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# HEAVY METAL RESIDUES IN SOME FRESH EGYPTIAN FISHES

By

**Noha, R. M. Abd-El-Fatah and Ghada, S.E. Salem**
Food Hygiene department Animal Health Research Institute-Dokki-Giza

## ABSTRACT

**A total of one hundred and twenty fresh fish samples were randomely collected from Giza and Cairo markets (60 samples; 20 of *Tilapis nilotica, Mugil cephalus and Bagrus bayed "- 20 of each" )* 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±S.E of Hg in examined *Tilapia nilotica, Mugil cephalus and Bagrus bayed* were (2.2±0.26 and 2.1±0.92 , 2.01±0.71 and 1.1±0.88 , 0.115±0.015 and 0.021±0.042 ppm) in Giza and Cairo Governorates respectively .Also Pb residues were (1.015±0.5 and 1.1±0.84 , 1.8±0.61 and 1.9±1.01 , 1.12±0.13 and 0.321±0.14 ppm) respectively. While Cd were (0.85±0.11 and 1.09±0.416, 3.1±0.72 and 2±0.92 , 2.51±1.51 and 0.62±0.32 ppm) respectively. Concerning Zn such values were (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±0.119 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 factories 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 **(Farag 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 sulfhydryl groups and structural protein **(Ahmed et al., 1993)**, and it is trans 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 injuries 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 peptie 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 randomly collected from Giza and Cairo markets (60 samples; as 20 each of *Tilapis nilotica, Mugil cephalus and Bagrus bayed"20 of each"* ) 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 transported to the laboratory for digestion and analysis.

***II- Washing procedure:* (El-Mawafi, 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 $HNO_3$: $H_2SO_4$:$HCLO_4$ (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:***

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

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 |

## 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 **(Katyal and stock, 1993).**

Hg is an extremely toxic metal in all its forms, major sources of mercury are the chalklike industry and electric generating industry **(Goyer et al., 1989),** and 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, 1993) and** 0.3 ppm/week that is not include more than 0.2 ppm of methyl l alcohol **WHO (1976).**

In tables (2,3) the mean values of residual content of Hg in *Tilapia nilotica, Mugil cephal;us 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 17.5-26.7μ/g ,but nearly similar to **Tariq et al. (1994)** who reported maximum concentration of Hg in fresh water fish in Pakistan to be 2.301ppm **,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 μg/gram.

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 ±.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

Fig (1) Hg, Pb, Cd and Zn (ppm) in fresh water fish in Giza governorate

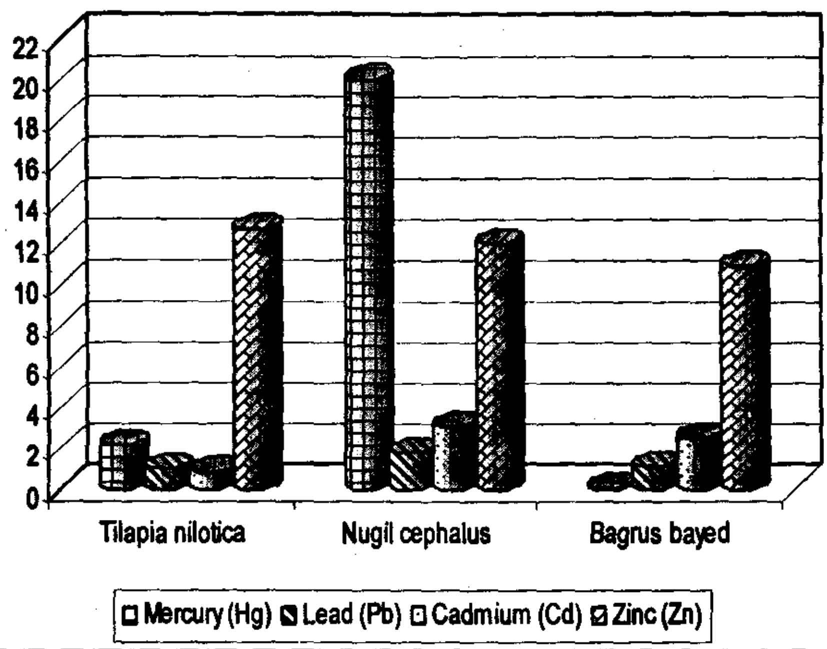
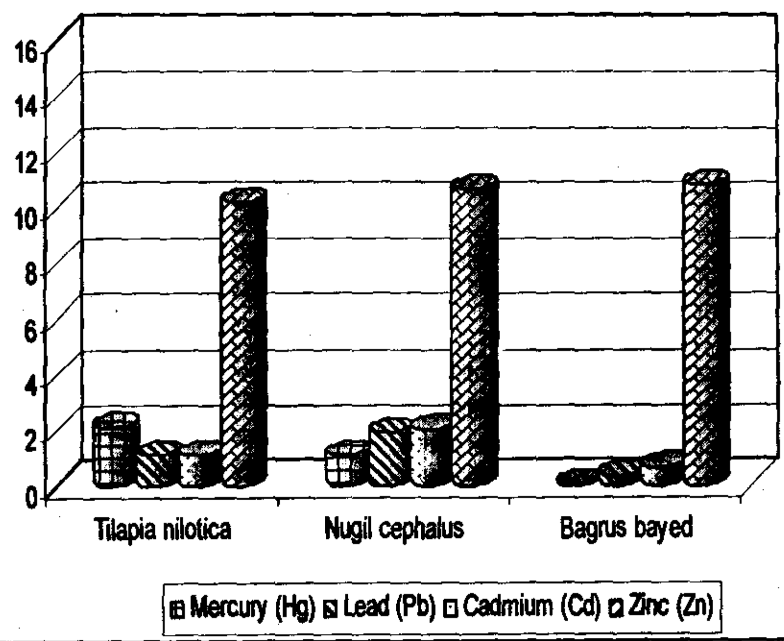



Fig. (2) Hg, Pb, Cd and Zn (ppm) in fresh water fish in Cairo governorate



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 musculature 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 as 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 **Casarett 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 decreases since 1940, as the intake was 400 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 1.1±0.84 , 1.8±0.61 and 1.9±1.01 , 1.12±0.13 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*, **Abd El-Aziz (1996)** reported that *Tilapia nilotica* in Gharbia Governorate contained 0.628ppm 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 fillets in Germany by 11, 22, 16, 25 and 26 mg/kg respectively, while nearly similar results were reported by **Shakweer (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" No., 2360(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 seated in **"EOSQC" No., 2360(1993)** (0.1 mg/kg) in fresh 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 **OechlenSchlaeger (1990), Tariq et al. (1991)** and **Abd-El 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 35-45 µg/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 **Villarrel-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) Nahrung (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" No., 2360, 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 .

## REFERENCES

**Abd El-aziz, A. A. H. (1996): Studies on heavy metals contaminating fresh water fish in Gharbia Governorate in Egypt. Ph. D. Thesis, Fac. Vet. Med., Moshtohor . Zagazig Univ. Benha Branch.**

**Abd El-Nasser, M; Shaaban, A. a, Aly, S. M and Sayed, M. M. (1996): Level** of some heavy metals in fish caught from River Nile at Assuit governorate, Egypt Assuit Vet. Med. J. 34:68.

**Abou-Donia, M.A . (1990):** Selected devised techniques for detecting fish contaminants. Ph.D. Thesis, Fac. Agri, Ain_Shams UNiv.

**Ahmed,F.E. ; Wolke , D .and Steinman ,D.(1993):** Risk assessment and managmentof chemical contaminants in fishery products consumed in U.S.A.J.Applied Toxicol.,13(6):395-410.

**Bryson, P. DC (1989):** "Comprehensive reviewed in toxicology." 2nd ed. Aspen Publishers. Inc, Rock Vile, Maryland, Royal Cambirdge Wells. Chap 39. pp 456-484.

**Bucular, H. M, Smith, W. D and Rees, S. D (1986):** Self poisoning with oral cadmium chloride. Br. Med. J. 292: 1559-1560.

**Canli, M. and G. Galic (2003):** "The relathionships between heavy metal (Fe, Pb, Zn, Cu, Cr) levels and the size of six Mediterranean fish species." Environ. Poll. (121) (1): 129-36.

**Cappon, C. I. (1987):** "Cadmium and lead in lake Ontarian salam onoids". Bull. Environ. Contam. Toxicol. 38: 695.

**Casarett, L. J. and Doull, L. (1975):** Toxicology "The basic science of Poisons" chapter 18 pp 458. MacMillan Publisher Co. Inc, New York, Collier MacMillan, Canada Ltd. Toronto, Bacilliere. Tindall, London.

**Chisaolm, J. (1973):** "Management of increased lead absorption and lead poisoning in Eng." J. Med 289: 1016-1017.

**Commission of the European Communities (1978):** "Criteria dose/effect relationship) for cadmium. Oxford pergmon Prell.

**El-Mowafi, A. F. A. (1995):** "Role of some minerals in fish nutrition". Ph. D. Thesis, (Animal nutrition). Fac. Vet. Med. Zagazig.

**El-Nabawi, A. Heimzo, B. and Kruse, H (1987):** As Cd, Cu, Pb, Hg and Zn in fish from Alexandria region. Egypt. Bull. Env. Contam. Toxicol, 39: 889.

**Ely, R. B (1970):** Methyl Mercury poisoning in fish and human beings. Modern Medicine 135. In: Koli et al. (1977).

**Emmerson, B. T. (1973):** Chronic lead nephropathy (edit ional).Kidney Int., 4, 1. Engman, J. and Jorhem, L.(1998): Toxic and essential element in fish from Nordic waters, with the results seen from the perspective of analytical quality assurance. Food Additive and Contaminates. 15(8):884_892.

**EOSQC (1993):** Egyptian Organization for Standardization and Quality Control. Maximum residue limits for heavy metals in food and fish. Egyptian Specification Standard (E.S.S) No.2360/1993 pp. 5, Ministry of industry, Cairo, Egypt.

**FAO/WHO (1992):** Codex alimentarius commission. Standard programme codex committee on food additives and contaminants .24th session, Hague, 23-28 March, 1992.

**Farag, M. S. Mohmoud, A. R and Thakeb, M. M. (2000):** "Monitoring of some heavy metals pollution in some fish farms" J. Egypt Vet Med. Ass. 60 (3): 39-45.

**FDA (1984):** Guide line for cadmium, lead, chromium and mercury in sea foods (c.f.Zook et al, 1976) J. Agric. Food Chem .Vol. 24(1):47

**Gado,M.S and El-Midany, S,A.(2003):** Studies on some heavy metal pollutants in cultured *Oreochromis niloticus* fish at Kafr El_Sheikh Governorate.Kafr El_Sheikh Vet.Med.J. Vol. 1 No.2(83_96)

**Gajeweski, R. and Nabrzyki, M. (1977):** Mercury, cadmium and lead contents of sea and fresh water fish. Roczinki, Panstwowego Zakladu Hygiene 28:215.

**Gough,L.and Shacklette,H.T.(1976):** Toxicity of selected elements to plants, animals and man.U.S.Dept.Interior.Geological Survey.Open_Fille Rep.No.76:746.

**Goyer, R. A. and Clarkson, T. W. (2001):** "Toxic effects of metals In: Casarett and Doull's Toxicology 6th ed. Pp. 811-867. Mcgraw Hill, New York.

**Goyer, R. A; Miller, C. R and Zhu, S. Y. (1989):** Non-mettall on thionein bound cadmium in the pathogenesis of cadmium nephrotoxicity in the rat Toxicol. Appl. Pharmacol. 101: 232.

**Goyer,R.A.(1986):**Toxic effects of metals .The basic science of poisons.Mac Millian Publ. Co.,New York.

**Hassan, H. A and Youssef, H (1985):** Determination of cadmium, copper, zinc in muscles of some fresh water fishes. Assiut. Medical. J: 9-21.

**Hawk, P. B, (1979):** Hawks physiological chemistry,14th ed.Tata Mcgraw-Hill Pub., company limited, Mohan Makhijani at Rekha printers pvt.Ltd., New Delhi. Chap. 20,p.541-572.

**Katyal, T. and Stoke, M. (1993):** Introduction to environmental pollution. Anmol Publications, New Dellhi, Edited by Rajkaman.

**Khangarot,B.S.and Ray,P.K(1987):**Bulletin environmental contamination and toxicology.38:755-756.

**Kakle,G.H.; Diffay,B.C.; Datiri,B.; froster,D. M. and Thompsons. J (1997):** Heavy metal in liver and kidney of goat in Albania. Bull.Envir.Contam.Toxicol. 55:568-573.

**Koss, B. and Long, L. (1976):** Mercury toxicity in the pregnant woman, fetus and newborn infant. Am. J. Obst. Gynecol. 126: 390.

**Lovett, R. J.; Gutenman, W.H; Pakkala, I. S.; Youngs, W. O. and Lisk, D.J (1972):** A survey of total cadmiumcontent of 406 fish from New York State fresh water. J.Fish Res.Bd. Canada,29:1283:1290.

**Luckey, T. D and Venugopal, B. (1977):** Metal toxicity in mammals. Plenum Press, New York.

**Manahan, S. E. (1989):** Toxicological Chemistry. A guide to toxic substances in chemistry. P:256_257. Brooks/Cole Publishing Co. C. A.

**Matida Y, Kumuda H, Kimuwa S, Saiga Y, Noset, Yokote M. and Kawatsu, H. (1972):** Toxicity of Mercury compounds to aquatic organism and accumulation of the compounds by the organisms Bull-Fresh water fish Res. Lab 21: 197.

**Mohamed, A. A (1993):** Some trace elements in tissue of fresh water fish. Ph. D Thesis (Meat Hygiene). Fac. Vet. Med. Assiut Univ., Assiut. Egypt.

**Nahrung (2000):** "Chemical and biochemical composition of Mugil cephilus from different part of south Poland". Envir. Cont. Pollution (44): 233-7.

**OehlenSchaeger, J (1990):** Heavy metals contents in various part of fish fillets in form fish wirt 37: 32.

**Saleh, M. B, Sa.eh, M. A, Fouda, M. M. Saleh M. A, Abdel Lattif M. S. and Wilson B. L. (1998):** "Inorganic pollution of the man. Mad lakes of Wadi EL-Rayian and its impact on aquaculture and wild life of the surrounding Egyptian Desert. Arch. Envir, Contam, Toxicol. 17: 391.

**Shakweer,L.M.(1998):** Concentration levels of some trace metals in *Oreochromis niloticus* at highly and less polluted areas of Mariut lake.J.Egypt.Ger.Soc.Zool., 25(A),Comparative Physiology,125-144.

**Shoe, H. J. Hanog, S. S and Kim, G. M (1991):** "A study on conients of heavy metal in fresh water fish Yeoung San River". J. Kor. Soc-Food-Nutr. 20: 615.

**Soliman-Zienab,I. and Galab,Marcel, F. (2001):** A study on lead pollution in water and Tilapia fish in Manzala lake.J. Egypt Vet. Med. Ass. 61, No. 6c: 71-76.

**Soon-KyunKim and Ae, Jung, Kim (1997):** "The study of the amount trace elements in some fermented fish from some areas of the west coast in Korea". Journal of Korean Society of Food Science and Nutrition 26 (6)-1063-1076.

**Sorensen, M. BC (1991):** Metal poisoning in fish, Haanbook, CRC, Press. Inc. 2000 corporate brud. N: W. boca. Roton, Florida 33431.

**Tariq J, Jaffar M and Moazzam M. (1991):** "Concentration correlations between major catiens and heavy metals in fish from Arabian Sea-mar. Pollut. Bull. 22: 262.

**Tariq, J. Ashraf, M. and Jaffar, M. (1994):** Assessment of pollution of rivers Jehlum and sultej Pakistan through trace metals in fish, sediment and water toxicol. Environment CHem. 43: 169.

**Tüzen, M. Zdemir, M. and Demirbas, A. (1998):** Study of heavy metals in some cultivated and uncultivated mushrooms of Turkish origin. Food Chemistry, 63 (2):247_251.

**Underwood.E. J. (1977):** Trace elements in human and animal nutrition 4th Ed. Academic Press, New York. San Francisco,London.Asubsidiaryof Harcaurt Brace Jovanovich,Publisher.

**UNEP (1987):** Assessment of the state pollution of Mediterranean Sea by Mercury and Mercury compounds. MAP Technical report series No. 18 UNEP, Athens.

**USEPA (1982):** Food and Drug Adminstration: Coin Pliance Prgram Report of finding fiscol. Year 79 pesticides and metals in fishy program US department of health and human services, Public health services, US food and drug administration, Washington DC.

**Villarreal-Trevina, C. M. (1986):** Bioaccumulation of lead, copper and zinc by fish in trancect of the Santa Catarina River in Cadereyta, Jimenes, Mexico, Bull. Env. Contam. Toxicol. 37: 395.

**WHO (1972):** "Health hazards of human environment" WHO Report, Geneva, pp 61.

**WHO(1976):** Environmental health criteria for lead. WHO Geneva.

**Zhou, H. Y and Wong, M. H (2000):** Mercury accumulation in fresh water fish with emphasis on the dietary influence. Water Research , 34 (17) 4234-4342.