Ass. Univ. Bull. Environ. Res. Vol. 14 No. 1, March 2011

AUCES

RESIDUES OF SOME HEAVY METALS IN FRESHWATER FISH (*OREOCHROMIS NILOTICUS* AND *LABEO NILOTICUS*) IN ASSIUT CITY MARKETS

H. H. Essa* and H. Z. Rateb**

***Dept. of Food Hygiene, Animal Health Research institute Assiut, Egypt**

****Dept. of Clinical Lab. Diagnosis. Faculty of Vet. Med., Assiut University**

ABSTRACT:

This study was conducted to determine the residues of lead (Pb) cadmium (Cd) and mercury (Hg) in the muscles of the freshwater fish, 40 random samples (20 from Oreochromis niloticus and (20 from *Labeo niloticus*) were used and collected from different markets in Assiut City, Egypt. They were analyzed by using Ph meter Orion 920 research electrode. The results revealed that levels of Pb, Cd and Hg in the Oreochromis niloticus samples were 0.125 (0.046-1.126), 0.976 (0.198-1.938) ppm and 4.875 (3.686-7.220) µg/kg, respectivey. While the concentration of Pb, Cd and Hg were 0.119 (0.021-0.721), 0.621 (0.379-1.032) ppm and 4.039 (3.687-5.620) µg/kg in the *Labeo niloticus* sample respectively. The results of this study indicate that the Pb, Cd concentrations in all examined samples were lowed than the Egyption Organization of Standardizatian and Quality Control (EOSόQC, 1993). The consumption of these contaminated fish regularly even in a small amounts for long time may lead to health troubles. Public health importamce and the hazardous toxic effects of the examined heavy metals as well as the suggestive recommendation to reduce or control the sources of pollution to the fresh water fish with these metals were discussed.

INTRODUCTION:

From the public health stand point of view attention must be paid, not only to the study of the nutritional benefits of animal origin, but also to the safety aspects, especially those concerns with the presence of harmful pollutant substances to human health.

Heavy metals make up one of the most important group of pollutants. From the point of food analyst, heavy metals which are referred to the inorganic elements, metallic in nature had a hazardous effect even at relatively low concentration. Moreover, not broken down at all or may chelated over along time scale to become permanent additions to the environment and animal, and consequently to human tissues. These heavy metals are not needed as structural components of organs and tissues, not constituents of body fluids and not a constituent or activators of enzymes system in

body except traces of arsenic, which are needed in a very low concentration (Royal Commission on Environmental pollution, 1979).

Water pollution referred to the addition to the water of an excess of material that is harmful to humans, animals and fishes. The materials found in water and considered toxic to fishes in one way or another can be categorized into (oxygen debilitating materials, toxic materials, toxic gases, toxic organic compounds and pesticides (Omima, 2010).

Contamination of fish tissues by heavy metals is arisen mainly from the contamination of feed, water, air beside the accidental addition wich can be associated with soils naturally high in these elements, environmental pollution from local industry, and feeding grain (Hecht, 1990) Thus heavy metals enter food chain and lead to unwanted residues in food animals. These residues have a pharmacological action and conversion products, then are transmitted to the target organs in the animal body which are mainly the edible affsl of the food animals (Gracey and Collins, 1992).

Heavy metals are undesirable and produce no lesion in animal tissues that can be observed post–mortem except in heavy intoxicadion (Royal Commission on Environmental Pollution, 1979). Heavy metals are persistent type of pollutants and can not be destroyed by heat treatment, so that their persistence enchances their potential to reach and affect the human being (Levensen and Barnard 1988). Excessive intake of heavy metals in food had led to many cases of intoxication, ranged between the gastrointestinal disturbance to liver and kidney dysfunction and lung carcinoma (Gracey and Collins, 1992).

Lead is one of the most toxic metals that has probably plagued humans since early civilization. The distribution of lead in the environment is a major healthhazard and intoxication with lead may occurs as pandemics in human (Needlemon, 1980).

Lead is recognized as a known neurotxicant with major public health concern which causes both acute and chronic intoxication (Gossel and Bricher, 1990). The toxicity may show in the form of anemia, abdominal colic, liver dysfundtion, renal damage, peripheral neuropathy in adults, CNS disorders in the form of permanent brain damage in children and case of extreme lead poisoning, convulsion followed by coma and death, might occurred. Moreover lead had a biological half life of about 27 years in human bones (Shibamoto and Bjeldanes, 1993).

Cadmium intoxication in human resulted in renal damage and dystrophic changes associated with hypercalcuria, glucosuria, proteinuria and aminoaciduria with hypertension (Ragan and Mast, 1990, Carl, 1991, Gracey and Colins, 1992), and itai itai disease which characterized by sever pain, soft bones and the death may occur as a result of renal failure (FAO/WHO, 1972 and Peter, 1993). Also a dystrophic change in liver and testis (Gruenwedel, 1990; Gracey and Colins, 1992) associate with anemia (Robards and Worsfold, 1991) has been reported.

Cadmium contaminating air and water from industrial sources may be transmitted to man through contaminated food stuff (Carstensen and Poulsen, 1974). Generally, cadmium is virtually absent from the human body at birth and accumulates with age in the body tissues resulting in renal failure (Gracey and Collins, 1992).

Mercury is considered as one of the most impotent pollutant in our environment. Mining, smelting, industrial discharge, loss of mercury in water effluent from chloralkali plants, mercury in paper pulp industries and fossil fuel. It is estimated that about 5000 tons of mercury per year may be emitted from burning coal, natural gas and from the refining of petroleum products are considered as a main source of mercury in the environment (Goyer, 1996). Mercury is popular in agriculture because of its ability to counteract fungi and mold. It therefore has been widely used to prevent grain spoilage. In the form of pesticides (fungicides for seed dressing) and in industry as wood preservative, production of dyes, initial explosive in boosters and ingniters (Bartik and Piskac, 1981, Gossel and Bricker, 1990).

Mercury has been recognized as severe environmental pollutant, with high toxicity even at low concentrations and it has the ability to enter into biological systems (Porto *et al.*, 2005). It has strong tendency to accumulate in aquatic food chain, and about 95% of the methyl mercury in humans originated from ingested fish (Houserova *et al.*, 2007; Voegborlo and Akagi, 2007). Methyl mercury is a neurological toxicants to humans. In addition, methyl mercury is also classified as a group of possible human carcinogen (Commission of the European Communities, 2001). Mercury has deleterious effects on the immune system, renal reproductive, CNS, heart, oral and gut bacteria (Hibberd *et al.*, 1998).

During recent years the importance of mercury in the food chain has become better understood. Inorganic and organic mercury derivatives are arising as effluents from industrial processes and converted in the lakes and rivers into soluble methyl mercury. This is carried down to the sea, where it is taken by man and animal through drinking water or through eating fish.

The aim of the present study is to determine the lead, cadmium and mercury levels in fresh water fish (*Oreochromis niloticus* and *Labeo niloticus*) to ensure the safety to the consumer and direct the attention to their public health significance.

MATERIALS AND METHODS:

Collection of samples:

A total of 40 random meat samples of freshwater fish *Oreochromic niloticus* and *Labeo niloticus* (20 of each) were collected from different markets in Assiut City for determination of lead, cadmium and mercury levels.

Digestion of samples:

Five grams from each sample were digested by using a mixture of nitric and perchloric acids (Khan *et al.*, 1995). Till use for determination.

Estimation of metals:

Lead, cadmium and mercury were determined by using ph meter Orion 920 research electrode (USA).

RESULTS:

Table 1: Lead levels (ppm) in examined samples of *Oreochromis niloticus* and *Labeo niloticus*

Examined Samples (Muscles)	Number of samples	Minimum	Maximum	Mean	±S.E.
Oreochromis niloticus	20	0.046	1.126	0.125	± 0.024
Labeo niloticus	20	0.021	0.721	0.119	± 0.025

Table 2: Cadmium levels (ppm) in examined samples of *Oreochromis niloticus* and *Labeo niloticus*

Examined Samples (Muscles)	Number of samples	Minimum	Maximum	Mean	±S.E.
Oreochromis niloticus	20	0.198	1.938	0.976	± 0.035
Labeo niloticus	20	0.379	1.032	0.621	± 0.030

Table 3 : Mercury levels (µg/kg) in examined samples of *Oreochromis niloticus* and *Labeo nilotius*

Examined Samples (Muscles)	Number of samples	Minimum	Maximum	Mean	±S.E.
Oreochromis niloticus	20	3.686	7.220	4.875	± 0.063
Labeo niloticus	20	3.687	5.620	4.039	± 0.048

Table 4 : Recommended levels of lead, cadmium and mercury in food

The mean heavy metals residues in all examined samples			EOSQC (1993) Maximum permissible limits in fish	WHO (1984)
Metals	Examined samples	Mean value		
Lead (ppm)	*Oreochromis niloticus* *Labeo niloticus*	0.125± 0.024 0.119±0.025	0.5 ppm	Pb level should not more than 0.05 ppm
Cadmium (ppm)		0.976±0.035 0.621±0.030	0.1 ppm	Cd should not exceed 0.05 ppm
Mercury (µg/kg)		4.875±0.063 4.039±0.048		Hg should not more than 5.00 µg/kg

EOSQC : Egyption Organization for Standardization and Quality Control
WHO :World Health Organization.

DISCUSSION:

Fish is widely consumed in many parts of the word by humans because it has high protein content, low saturated fat and also contain calcium, phosphorus, iron, trace elements like copper and a fair proportion of the B-vitamins known to support good health (Tucker, 1997).

Many reports on contamination of fish by chemicals in the environment were reported (Tuzen and Soylak, 2007). Heavy metals are considered the most important constituents of pollution from the aquatic environment and the sea due to toxicity and accumulation by marine organisms, such as fish (Inskip & Piotrowsiki, 1985 and Emami *et al.*, 2005). While lead, cadmium and mercury can be tolerated at extremely low concentrations, they are extremely toxic, persistent and not easily

biodegradable (Ikem and Egiebor, 2005). High contaminated fish may cause health risk to human. The toxic effects of heavy metals, particularly lead, cadmium and mercury, have been broadly studied (Porto *et al.*, 2005, Houserova *et al.*, 2007; Catsiki and Strogyloudi, 1999). The major source of exposure of human to heavy metals through food ingestion (Ikem and Egiebor, 2005).

In the present study, the results in table 1 revealed that lead levels were 0.125 and 0.119 (ppm) in *Oreochromis niloticus* (*Tiliapia niloticus*) and *Labeo niloticus* respectively. These results are nearly similar to that obtained by El Nabawi *et al.* (1987) who found lead level of 0.128 and 0.115 (ppm) in *Tilapia niloticus* and *Tilapia zillii*, but higher than the results recorded by Ekpo *et al.* (2008) who found that the mean value of lead in *Tilapia zilli* was 0.002 ppm. Our obtained results are higher than that rcorded by Ebrahim *et al.* (2010). They found that lead level in canned fish was 0.096 ppm. The lead levels recorded in rxamined *Oreochromis niloticus* and *labeo niloticus* samples exceeded the permissible limits of WHO (1984) which mentioned that lead level should not more than 0.05 ppm, but lead level in examined samples was lower than the permissible limits (0.5 ppm) recommended by Egyption Organization for Standardization and Quality Contral (EOSQC 1993), Table 4.

Chronic lead poisoning is characterized by neurological defects, renal tubular dysfunction and anema. Damage of CNS is a marked feature especially in children (Underwood, 1977). In men, lead affects the male gametes resulting in sperm abnormalities and decreased sexual desire as well as sterility (Needleman and Landrigan, 1981). In women, lead poisoning is associated with abnormal ovarian cycles and menstrual disorders in addition to spontaneous abortion (Needleman *et al.*, 1984).

The results in table 2 revealed that the mean cadmium level was 0.976 and 0.621 ppm in *Oreochramis niloticus* and *Labeo niloticus* respectively. These results are higher than the result found by Ekpo *et al.* (2008) and Ebrahim *et al.* (2010). They found that the mean value of cadmium was 0.001 ppm in *Tilapia zilli* and 0.050 ppm in canned fish respectively. But the obtained results was less than the result recorded by El Nabawi *et al.* (1987) who found that the cadmium level was 1.261 and 1.002 ppm in *Tilapia niloticus* and *Tilapia zilli*. The mean cadmium levels of examined *Oreochromis niloticus* and *Labeo niloticus* sample appeared to be within the permissible limits stipulated WHO (1984) which mentioned that the content of cadmium should not exceed 0.05 ppm. On the other hand the Egyption Standard (1993) recommended that the concentration of cadmium should not exceed 0.1 ppm, Table 4. So the obtained results in this study (Table 2) for cadmium in *Oreochromis niloticus* and *Labeo niloticus* samples were within permissible limits.

In the present study, Hg increased in *Oreochromis niloticus* and *Labeo niloticus* of all examind samples. Generally the concentrations of mercury were high, recording on overall range of 3.686-7.220 µg/kg with mean value 4.875 µg/kg in *Oreochromis niloticus* and 3.687-

5.620 µg/kg with mean value 4.039 µg/kg in *Labeo niloticus* samples. The *Oerochromis niloticus* samples contained higher levels of mercury than that of *Labeo niloticus* samples (Table 3) the obtained results revealed that mercury levels were higher than to that obtained by Ekpo *et al.* (2008) who found that mercury level ranged from 2.010–4.401 µg/kg with mean value 3.125 µg/kg in *Tilapia zilli.* The mean mercury levels of examined *Oreochromis niloticus* and *Labeo niloticus* samples appeared to be within the permissible limits recorded by WHO (1984), which mentioned that the level of Hg should not more than 5.00 µg/kg. Table 4.

Mercury occurs widely in the biosphere and has long been known as a toxic element presenting occupational hazards associated with both ingestion and inhalation. No vital function for the element in living organisms has yet been found. The toxic properties of mercury have evoked increasing in recent years due to the extent of its use in industry and agriculture, and the recognition that alkyl derivatives of Hg are more toxic than most other chemical forms and can enter the food chain through the activity of microorganisms with the ability to methyllate, the mercury present in industrial wastes (Underwood, 1977). Exposure to heavy metals such as cadmium and mercury is of immediate environmental concern. A direct relationship between heavy metal poisoning and thyroid dysfunction was reported in rabbits by Ghosh and Bhattacharya (1992).

This study improves the base line data and information on lead, cadmium and mercury concentration in freshwater fish (*Oreochromis niloticus* and *Labeo niloticus*) commonly marketed in Assiut City of Egypt. Such data provide valuable information on safety of fishes commonly consumed by the public.

REFERENCES:

Bartik, M. and Piskac, A. (1981): Copper. In: Vet. Toxicology Elsevier Scientific Publishing Company, Amsterdam, Oxford, New York, pp. 84, 96-97.

Carl, M. (1991): Heavy metals and others trace elements. Monograph on residues and contaminants in milk and milk products. Chap. 6, pp. 113, International dairy federation, Belgium. of Lead. food Addit. Contam. 10:325-335.

Carstensen, J., and Poulsen, E. (1974): Public health aspects of environmental pollution with mercury and cadmium in Scan-dinavia problems of the contamination of man and his environment by mercury and cadmium. The Commission of European Communities, Luxembourg.

Catsiki, VA and Strogyloudi, E. (1999): Survey of metal levels in common fish species from Greek water Sci. Total Environ 237/238 :387-400.

Commission of the European Communities (2001): Commission Regulation (EC) No. 221/2002 of 6 February 2002 amending regulation (EC) NO. 466/2002 setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Commucities, Brussels, 6 February 2002.

Ebrahim, R, Mazyar, H., Hamid, R.K., Ali, CH, Amin, K., Mohamed, D., Mahdi, M., Abdel Ghaffar, E., Seyed, A. R. and Maryam, F. K. (2010): Analysis and determination of mercury, cadmium and lead in canned fish marketed in Iran. African Journal of Biotechnology 9 (31): 4938-4941.

EOSQC (Egyptian Organization for Standardization Quality and Control) (1993): Maximum level for heavy metal contaminants in food, ES No. 2360.

Ekpo, K. E., Asia, I.O., Amayo, K.O. and Jegede, D.A. (2008): Determination of lead, cadmium and mercury in surrounding water and organs of same species of fish from Ikpoba River in Benin City, Nigeria. International journal of Physical Sciences, 3(11): 289-292.

El Nabawi, A., 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.

Emami, K. F., Ghansari, M. and Abdollahi M. (2005): Heavy metals content of canned fish. Food Chem. 93(2): 293-296.

FAO/WHO (1972): Joint Expert Committee on food additives, evaluation of certain food additives and contaminants WHO Technical Report Series No. 505, Geneva.

Ghosh, N. and Bhattacharya, S. (1992): Thyrotoxicity of the chlorides of cadmium and mercury in rabbit. Biomed. Environ, Sci., 5:236-240.

Gossel, T.A. and Bricker, J.D. (1990): Metals. In: Principles of Clinical Toxicology. 2nd Ed., Raven Press, New York, pp. 162-192.

Goyer, R.A. (1996): Toxic effects of metals. In Caserett and Doll's Toxicology, the basic science of poisons. Klaassen, C.D. Amdur, M. O., Doull, J. (eds), 5th Ed., McGraw-Hill Companies, New York, pp. 691-736.

Gracey, J. and Collins, D. (1992): Meat Hygiene. 9th Ed., ELBS with Baillier Tindell. Chap. 10, pp. 205-221. London, U.K.

Gruenwedel, D. (1990): Industrial and environmental chemicals in the humans food chain: inorganic chemicals. In "Chemicals in the human food chain" (Winter, C.W., Sieber, J. N., Nuckton, C. F. eds) pp. 129-182. Van Nostrand Reinhold, New York.

Hecht, H. (1990) Umweltbedingte Ruckstunde in tierischen Geweben. Fleischwirtschaft. 70 (90) 1016-1028.

Hibberd Ar, Howard, M.A. and Hunnisett, A.G. (1998): Studies on oral chelating agents for assessing and reducing mercury burdens in humans. Journal of Nutritional and Environmental Medicine 8, 219-231.

Houserova, P., Kuban, V., Kracmar, S. and Sitko J. (2007): Total mercury and mercury species in birds and fish in an aquatic ecosystem in the Czech Republic. Environ. Pollut. 145 (1): 185-192.

Ikem, A. and Egiebor, NO (2005): Assessment of trace elements in canned fishes (Mackerel, Tuna, Salmon, Sardines and

Herrings) marketed in Georgia and Alabama (United States of America). J. Food Comp. Anal. 18(8): 771-787.

Inskip, Mj. and Piotrowesiki, JK (1985): Review of the health effects of methylmercury. J. Appl. Toxicol. 5(3):113-133.

Khan, A.T., Diffay, B.C.; Datiri, B.C., Forester, D.M.; Thompson, S.J. and Mielke, H.W. (1995): Heavy metals in livers and kidneys of goats in Albama. Bull. Environ. Contam. Toxicol., 55:568.

Levensen, H. and Barnard, W. (1988): Wastes in marine environment. Hemisphere Publishing Corporation, Cambridge, London, pp. 123-126.

Needleman, H. (1980): Low level lead exposure: The clinical implication of current research, Raven Press New York.

Needleman, H. and Landrigan, P. (1981): The health effects of low level exposure to lead. Ann Rev. Public Health, 2:277-298.

Needleman, H., Rabinowitz M. and Leviton, A. (1984):The relationship between prenatal exposure to lead and congenital anomilies JAMA, 251:2956-2959.

Omima A.S.A. Aboud (2010): Impact of pollution with lead, mercury and cadmium on the immune response of *Oreochromis niloticus*. New York Science Journal. 3(9) pp. 12-16.

Peter. O.N. (1993): Environmental chemistry. 2nd ed. Champan and Hall Press, New York pp. 203-221.

Porto, JIR, Araujo, CSO and Feldberga, E (2005): Mutagenic effects of mercury pollution as revealed by micronucleus test on three Amazonian fish species. Environ. Res. 97(3):287-292.

Ragan, H. and Mast, T. (1990): Cadmium inhalation and male reproductive toxicity. Rev. Environ. Contam. Toxicol. 114:122.

Robards, K. and Worsfold, P.(1991): Cadmium: toxicology and analysis. Analyst., 116: 549-568.

Royal Commission on Environmental Pollution (1979): The effect of pollution on agriculture. 7th report, Agriculture and pollution, Cmnd. 7644. Chap. VI, pp. 161-188. HMSO, London.

Shibamoto, T. and Bjeldanes, L.E. (1993): Introduction to food toxicology. Academic Press Inc. Harcourt Brace Company. New York, Food Science& Technology International Series.

Tucker, BW(1997): Overview of current seafood nutritional issues: Formation of potentially toxic products, in Shahidi F, Jones Y, Kitts DD (Eds.), Seafood safety, processing and biotechnology. Technomic Publishing Co. Inc., Lancaster, PA(USA).

Tuzen, M. and Soylak, M (2007): Determination of trace metals in canned fish marketed in Turkey. Food Chem. 101(4):1378-1382.

Underwood, E.J. (1977): Trace elements in human and animal nutrition. 4th Ed., Academic Press, New York.

Voegborlo, R.B. and Akagi, H. (2007): Determination of mercury in fish by cold vapour atomic absorption spectrometry using an automatic mercury analyzer. Food Chem. 100(2): 853-858.

WHO (1984): Evaluation of food additives and contaminates. 27th Report of the Joint FAO/WHO Expert Committee on food additives. WHO Technical Report No. 695, Geneva.

متبقيات بعض المعادن الثقيلة فى الأسماك الطازجة (البلطى والليبس النيلى) بأسواق مدينه أسيوط

حمدى حسين عيسى، حسن ذكى راتب

استهدفت هذه الدراسة تقدير متبقيات كل من عنصر الرصاص والكادميوم والزئبق فى لحوم بعض أسماك المياه العذبة (البلطى والليبس النيلى) الموجودة بأسواق مدينه أسيوط. وقد أجريت الدراسة على 40 عينة (20 عينة من سمك البلطى، 20 عينة من سمك الليبس)، تم هضمها وتحليلها باستخدام جهاز قياس التركيزات الأيونية لتحديد نسب وجود كل من عنصر الرصاص، الكادميوم، وكذلك الزئبق بها. وقد أظهرت النتائج أن متوسط تركيز كل من عنصر الرصاص، الكادميوم، الزئبق فى عينات سمك البلطى كانت 0.125 (0.046 – 1.126)، 0.976 (0.198– 1.938) جزء فى المليون، 4.875 (3.686– 7.220) ميكروجرام/كجم على التوالى، بينما كان 0.119 (0.021 – 0.721)، 0.621 (0.379 – 1.032) جزء فى المليون، 4.039 (3.687–5.620) ميكروجرام/كجم على التوالى فى سمك الليبس. وأوضحت هذه الدراسة أن العينات التى تم فحصها بها نسبة من الرصاص والكادميوم والزئبق، ولكنها أقل من الحدود المسموح بها فى المواصفات القياسية المصرية. ولذلك أن استهلاك هذه الأسماك الملوثة بهذه العناصر قد يؤدى إلى مشاكل صحية إذا تم أكلها لمدة طويلة وبصفة مستمرة. وقد تمت مناقشة الأهمية الصحية والتأثيرات السامة لهذه العناصر، وكيفية الحد من أو التحكم فى مصادر وصول هذه العناصر إلى أسماك المياه العذبة.