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CADMIUM, LEAD, NICKEL, COPPER, MANGANESE AND FLUORINE LEVELS IN RIVER NILE FISH

(With One Table and One Figure)

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مستويات الكادميوم ، الرصاص ، النيكل ، النحاس ، المنجنيز والفلورين في أسماك نهر النيل

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لاشك أن الكشف المبكر للسموم يعد من الأمور الهامه فى مجال التلوث وحماية البيئه من أخطارها. ولإهمية نهر النيل كمصدر رئيسى للمياه والأسماك فقد تم إجراء هذا البحث على خمسة أنواع من الأسماك النيليه وهى البلطى- القرموط- اللبيس- الشال والبياض لمعرفة مستويات كل من الكادميوم ، الرصاص ، النيكل ، النحاس ، المنجنيز والفلورين. فى لحوم هذه الأسماك للتعرف على مدى تلوثها بهذه العناصر وتأثيرها على الصحه العامه. وقد تم قياس هذه العناصر بواسطة جهاز امتصاص الطيف الذرى أما الفلورين فقد تم قياسه بواسطة الكترود الفلورين . وقد أظهرت النتائج ارتفاع فى معدلات كل من الكادميوم والرصاص فى أنسجة الأسماك بينما كانت العناصر الأخرى فى معدلاتها الطبيعية حيث بلغت متوسطات الكادميوم ٢٦ر. ، ٣٣ر. ٣٧ر. ، ٣٣ر. ، ٣٩ر. جزء فى المليون ومستويات الرصاص ٣٢ر. ، ٤٥ر. ، ٨٦ر. ، ٦٤ر. ، ١٢ر. جزء فى المليون فى هذه الأسماك على التوالى. مما سبق يتضح ضرورة التحذير من ارتفاع معدلات التلوث بالكادميوم والرصاص فى أسماك نهر النيل ومعرفة مصادره وضرورة الفحص الدورى للأسماك المختلفه وكذلك المياه للوقوف على معدلاتها من وقت لأخر.

SUMMARY

Five Nile fish species *Orechromis niloticus, Clarias lazera, Labeo niloticus, Synodontis and Bagrus bayad* were collected from fish sources. Twenty samples from each were weighed and muscles were digested, analyzed and calculated for cadmium, lead, fluorine, nickel, copper and manganese. The results revealed that the averages of the previously mentioned elements were 0.26, 0.33, 0.37, 0.33 and 0.39 ppm, 0.32, 0.45, 0.86, 0.64 and 0.12 ppm, 0.38, 0.20, 0.33, 0.12 and 0.16 ppm, 1.20, 2.48, 0.75, 0.83 and 0.84 ppm, 4.22, 5.55, 2.16, 3.78 and 1.68 ppm and 2.8, 3.2, 2.2, 2.9 and 1.2 ppm, respectively. The results indicate an increase of cadmium, lead levels and a slight increase in copper and nickel in fish muscles. The results are discussed with other previous reports and its hazardous health effects.

***Keywords:** Trace elements - Fish*

INTRODUCTION

As in every industrial and over populated country, the aquatic ecosystems in Egypt are still suffering from the large amounts of natural and xenobiotc compounds introduced in surface waters by man. Although the Government applied sanitary measures concerning the emissions of some chemicals in surface water, still a lot of work has to be done before water pollution is reduced to an acceptable level. Of course, the factors that influence the harmfullness of a pollutant are numerous and often difficult to predict (e.g. pH, temperature, hardness, synergism, antagonism, addition, suspended matters etc.). It is well known that heavy metals have a great ecological significance due to their toxicity and accumulative behavior playing a prominent role in aquatic ecosystems. They occure in all compartments in aquatic environment with tendency to accumulate in organism from different trophic levels of aquatic webs. Along this pathway, toxic heavy metal become a potential hazard for man and mammals *(DE GREGORI et al., 1994)*. We try to detect the levels of some hazardous elements in muscle tissues in some Nile fish species in one hand and estimation of other essential elements in the other hand. Lead, cadmium, nickel and fluorine in addition to copper and manganese were investigated in the water areas of Assiut Governorate.

MATERIAL and METHODS

Five species of Nile Fish (*Orechromis niloticus, Clarias lazera, Labeo niloticus, Synodontis and Bagrus bayad*) were collected from fish sources at Assiut Governorate. Twenty fishes resembling twenty lots of each species were weighed and muscles were removed. The average weight of each was 200-300, 400-1000, 150-250, 400-700 and 700-1000 gm, respectively. The obtained fresh muscles were wet digested using bidistilled nitric acid according to *FAHMY, (1971)*. The volume was adjusted and heavy metals cadmium and lead were estimated using flamless atomic absorption spectophotometer. Essential elements nickel, copper and manganese were determined using flam atomic absorption spectrophotometer following the instructions of the manufacture of the device. Fluorine was determined using fluorine specific electrode attached to expandable ion analyzer EA 920 Orion Research according to *FRY and TAVES (1970)*. The analyses of data was conducted according to *KALTON (1967)*.

RESULTS

The results of our data are illustrated in table 1 and Figure 1.

DISCUSSION

Published environmental research indicates that whole body cadmium levels in fish is 0.2 to 8 ppm on a dry matter basis, *(MURPHY et al., 1978 and VINIKOUR et al., 1980)*. Our results indicates a narrow concentration changes of cadmium between species. Generally, intra and inter-species comparisons of tissue cadmium levels assume that exposure time, growth rate and bioavailability are the same. Despite intra and inter-species specific variability in tissue loading of cadmium, levels in skeletal muscle tend to fluctuate less than those in the liver. The averages of cadmium concentration in skeletal muscle from an Egyptian study *(EL NABAWI et al., 1987)* and a lake powell US study *(BUSSEY et al., 1976)* were 0.018 ± 0.005 ppm and 0.018 ± 0.008 ppm, respectively. Lower cadmium levels in muscles may result from elevated concentrations of cystine and methionine than other proteins *(BEVERDGE, 1947)*. Absence of sulph-hydryl groups in these sulphur-rich amino acids probably play a role in decreasing cadmium binding in skeletal muscle. The degree of association of fresh water fish with sediments seems to play a critical role in cadmium accumulation. Higher whole body levels of cadmium are observed in benthic (bottom dwellig) than in pelagic (free-swimming) species of fish *(NEY and VAN HASSEL 1983)*. Many species of fish are extremely sensitive to cadmium. Even though some fish can accumulate cadmium to levels of ten to one- thousand times higher than the levels in ambient water *(FLEISCHER et al., 1974)*. Our data revealed a concentration of cadmium in muscular tissue (edible part) in levels fluctuating from 0.26-0.39 ppm wet weight. This stable level between species may indicating the same factors for cadmium accumulation in muscular tissues, which correlated with slight exposure of stable Nile fish to cadmium.

Lead behaves more like the alkaline earth metals (i.e., Cu, Sr and Ba) with respect to uptake, internal distribution, and excretion *(HIROO and PATTERSON, 1974)*. Levels of lead in edible tissues of sunfish, red horse and bass are reported at 18, 14 and 9 ppm (wet weight), respectively *(SCHMITT and FINGER, 1987)*.

Human consumption of lead contaminated fish must be at the level of 450 ug *(WHO, 1972)*. The levels recorded in this study considered to be slightly hazardous to human consumption. High ways also pose a threat to fish because of lead contamination from automobile exhausts *(PAGENKOPF and NEUMAN, 1974)*. Industrial and agricultural discharges are the primary source of lead poisoning of fish in Egypt *(EL NABAWI et al., 1987)*. Industrial and/or sewage effluents are the major source of lead in fish from Africa *(ELSA, 1991)*. Lead is absorbed by the epithelium of both gills and intestine and excreted rapidly, therefor, lead depuretion generally reduces organ levels of lead *(HOLOCOMBE et al., 1976)*. Lead levels in skeletal muscles generally are lower than those of other tissues due to low binding rate for lead to sulphhydryl groups in muscles, as well as low solubility and restricted relocation of lead salts *(MOORE and RAMAMOORTHY, 1984)*. The present data of lead in the five species indicating a level ranging from 0.12 to 0.86 ppm in fresh muscles (table, 1) clarify the lower variations between species. *ZOOK et al., (1976)* found that no species out of 34 species commonly consumed sea foods, exceeded 1 ppm and lead levels average 0.49 ppm in fresh fish muscle. Our results indicated a slight increase than previous recorded data from natural levels pointing to a possible pollution through agricultural and industrial sources at Assiut Governorate.

Fluorine levels in Nile fish are 0.126 ppm to 0.38 ppm (wet weight). The highest levels were in *Oreochromis niloticus specie*. The levels of fluorine in muscles' tissues indicate a normal level of fluorine in Nile water where no cumulative values are present in muscles of fish. Fish meat is considered of no hazardous effect regarding fluorine element.

Copper is an essential element in the body and part of about thirty enzymes and glycoproteins *(GOYER, 1986)*. Deposition of copper in tissues and organs is variable. One thousand-fold differences exist in livers of related species of fish collected from uncontaminated areas *(FRAZIER, 1984)*. White perch can accumulate hepatic levels of 2795 ppm copper, compared to normal level of 3 ppm found in striped bass. *CROSS et al., (1973)* found a level of 0.61 ppm in muscles of blue fish exposed to 3 ppb as environmental exposure levels. The brain, spleen, gonad and skeletal muscle of the exposed fish do not appear to be involved in copper accumulation since levels in exposed fish are similar to those of controls. Control blue gills average 29, 18, 5 and 1 ppm copper in brain, spleen, gonad and muscle respectively *(BENOIT, 1975)*. The present data (table, 1) indicates lower levels of copper (1.6-5.5 ppm) in muscles of all investigated species.

LEGORBURU et al., (1988) found a low level of manganese in muscles of Eels in a range from 0.1-0.34 ppm from Urola River water shed. While levels of brown trout ranged 0.4-0.9 ppm dry weight, while *LEGORBURU and CANTON (1989)* found levels of 1.1, 1.0, 1.3 in Salmon, Borbus and Chondrostoma fishes. In polluted area the levels reached 5, 7 and 0.2 ppm in muscles respectively. Our data indicated no source of exposure to manganese as the levels are within normal levels.

Nickel levels in polluted areas reached 34 and 28 in Salmon and Barbus fishes *(LEGORBURU and CANTON 1989)*. The recorded levels of nickel reveal no original sources of such pollution into the River Nile.

In conclusion we can consider the elevated values of cadmium and lead in muscular tissues of the investigated five species are an indicator for some sources of such pollution.

REFERENCES

Benoit, D. A., (1975): Chronic effects of copper on survival. growth and reproduction of bluegill (*Lepomis macrochirus*) Trans. Am. Fish Soc., 104:353-358.

Beveridge, J. M. R. (1947): Sulfur distribution in fish flesh proteins. J. Fish Res. Bd. Can. 7: 51.

Bussey, R. E., Kidd, D. E., and Potter, L. D. (1976): The concentrations of ten heavy metals in some selected Lake Powell game fishes. University of New Mexico, Albuquerque. Lake Powell Research Project Bulletin (1976) 1.

Cross, F. A., Hardy L. H., Jones, L. Y., and Borbrr, R. I (1973): Relation between total body weight and concentrations of manganese, iron, copper, zinc and mercury in white muscle of blue fish (pomatomus saltatrix) and a bathyl demersal fish (antimora saltatrix). J. Fish Res. Bd. Can. 30:1287.-1294.

De Gregori, I.; Pinochet, H.; Delgado, D.; Gras, N. and Munoz, L. (1994): Heavy metals in Bivalve Mussels and their habitats from different sits along the children coast. Bull. Environ. Contam. Toxicol., 52: 261-268.

EL Nabawi, A. G., Heinzow, B. and Kruse, H. (1987): As, Cd, Cu, Pb, Hg and Zn in fish from the Alexandria region, Egypt Bull. Environ. Contam. Toxicol. 39: 889-897.

Elsa M. B.Sorensen (1991): Metal Poisoning in Fish. Austin, Texas 78720, CRC Press Boca Raton, Ann Arbor, Boston.

Fahmy, F (1971): Studies on factor affecting copper in Egyption Sheep. Ph.D. Thesis, Vet. Med. Cairo University, Egypt.

Fleischer, M., Sarofim, A. F., Fassett, D. W., Hammond, P., Shacklette, H. T., Nisbet, I. C. T., and Epstein, S.(1974): A review by the panel on hazardous trace substances. Environ. Hlth. persp., 253-323.

Fry, B.W. and Taves, D.R. (1970): Serum fluoride analysis with the fluoride electrodes. J. Lab. & Clinic. Med., 75: 1020-1025.

Goyer, R. A. (1986): Toxic effects of metals, in Klaassen, C. D., M. O. Amdur, and J. Doull (Eds), Casarett and Doull s' Toxicology : The Basic Science of Poisons. Mac Millian Publ. Co., New York, 582.

Hiroo, Y., and Patterson, C. C. (1974): Lead aerosol pollution in the High Sierra overides natural mechanisms which exclude lead from a food chain. Science 184:989-992.

Holocombe, G. W., Benoit, D. A., Leonord, E. N., and Mc kim, J. M. (1976): Long term effects of lead exposure on three generations of brook trout (Salvelinus Fontinalis). J. Fish Res. Bd. Can., 33:1731-1737.

Kalton, G. (1967): Introduction to statistical ideas from social scientist, 2nd Acad, Press, London.

Legorburu, I. and Canton, L. (1989): Heavy metal analysis in fish kill, casis in Rivers in Guipuzcoa (Spain). Toxicological and Environmental Chemistry, vol. 23:161-167.

Legorburu, I., Canton, L., Millan, E., C Aspdo, A. (1988): Trace metal levels in fish from Urola River (Spain) Anguillidae, Mugillidae and Salmonidae. Environ. Technol. Letters, vol. 9 pp. 1373-1378.

Moore, J. W. and Ramamoorthy, S. (1984): Lead, Heavy metals in natural waters. Applied Monitoring and Impact Assessment, Springerverlag, Berlin, 100-120.

Murphy, B. R., Atchison, G. J. and Mc Intosh, A. W. (1978): Cadmium and zinc content of fish from an industrially contaminated lake. J. Fish Biol., 13:327-331.

Ney, J. J. and Van Hassel, J. H. (1983): Sources of variability in accumulation of heavy metals by fishes in a road side stream. Arch. Environ. Contam. Toxicol. 12:701-708.

Pagenkopf, G. K. and Neuman, D. R. (1974): Lead concentration in native trout. Bull. Environ. Contam. Toxicol. 12:70.

Schmitt, C. J., and Finger, S. E. (1987): The effects of sample preparation on measured concentrations of eight elements in edible tissues of fish from streams contaminated by lead mining. Arch. Environ. Contam. Toxicol. 16:185-196.

Vinikour, W. S.; Goldstein, R. M. and Anderson, R. V. (1980): Bioconcentration patterns of zinc, copper, cadmium and lead in selected fish species from the Fox river, Illionis. Bull. Environ. Contam. & Toxicol. 24: 727-731.

WHO (1972): Evaluation of mercury, lead, cadmium and the food additives amaranth, diethylpyrocarbonate and actyl gallate. WHO, 16th Rep. Joint FAO/WHO Expert Committee on Food Additives, WHO Techn. Rep. SERV. No. 505.

Zook, E. G., Powell, J. J., Hackley, B. M., Emerson, J. A., Brooker, J. R and Knobl jr., G. M. (1976): National Marine fisheries service preliminary survey of selected sea foods for mercury, lead, cadmium, chromium and arsenic content. J. Agric. Food Chem. 24:47-53.

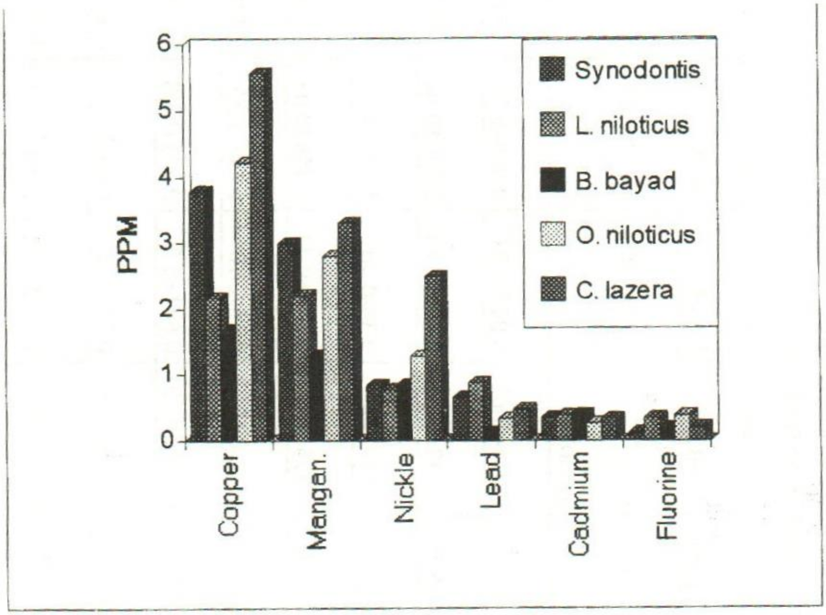

Fig. 1: Copper, manganese, nickel, lead, cadmium and fluorine levels (ppm) in some Nile fish species collected from Assiut Governorate.

Table 1. Cadmium, lead, nickel, copper, manganese and fluorine levels (ppm) in some Nile fish species collected from Assiut Governorate.

Fish type	Conc. ppm	Cadmium	Lead	Nickel	Copper	Manganese	Fluorine
O. niloticus	Mean±S.E	0.26 ±0.007	0.328±.024	1.274±.054	4.221±0.14	2.80±0.091	0.38±0.026
	Range	0.015- 0.62	0.015-1.81	0.069-4.45	0.54-7.86	0.285-9.25	0.033-0.66
C. lazera	Mean±S.E	0.332±0.01	0.456±0.01	2.484±0.04	5.558±0.12	3.296±0.004	0.203±0.01
	Range	0.03-0.48	0.30-0.90	1.65-3.40	1.20-7.21	0.042-0.435	0.042-0.43
L. niloticus	Mean±S.E	0.376±0.03	0.864±0.43	0.759±0.03	2.168±0.07	2.20±0.067	0.333±0.04
	Range	0.12-0.63	0.15-2.10	0.111-1.35	0.495-3.28	1.03-3.85	0.021-1.50
Synodontis	Mean±S.E	0.339±0.02	0.641±0.2	0.831±0.08	3.789±0.23	2.985±0.19	0.126±0.01
	Range	0.045-0.78	0.015-2.4	0.06-2.1	0.465-7.35	1.39-6.15	0.025-0.39
B. bayad	Mean±S.E	0.39±0.02	0.12±0.016	0.84±0.041	1.685±0.05	1.285±0.091	0.18±0.01
	Range	0.345-0.44	0.015-0.3	0.225-1.54	1.24-2.22	0.69-2.1	0.007-0.01

NB: number of analyzed samples were 20 for each.