

Fish had long been regarded as a nutrition and highly desirable food due to its contribution of high quality animal protein, its richness in calcium and phosphorus as well as its generous supply of vitamins.

In recent years much attention had been paid to the possible danger of metal poisoning in human as a result of consumption of contaminated fishes.

The heavy metals are recognized as toxic substances due to the low rate of elimination from the consumer body. The contamination with heavy metals such as lead, cadmium, mercury, copper and zinc which are widely distributed in the air, agricultural lands and water is possible. Fishes which are obtained from such water, may absorb metals from water through gills, skin and digestive tract. Some of these metals are toxic to virtually every system of the human body and may cause serious healthy hazardous to man depending on their levels of contamination (Luckey and venugopal, 1977). Industrial and agricultural discharges, coal and oil combustion, chemical and chloride plants emissions, aerial fallout, phosphate fertilizers and sludge used on agricultural lands, sewage effluents, some types of plastics and pesticides are considered the primary sources of lead, cadmium and mercury pollutions in fish (EL-Nabawi et al., 1987; Sorensen, 1991; WHO, 1992 and Shibamoto and Bjeldanes, 1993).

Lead: It is recognized as a toxic substance which accumulates in the body due to its low rate of elimination and it is naturally present in soil but its concentration is not constant and varies with depth, where the concentration of lead near the surface is higher than the lower horizons (Swaine and Mitchell, 1960). Lead paint, lead gasoline and lead arsenate contain a large quantities of lead and are possible sources of lead for both man and animal. Chronic lead poisoning is characterized particularly by neurological defects, renal tubular dysfunction and anemia (Underwood, 1977). Its potential carcinogenic nature has also been shown by Zawurska and Medras (1988).

Cadmium: It is apparently non-essential element that is virtually absent from the body of man and mammals at birth and gradually accumulates with age. Air pollution with cadmium from industrial sources (manufacturing of plastics, solder alloys, nickle-cadmium batteries, photocells and rubber tires) may be transmitted to man through contaminated vegetables used as food stuffs (Carstensen and Poulsen, 1974). Many studies revealed that cadmium had a significant role in the incidences of some diseases as diabetes mellitus (Merali and Singhal, 1977), human hypertension (Nishiyama et al., 1986), anemia (Watanabe and Murayama, 1974) and kidney failure (Gracey and Collins, 1992). Surface water that contains more than a few micrograms of cadmium per litre have probably been contaminated by discharges of industrial wastes and other sources like mercury and lead (Commission of the European Communities, 1978).

Mercury: Hg is an extremely toxic metal in all its forms, it is accumulative poison because of the high affinity of tissues to it (Timbrell, 1982). The Minamata Poisoning in Japan in 1953 were responsible for neurological damage, loss of vision, paralysis and death to people consuming fish contaminated with organic mercury, it also passed through placenta causing chromosomal disorders and teratogenicity (Sorensen, 1991), moreover, it causes severe kidney damage in both man and animals (Manahan, 1989).

Copper: It is an essential element for all plants and animals, it is widely distributed and always present in food. It is important in formation of erythrocytes, release of tissue iron, development of bone, central nervous system and connective tissues. Acute exposure to copper causes hypotention, haemolytic anemia and cardiovascular collapse, while chronic exposure resulted in jaundice in human (Gossel and Bricker, 1990).

Zinc: It is distributed in agricultural lands and water. Oral toxication by zinc leads to bloody watery diarrhoea, intense abdominal pain, C.N.S. depression and tremor (Gossel and Bricker, 1990).

The purpose of this study was to determine the concentrations of lead, cadmium, mercury, copper and zinc in water and fish samples (*O. niloticus*) which were collected from some River Nile water resources associated with industrial drainage pollutants in Helwan "El-Marazek Bridge". Kaha and Kafr El-Zayat during the summer season in 1998 and also studying the effect of heat treatments (frying and roasting) on residual concentrations of mercury in examined fish samples to ensure their safety for human consumption.

MATERIAL AND METHODS

(1) SAMPLING:

(A) Collection of water samples:

The water samples were obtained from some River Nile water resources associated with industrial drainage pollutants. Thirty water samples were collected from three industrial localities (Helwan "El-Marazek Bridge", Kaha and Kafr El-Zayat) during the summer season in 1998, whereas ten water samples were collected from each locality at various distances from the outlet of the local establishments.

(B) Collection of fish sampels:-

Sixty fishes (*O. niloticus*) were obtained from the same localities, also during the period of summer season in 1998. Twenty fishes were collected from each locality, their weight ranged from 90 to 200 gram.

At laboratory, the fish samples were washed with deionized water and wrapped separately in acid washed polyethylene bag and were stored frozen at -20°C until analysis was carried out.

(2) PREPARATION AND ANALYSIS OF WATER SAMPLES:

The analysis of water samples was carried out according to A.P.H.A. (1985). The water samples were preserved by the addition of one ml. of concentrated nitric acid per liter until the time of analysis. The water samples were filtered through 0.45µ membrane filter. The required volume (100 ml) of the filterate was collected to measure lead, cadmium, copper and zinc levels in water samples by using Air/Acetylene Flame Atomic Absorption Spectrophotometer (UNICAM 696 AA Spectrometer). Where as Flameless Atomic Absorption Spectrophotometer equipped with (MHS) mercury hydride system "Cold Vapour Technique" was used for determination of mercury levels in examined water samples.

(3) PREPARATION AND ANALYSIS OF FISH SAMPLES:

Procedure (A): Each fish sample was represented by one gram of flesh dissected from the axial muscle behined the head after removal the scales at this region, then placed in a clean screw-capped tube and digested according to the method described by Finerty et al. (1990). The obtained solutions were then analyzed by using Air/Acetylene Flame Atomic Absorption Spectrophotometer (UNICAM 696 AA Spectrometer) for determination of lead (Pb), cadmium (Cd), copper (Cu) and zinc (Zn) levels in examined fish samples.

Procedure (B): Because of volatilization of mercury at temperature below 100°C, so this procedure was carried out for mercury determination at minimal temperature for all fish samples. 0.5 gram macerated fish muscle was digested according to the technique described by Diaz et al. (1994). Five milliliters stannous chloride solution were added to the obtained solutions to reduce mercury to elemental form and then analysed by using Flameless Atomic Absorption Spectrophotometer equipped with "MHS" mercury hydried system "Cold Vapour Technique" for measuring the mercury levels in examined fish samples.

(4) APPLICATION OF SOME HEAT TREATMENTS ON FISH:

Heat treatments:

Mercury is volatile at temperature below 100°C (Julshamn, 1983). Both frying and roasting were applied on examined fish smaples as follows:-

a) **Frying**: Frying was applied on sixty fish samples (*O. niloticus*) which were collected from Helwan, Kaha and Kafr El-Zayat to determine the effect of frying on residual concentrations of mercury.

b) **Roasting**: Roasting was applied on sixty fish samples (*O. niloticus*) which were collected from the same three localities to determine the effect of roasting on residual concentrations of mercury.

* The obtained data were statistically analysed according to the methods of Milton and Tsokos (1983).

RESULTS

The obtained results were outlined in table (1,2 and 3). The recommended international levels of heavy metals in water and fishes were summerized in table (4).

Table (1): Heavy metals concentrations (p.p.m.) in water samples from three industrial polluted areas in Egypt.

Source of samples	Metal	No. of examined water samples	Min.	Max.	$\overline{X}$	S.D.	± S.E.	C.V.
Helwan "El-Marazek Bridge"	Pb	10	0.084	0.230	0.184	0.038	0.012	20.652
	Cd		0.003	0.047	0.021	0.016	0.004	76.190
	Hg		0.180	0.403	0.257	0.075	0.024	29.183
	Cu		0.002	0.016	0.007	0.004	0.001	57.143
	Zn		0.046	0.469	0.256	0.139	0.043	54.296
Kaha	Pb	10	0.484	0.700	0.546	0.069	0.022	12.637
	Cd		0.021	0.044	0.037	0.006	0.002	16.216
	Hg		0.160	0.353	0.253	0.062	0.019	24.505
	Cu		N.D	N.D	N.D	N.D	N.D	N.D
	Zn		0.175	0.350	0.243	0.057	0.018	23.456
Kafr El-Zayat	Pb	10	0.464	0.789	0.648	0.096	0.030	14.815
	Cd		0.020	0.051	0.033	0.008	0.002	24.242
	Hg		0.260	0.395	0.326	0.053	0.017	16.257
	Cu		0.755	0.995	0.890	0.109	0.034	12.247
	Zn		1.920	3.670	2.811	0.512	0.162	18.214

p.p.m.: Part Per Million, Pb. Lead, Cd: Cadmium, Hg: Mercury, Cu: Copper, Zn: Zinc, Min.: Minimum values, Max.: Maximum values, $\overline{X}$: Mean values, S.D.: Standard Deviation, ± S.E.: Standard Error, C.V.: Coefficient of Variation.

C.V. = $\frac{S.D}{\overline{X}}$ x100, N.D: Not Detected.

Table (2): Heavy metals concentrations (p.p.m.) wet weight in fish muscles (*O. niloticus*) from three industrial polluted areas in Egypt.

Source of samples	Metal	No. of examined Fish samples	Min.	Max.	$\overline{X}$	S.D.	± S.E.	C.V.
Helwan "El-Marazek Bridge"	Pb	20	4.320	10.231	8.352	1.677	0.375	20.079
	Cd		2.712	6.017	4.631	1.064	0.238	22.975
	Hg		0.510	0.991	0.775	0.122	0.027	15.741
	Cu		6.200	8.250	7.040	0.606	0.136	8.607
	Zn		9.000	17.335	13.656	2.873	0.643	21.038
Kaha	Pb	20	2.005	3.974	2.904	0.569	0.127	19.593
	Cd		0.382	0.523	0.467	0.046	0.014	9.850
	Hg		0.474	0.974	0.768	0.155	0.035	20.182
	Cu		0.117	0.465	0.330	0.083	0.018	25.151
	Zn		7.980	9.455	8.903	0.531	0.119	5.964
Kafr El-Zayat	Pb	20	3.471	4.216	3.823	0.230	0.051	6.016
	Cd		0.303	0.510	0.417	0.061	0.010	14.628
	Hg		0.895	1.020	0.970	0.045	0.016	4.639
	Cu		1.471	4.216	2.714	0.621	0.139	22.881
	Zn		8.702	12.980	10.367	1.362	0.304	13.137

Table (3): Effect of heat treatments on residual concentrations of mercury (p.p.m.) wet weight in fish muscles (*O. niloticus*) .

Source of samples	No. of examined Fish samples	Heat treatments	Min.	Max.	$\overline{X}$	S.D.	± S.E.	reduction rate %
Helwan "El-Marazek Bridge"	20	Raw samples (not treated)	0.510	0.991	0.775	0.122	0.027	—
		Fried samples	0.235	0.454	0.328	0.070	0.016	57.67%
		Roasted samples	0.270	0.563	0.448	0.079	0.018	42.20%
Kaha	20	Raw samples (not treated)	0.474	0.974	0.768	0.155	0.035	—
		Fried samples	0.220	0.430	0.301	0.069	0.015	60.80%
		Roasted samples	0.380	0.560	0.456	0.057	0.012	40.62%
Kafr El-Zayat	20	Raw samples (not treated)	0.895	1.020	0.970	0.045	0.016	—
		Fried samples	0.382	0.530	0.434	0.059	0.013	55.25%
		Roasted samples	0.450	0.710	0.599	0.101	0.022	38.25%

Table 4: Recommended international levels of heavy metals in water and fishes.

Metal	Permissible limits in water	References	Permissible limits in fishes	Country and References
Lead (Pb)	0.050 p.p.m	WHO (1984)	0.1 mg/kg	Egypt: Egyptian Organization for Standardization and Quality Control "E. O. S. Q. C." (1993).
			0.5 p.p.m	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)	0.005 p.p.m	WHO (1984)	0.05 p.p.m	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).
Mercury (Hg)	0.001 p.p.m	WHO (1984)	0.5 p.p.m	FAO/WHO (1992).
			0.5 mg/kg	Egypt: "E.O.S.Q.C." (1993) as methyl mercury
			1.0 µg/g	Spain: Boletin Oficial del Estado (1991). In: Schuhmacher and Domingo (1996).
Copper (Cu)	1.000 p.p.m	WHO (1984)	20.0 p.p.m	Food Stuffs, Cosmetics and Disinfectants (1972).
			20.0 µg/g	Spain: Boletin Oficial del Estado (1991). In: Schuhmacher and Domingo (1996).
Zinc (Zn)	5.000 p.p.m	WHO (1984)	50.0 p.p.m	Food Stuffs, Cosmetics and Disinfectants (1972).
			50.0 mg/kg	England: Food Standard Committee "FSC." In: Eromosele et al. (1995).

N.B: p.p.m.= µg/g= mg/kg.

DISCUSSION

Toxic metals are naturally present in the environment and industrial processes which resulted in an increased concentration of heavy metals in the air, water and soil. The present study was concerned with the pollution of River Nile water with heavy metals through the drainage of some industrial establishments and the implication of this problem on the tissue burden of metals in fishes especially *O.niloticus* in Egypt.

Lead: Data displayed in table (1) and (2) recorded the range and the mean values ± S.E. of lead in water and fish samples, respectively which collected from Helwan, Kaha and Kafr El-Zayat.

The obtained data of lead concentrations in water which collected from Helwan (Table 1) were nearly agreed with that detected by Tantawy (1997)in water from Qaroun lake. Also lead concentrations in water which collected from Kaha and Kafr El-Zayat (Table 1) were nearly similar to the findings reported by Abd El-Kader et al. (1993) in water of six fish ponds in the region of Bahr El-Bakar, Sharkia Governorate. From the illustrated results which tabulated in table (1), it was found that the lead concentrations in water were higher than the permissible limits which recommended by WHO (1984) in table (4).

The recorded results of lead concentrations in fishes collected from Helwan in table (2) were higher than the permissible limits intended by MAFF (1979) in England, Julshamn (1983) in New Zealand, Boletin Oficial del Estado (1991) in Spain, FAO/WHO (1992) and Egyptian Organization for Standardization and Quality Control "E.O.S.Q.C". (1993) in Egypt, in table (4) and also higher than the findings recorded by Mohamed (1993) in fishes collected from Assiut City. Lead levels in fishes collected from Kaha and Kafr El-Zayat (Table 2) were within the permissible limits intended by Julshamn (1983) in New Zealand and Boletin Oficial del Estado (1991) in Spain; but were higher than the recommended levels intended by MAFF (1979) in England, FAO/WHO (1992) and "E.O.S.Q.C." (1993) in Egypt (Table 4).

Low lead levels in muscles of *Tilapia sp.* were reported in many areas in Egypt such as: Sharkia Governorate "Abbassa farm" (El-Kelish, 1995); El-Manzala lake (EL-Mowafi, 1995), Assuit Governorate (Seddek et al., 1996), Abbassa aquaculture ponds, Qaroun lake and Wadi Al-Raiyan lake (Tantawy, 1997). From the present study, it is concluded that the low lead levels which were reported by some authoress may be attributed to the collection of fish samples from areas far from industrial discharges, but high lead findings in the present data may be due to the collection of water and fish samples from areas subjected to motor cars (high gasoline consumption), industrial discharges (battries factories, steel and iron factories and coal factories in Helwan and canned food factories in Kaha) and agriculture discharges (super phosphate fertilizers) which are the primary sources of lead poisoning in fish in Egypt. These findings concides with those reported by El-Nabawi et al. (1987).

Cadmium: Data presented in table (1) and (2) showed the range and the mean values ± S.E. of cadmium in water and fishes (*O. niloticus*), respectively which collected from the same three localities.

The recorded results of cadmium concentrations in water (Table 1) were agreed with the findings which reported by Tantawy (1997) in water of Wadi Al-Raiyan and Abd El-Kader et al. (1993) but the obtained data in table (1) were higher than the recommended limits of WHO (1984) in table (4).

The obtained results of cadmium concentrations in fishes collected from Helwan were nearly similar to the findings detected by Oehlenschager (1990). Also the recorded data of cadmium concentrations in fishes collected from Kaha and Kafr El-Zayat in table (2) were within the permissible limits of Spain which intended by Boletin Oficial del Estado (1991) in table (4) and agreed with the findings reported by El-Safy (1996) in *Tilapia sp*, from El-Manzala lake. It was detected that the obtained data of cadmium concentrations in fishes in table (2) were higher than the permissible limits of FAO/WHO (1992), "E.O.S.Q.C." (1993) in table (4) and also higher than the levels which detected by Abd El-Kader et al. (1992) in *Mugil sp.* and Tantawy (1997) in *Tilapia sp.* and lower than the values which detected by Kruse and Kruger (1984).

From the obtained findings it is achieved that the low concentrations of cadmium in water which reported by some authoress may be attributed to the low level of cadmium in water and/or the short time of exposure to cadmium. On the other hand, the low levels of cadmium in fish muscles may result from elevated concentrations of cystine and methionine than other proteins (Beveridge, 1947). Absence of sulph-hydryl groups in the sulphur rich amino acids probably play a role in decreasing cadmium binding in skeltal muscle. The degree of association of fresh water fish with sediments seems to play a critcal role in cadmium accumulation. High cadmium findings in the present study may be attributed to the collection of water and fish samples from areas exposed to industrial pollutions such as nickle-cadmium batteries, rubber tires, coal and steel and iron factories which found in Helwan and Kafr El-Zayat.

Mercury: Data displayed in table (1) and (2) pointed out the range and the mean values ± S.E. of mercury in water, and in fishes respectively from the same three localities, while the data illustrated in table (3) showed the effect of heat treatments on mercury concentrations in fish flesh (*O.niloticus*).

The present results of mercury concentrations in water (Table 1) were higher than the permissible limits recommended by WHO (1984) in table (4) and also higher than the data obtained by Tantawy (1997), while they were lower than the findings which reported by Abd El-Kader et al. (1993). The present data of mercury concentrations in fishes in table (2) were within the permissible limits of Spain in table (4) which intended by Boletin Oficial del Estado (1991). The obtained data of fish smaples collected from Kaha and Kafr El-Zayat were nearly agreed with the findings reported by Tantawy (1997) in fishes from Abbassa aquaculture ponds and Diaz et al. (1994), respectively. Low values of mercury in fishes were recommended by FAO/WHO (1992) and "E.O.S.Q.C." (1993) in table (4), but higher values of mercury in fishes than the recorded results in table (2) were estimated by Abd El-Kader et al. (1993).

Mercury values in fishes collected from Helwan, Kaha and Kafr El-Zayat after heat treatments (Table 3) were within the permissible limits intended by Boletin Oficial del Estado (1991) in Spain, FAO/WHO (1992) and "E.O.S.Q.C." (1993) in Egypt, except fish smaples (roasted sampels) collected from Kafr El-Zayat were higher than the permissible limits of FAO/WHO (1992) and "E.O.S.Q.C." (1993).

From the obtained data in table (3), it could be concluded that the reduction rate of fried samples were higher than the reduction rate of roasted samples. So frying the fishes are the best than roasting the fishes in decreasing the residual mercury concentrations in fish flesh. These resutls were agreed with the data recorded by Sallam (1997).

In the present work, the high level of mercury in water and fishes may be attributed to the increasing in use in various industrial process such as batteries factories and Kafr El-Zayat factories for pesticides and chemicals in kafr El-Zayat and much of it escapes as organic and inorganic compounds to water. Meanwhile, the most notorious mercury compounds in the environment are monomethyl and dimethyl salt of mercury which are soluble. They are produced from inorganic mercury in sediment by anerobic bacteria through the action of methyl-cobalamine and intermediate in the synthesis of methane and get into natural water (Manahan, 1989), also the elevation of mercury concentrations in fish samples have been attributed to high affinity of mercury to muscle tissues of fishes (Lovett et al., 1972). The average(88.9%) of total mercury in fish musculature was in the form of methyl mercury (Bishop and Neary, 1974) which are lipid soluble and easily absorbed and distributed through biological system (Manahan, 1989). Mercury is a reactive element and its toxicity is probably due to its reaction with proteins. It binds to sulph-hydryle groups in protein (Rossi and Santaroni, 1976).

Copper: The findings set out in table (1) and (2) revealed the range and the mean values ± S.E. of copper in water and fishes which were collected from Helwan, Kaha and Kafr El-Zayat.

The copper concentrations in water from Helwan (Table 1) were lower than the maximum permissible limits recommended by WHO (1984) in table (4), also low copper concentrations in water were recorded by Tantawy (1997) and Abd El-Kader et al. (1993) but copper concentrations in water from Kafr El-Zayat (Table 1) were within the recommended limits intended by WHO (1984). The obtained data of copper concentrations in fishes (*O.niloticus*) in table (2) were under the maximum permissible limits which recommended by Food Stuffs Cosmetics and Disinfectants (1972) and Boletin Oficial del Estado (1991) in Spain (Table 4). Nearly similar values of copper were detected by Sallam (1997) in muscles of *Clarias lazera* and in *Tilapia sp.* from Zagazig City, but higher copper values than the recorded results in table (2) were estimated by

Tantawy (1997) in *Tilapia sp.*

Zinc: Data displayed in table (1) recorded the range and the mean values ± S.E. of zinc in water samples which were collected from River Nile water resources in Helwan, Kaha and Kafr El-Zayat and in fish muscles (*O.niloticus*) from the same localities (Table 2).

The obtained results of zinc in water (Table 1) were under the maximum permissible limits which intended by WHO (1984) in Table (4) but the recorded results of zinc in water samples which were collected from Kaha concided with the findings reported by Abd El-Kader et al. (1993). Low zinc levels in water were estimated by Tantawy (1997). Zinc concentrations in fish muscles (*O.niloticus*) in table (2) were under the maximum permissible limits which recommended by Food Stuffs, Cosmetics and Disinfectants (1972) and Food Standard Committee "FSC" of England; Eromosele et al. (1995) in table (4), while zinc levels in *O.niloticus* which were collected from Kaha were nearly agreed with the findings detected by Sallam (1997) in *Tilapia sp.* from Kafr El-Zayat City. Low zinc values in *Mugil sp.* were estimated by Abd El-Kader et al. (1993) but higher values of zinc than the recorded results (Table 2) in *Tilapia sp.* were reported by Tantawy (1997).

The obtained results of copper and zinc in table (2) revealed that copper accumulation in fishes was not so remarkable. These findings concided with Heth et al. (1966) and Clark (1989) who stated that although fish from areas known to be contaminated, contain higher concentrations 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.

From the obtained data, it was concluded that the highest pollution percent with heavy metals in fishes was found in Helwan, follwed by Kafr El-Zayat and Kaha.

In conclusion, the variations of Pb, Cd, Hg, Cu and Zn concentrations between the results here in and the other levels which recorded by previous investigatores, are considered logical due to the differences in fish species, sizes, localities, time of sample collection, the analytical procedures, as well as the environmental pollution. In the present study, the elevated values of some heavy metals in water and in muscular tissues of *O.niloticus* are an indicator for pollution from industrial drainage. Therefore, the preventive measures intended for minimizing the pollution of water and raw fish with such metals are of significant concern including:

1) Sanitary protection of surface water against heavy metal pollution through governmental plane and periodical examination of water supplies should be done and assessed according to the international standards.
2) Minimizing the use of phosphates and sludge for land fertilization as possible.
3) Regular analysis of raw fish for heavy metal pollution and their load of heavy metals should be evaluated according to the international guide lines as a fruitful advise to delay environmental contamination.

4) Frying or roasting the fishes must be done very well before eating because heat treatments reduce the residual mercury in fish flesh, but frying had a stronger effect than roasting in reducing the residual mercury in fishes.

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