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The extent of the presence of some heavy metal residues in cultured fish and wild fishes

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Abstract

A total of 48 fresh water fishes, 16 from each of Tilapia Nilotica *(Oroochromis Niloticus),* Mullet (*Mugil Cephalus*), and Common Carp (*Cyprinus Carpio),* with an average weight 200 g for each sample, collected samples were divided into 2 groups, the first group was collected directly from fisher men at aquaculture places with 8 samples from each fish species. The second group was collected directly from Maruite and Nozha lakes (wild fishes) 8 samples from each of Tilapia, Mullet and Carp. The collected samples were analyzed for determination of lead, cadmium and mercury residues using Perkin Elmer Atomic Absorption Spectrophotometer. The mean values of lead in Tilapia, Mullet and Carp farm fish samples were 0.413, 1.913 and 1.112 ppm., respectively while naturally life fishes were 0.239, 1.171 and 0.601 ppm, respectively. Moreover, the mean values of cadmium in cultured and wild fish were 0.425, 0.413 ,0.312 ppm and 0.361, 0.277, 0.253 ppm., respectively. Also, the mean values of mercury in the examined cultured fishes were 0.769, 0.766 and 1.160 ppm, respectively and at naturally life were 0.480, 0.490 and 0.690 ppm, respectively. Besides, the results showed that three metals exceed the permissible limits especially in most of farm (cultured) fish than wild (Nile and lakes) fishes. The public health importance and sources of fish contamination with such toxic elements as well as the suggestive measures to minimize those pollutants in aquatic environment were discussed.

Keywords: *Tilapia, mullet, common carp, cadmium, lead, mercury, residues.*

Introduction

Environmental pollution represents a major problem in the world, especially in developing countries. Egypt is one of these countries which somewhat suffer from biosphere pollution (air, soil and water). Pollutants in water including heavy metals, pesticides, hydrocarbons that come from agricultural, industrial and sewage wasted accumulate in fish tissues and organs causing severe health problem to the consumers**. (Jordao *et al*., 2002, and Connell and Yu, 2008)**.

The study of heavy metals in fish has recently become a topic concern because metals such as Mn, Pb, Hg, Cd, Ni. etc.…. may be concentrated to a dangerous level by fish in the human food chain. **(Essa and Rateb, 2008 and Askarysary and Beheshti, 2012**).

Lead is recognized as a known neurotoxicant and of a major public health concern which causes both acute and chronic intoxications. It causes encephalopathy in children. The provisional weekly intake of lead in food must not exceed than 0.05 ppm as recommended by **FAO/WHO (1989)**. However, **Tong *et al.* (2000)** postulated that the acceptable limits ranged from 0.05-0.2 ppm.

Cadmium, a toxic heavy metal, has a number of industrial applications, such as metal plating, pigments, batteries, and plastics. However, for most people the primary source of cadmium exposure is food (**WHO, 1982**), since food materials tend to take up and retain cadmium.

Cadmium is not known to have any beneficial effects, but can cause a broad spectrum of toxicological and biochemical dysfunctions (**Annabie *et al*., 2013)**

Mercury is considered as one of the most important pollutant in our environment. Mining, smelting, industrial discharge, mercury in paper pulp industries and fossil fuel. Mercury is popular in agriculture as a result of its ability to counteract fungi and mold. It therefore, has been widely used to prevent spoilage, as pesticides (fungicides for seed dressing) and in industry as wood preservative, production of dyes, initial explosive in boosters and igniters **(Hashim *et al*., 2007)**. During recent years, the importance of mercury in 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. Toxic effects of Hg compounds in humans have been known for many years (**Goyer, 1996**).

The main effects of mercury on the kidney leading to uremia and anuria. The early symptoms of acute inorganic mercury poisoning are gastrointestinal upset, abdominal pain, nausea, vomiting, and bloody diarrhea (**Buger *et al*., 2001)**.

The difference in concentration between deficiency and toxicity is often small. Heavy metals and other trace elements have been considered as a dangerous substance causing serious health hazards to human and other living organisms through progressive irreversible accumulation in their bodies as a result of a repeat consumption of small amounts of these elements. Because of large amounts of wastes discharged through human activities, Alexandria and Behera coast which is characterized by fish productivity has been somewhat polluted (**Noha *et al.,* 2007 and Uysal *et al*., 2012)**.

The aim of the present study was to compare between the concentration of some heavy metals in the musculature of the common fish species which surviving in Alex. and Behera farms, and wild fish, this enables us to collect the necessary and basic information that help in detecting the trends of fish contamination by heavy metals in these fishing group farms, and naturally relation to public health hazard.

Materials and Methods

Collection of the samples:

A total of 48 fresh water fishes ,16 samples from each, Tilapia Nilotica *(Oreochromis niloticus),* Mullet (*Mugil cephalus*), and Common Carp (*Cyprinus carpio).* With average body weight 200 g for each fish species which were divided into 2 groups.

-The first group farm fish (cultured) was collected directly by the aid of fishermen at aquaculture places by 8 samples from each of Tilapia, Mullet and Carp species.

-he second group naturally life fish (Nile and lakes) that collected directly from lakes of Maruit and Nozha, from each of Tilapia, Mullet and Carp (8 samples of each).

lake Nozha receives its water from the Nile river (Mahmoudia canal) so it represents the Nile river water, and used for about 40 years as open farm for fresh water fish species,and characterized by fish productivity **(Shakwer and Abbas, 1997**).

The samples were collected and kept in clean bags into ice box until they reached to the laboratory where they analyzed.

-Preparation of samples: Tissues were homogenized in high speed blender.

-Digestion: according to **Tsoumbaris and Papadopoulou, (1994):** 5g of sample was digested using a mixture of HNO3: H2SO4: HCLO4 (3: 1: 1) V: V (20 ml for every sample), and heating at 80ºC for 3hrs. After cooling, 20 ml. demineralized water was added, the digested sample was heated again to 150 ºC for 24 hrs., all digests were filtrated through a What man 42 filter paper, then diluted to a volume of 25 ml. with demineralized water.

-Determination of heavy metals concentration: All filtrated samples were analyzed for their contents by using Atomic absorption spectrophotometer (Perkin Elmer Model 2380) equipped with Mercury Hyide System, USA 1988.

-Statistical analysis: Maximum, Minimum, mean and standard error were calculated according to **Petrie and Watson, (1999)**.

Results

Table (1). Concentration of heavy metal residues (ppm) in musculature of examined cultured fish (n=24)

Metal		*O. niloticus*	*M. cephalus*	*C. carpio*
Lead	Minimum	0.212	1.713	0.219
	Maximum	0.839	2.619	2.012
	Mean±SE	0.413± 0.034	1.913 ± 0.010	1.112 ± 0.79
Cadmium	Minimum	0.218	0.129	0.082
	Maximum	1.003	0.815	0.838
	Mean±SE	0.425 ± 0.071	0.413 ± 0.079	0.312 ± 0.051
Mercury	Minimum	0.690	0.390	0.880
	Maximum	0.831	1.018	1.312
	Mean±SE	0.769± 0.042	0.766 ± 0.100	1.160 ± 0.061

mean calculated according to the +ve samples only

Table (2). Concentration of heavy metal residues (ppm) in musculature of examined wild (Nile and lakes) fish (n=24).

Metal		*O. niloticus*	*M. cephalus*	*C. carpio*
Lead	Minimum	0.081	0.501	0.238
	Maximum	0.513	1.712	1.019
	Mean±SE	0.239 ± 0.031	1.171 ± 0.052	0.601 ± 0.051
Cadmium	Minimum	0.072	0.092	0.053
	Maximum	0.739	0.531	0.413
	Mean±SE	0.361 ± 0.052	0.277 ± 0.061	0.253 ± 0.043
Mercury	Minimum	0.350	0.290	0.650
	Maximum	0.629	0.632	1.091
	Mean±SE	0.480 ± 0.031	0.490 ± 0.042	0.690 ± 0.033

mean calculated according to the +ve samples only.

Table (3). Frequency distribution of examined fish samples in relation to heavy metals:

Metal	**Lead**						**Cadmium**						**Mercury**					
Samples	**cultured fish N= 8**			**Wild fish N= 8**			**cultured fish N= 8**			**Wild fish N= 8**			**cultured fish N= 8**			**Wild fish N= 8**		
Variation	**T**	**M**	**C**	**T**	**M**	**C**	**T**	**M**	**C**	**T**	**M**	**C**	**T**	**M**	**C**	**T**	**M**	**C**
ND – 0.1	-	-	-	2	-	-	-	-	1	3	2	4	-	-	-	-	-	-
>0.1 – 0.5	5	-	1	4	-	3	5	4	4	3	5	4	-	2	-	6	5	-
>0.5 – 1.0	3	-	2	2	2	3	3	4	3	2	1	-	8	3	3	2	3	-
>1.0 – 1.5	-	-	3	-	3	2	-	-	-	-	-	-	-	3	5	-	-	7
>1.5 – 2.0	-	4	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1
>2.0 – 2.5	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
>2.5 – 3.0	-	2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-**N**. of +ve above MPL	8	8	8	6	8	8	8	8	7	5	6	4	8	6	8	2	3	8
-**%** of+ve above MPL	100	100	100	75	100	100	100	100	87	62	75	50	100	75	100	25	37	100

T = O. nilotica **M** = M. cephalus **C** = C. carpio **N** = number of samples
ND = not detected **MPL**= maximum permissible limit

Discussion

Redistribution of heavy metals in the air, water and soil ultimately appears in the food chain as they accumulate in plants and animals because many animal species have no homeostatic control for toxic elements, hence accumulate in the animal tissue over time (**Shafaqat and Rehan, 2014** and **Bawuro *et al.*, 2018).**

Exposure of fish to either high levels of toxic elements or less than optimal levels of the essential microelements can engender adverse effects such as reproductive impairment, physiological and behavioral abnormalities or even death (**Castro and Mendez 2008 and Vinodhini and Narayanan, 2009)**. These toxic elements which accumulate in fish can be passed on to people who consume the fish and become a health hazard to the public **(El-Sadaawy *et al.*, 2013).**

Egyptian Organization for Standardization and Quality Control (**EOSQ, 2010)** stated that heavy metals residues in fish should not exceed the Maximum permissible limits (MPL) of 0.1, 0.1 and 0.5 ppm for Lead, Cadmium and Mercury, respectively.

Lead is a nutritive toxic element, it produces a hematological, neural effects. Concerning the mean levels of Lead in the examined musculature of Tilapia, Mullet and Carp in both farm (cultured) and naturally life (Nile and lakes), the obtained results were calculated in Tables (1) , (2) and (3) which showed that, most of examined fish samples exceeded the maximum permissible limits of Lead (0.1 ppm) especially cultured fish samples in Tilapia, Mullet and Carp 0.413 (100%), 1.913 (100%) and 1.112 (100%) ppm., respectively. While wild fishes were 0.239 (75%), 1.171(100%) and 0.601 (100%), respectively.

Lead is more cumulative concentration in cultured fish, this may be due to industrial and sewage wastes factories dumped directly without treatment, most farms receive its water from drainage system which containing various types of pollutants discharged through the long travel, in addition to the other sources of (Pb) as air pollution because of run way near to the fish farms **(Tong *et al.,* 2000).**

Lead levels in the present study were lower than that reported by **Ghazaly,1992; Mohamed El-Deek, 1995; Atta *et al.*, 1997, and Azza, 2003**, who showed 4.50, 9.92, 8.85and 35.15 ppm in tilapia., respectively**.** Also nearly to **Noha *et al.*,2007; Salah *et al.*, 2009 ; Malhat, 2011** and **Askarysary and Beheshti, 2012,**which were(0.65, 0.41, 0.20 and 0.83 ppm) in tilapia, and higher than that recorded by **Omaima *et al.,* 2002 ; Aioub *et al.,* 2012** and **Dalia *et al.*, 2017,** which were (0.04, 0.12 and 0.08 ppm) in Tilapia , but in Carp were nearly similar to that recorded by **Rahman *et al.*, 2012,**who found (1.61ppm) and higher than **Rajeshkumar and Li, 2018** (0.09ppm) in carp fillet.

Tables (1, 2 and 3) showed the main values of Cadmium (Cd), in the examined fish tissue Tilapia and Mullet. The values exceeded the permissible limits (0.1 ppm), in 100% as recommended by **Egyptian organization for standardization and quality control (2010).** In cultured Tilapia fish, Cadmium is more concentrated than fish from Nile and lakes Mullet and Carp (0.425(100%), 0.413(100%) and 0.312 (87% ppm), respectively. While in wild fish the values were (0.361(62%), 0.277(75%) and 0.253(50%) ppm), respectively. In Tilapia there is more accumulation of Cd, than Mullet and Carp fish.

These results lower than that recorded by **Hemat, 1999, Mervate, 2001** and **Azza, 2003,** which were 1.90, 3.61 and 3.99 ppm. respectively, and nearly similar to **Omaima *et al.,* 2002; Aioub *et al.*, 2012; Hashim *et al.*, 2007; Essa and Rateb, 2008** and **Dalia *et al.*, 2017** which are 0.67,0.43 ,0.35,0.28 and 0.14 ppm., and higher than levels which were reported by **Salah *et al.*, 2009; Malhat, 2011** and **Askarysary and Beheshti, 2012** in fresh water fish which were 0.078, 0.045, and 0.0211ppm.
Cadmium is a cumulative toxic metal with biological half-life ranging from 20-40 years, while the time of accumulation continuous, the quantities of metal in organ also increase, these properties of cadmium make it especially dangerous, the toxic effects include gastroenteritis,

acute pulmonary odema, hypertension and carcinogenesis **(Ellenhorn and Bareeloux, 1988** and **Shibamoto and Bjeldanes, 1993)**.

From **Tables (1, 2 and 3),** it is obvious that the main levels of Mercury in the examined musculature cultured fish and wild exceeded the permissible limits (0.5 ppm.), in most samples as recommended by **Egyptian organization for standardization and quality control, (2010)**. It could be observed that in Carp there is more accumulation of (Hg) than in Mullet and Tilapia in Nile and lakes fish.

The main level of mercury in examined cultured samples were 0.769(100%), 0.766(75%) and 1.160(100%) ppm., in Tilapia, Mullet and Carp, respectively, while, in wild fish samples were 0.480(25%), 0.490(37%) and 0.610 (100%) ppm, respectively. This result is higher than the finding that obtained by **Omaima *et al.*, 2002; Aioub *et al.,* 2012** and **Dalia *et al.*, 2017** who found 0.14, 0.16, and 0.52, respectively, and also lower than **Salah *et al.*, 2009; Mohammdi *et al.*, 2011** and **Askarysary and Beheshti, 2012** which were 3.45, 5.85, 4.44ppm in fresh water fish.

Mercury is not essential for man due to its affinity to sulfhydryl group in protein, its compounds are potent enzyme poisons. It causes neurological effects and embryo toxicity. Moreover, it causes several kidneys damage in both man and animal **(Omaima *et al.*, 2002).**

Enrichment by these heavy metals ascribed to pollution from mainly domestic and agricultural sewage effluents entering the lake. As a result of population growth and industrial development pollution will increase. So, concentrations of these elements were being introduced by man in level that exceed natural background level **(Rashed, 2001** and **Atobatelea *et al.*, 2015).**

Table (3) show the frequency distribution of examined samples in relation to heavy metals. Most samples were more than the maximum permissible limits according to Egyptian Organization for Standardization and Quality Control (EOSQ /2010), And also show the number of positive samples at every variation.

For minimizing the heavy metals in fish, catching and selling of fish from areas polluted by chemical industrial wastes should be avoided because fish have the ability to concentrate chemical pollutants, specially metals in their tissues in higher levels than those in water where they live. The industrial water products and sewage drainage at water sources should be avoided. Hygienic disposal for treatment of water and sewage must be applied to protect human health from dangerous effects of heavy metals by adding some normal materials as Beat-moss, Clay, Chittting, Zeolites, for reducing heavy metals by adsorption. Education of fish handlers and consumers with fish pollution, their sources, health hazards and control through educational training programs. Administrations of diets rich in proteins vitamins as vitamin D and E, ascorbic acids, calcium, zinc and iron play an important role in decreasing the absorption and toxicity of heavy metals such as Lead and Cadmium.

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