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Original Research Article

Heavy metal residues in local and imported fish in Egypt

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ABSTRACT

A total of 100 random muscle samples of Oreochromis niloticus, Claries lazera, imported Mugil cephalus and Scomber scombrus fish (25 of each) were collected from different markets in Fayoum City for determination of lead, cadmium, copper and mercury residual levels to ascertain whether these levels exceeded the prescribed legal limits. The mean mercury levelin the edible muscles tissues of fish species were ranged from below detectable level to 0.29 ppm in local fish and to 0.28 ppmin imported fish. The residual levels were not exceeded the prescribed legal limits of Commission Regulation (E.C). The highest mean levels of cadmium were recorded in Mackerel (0.119 ± 0.060, ppm) which exceeded the permitted values stipulated by Commission Regulation (E.C). Mostly samples in this study contained copper within of the general guideline limit for copper in food. The highest mean levels of lead were also recorded in Mackerel (0.477±0.073 ppm) which exceeded the permitted value stipulated by Commission Regulation (E.C). The results were evaluated according to International standards of WHO and EC and Provisional tolerable weekly intakes would also be used in this study to assess the relative safety of Fayoum fish markets.The public health significance of heavy metal residues in such fish was discussed.

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INTRODUCTION

Fish is widely consumed in many parts of the world by humans because it has high proteincontent and low saturated fat. Contamination of fish and aqua culture by drainage of sewage effluents, industrial and agricultural untreated discharges, carless using of crude chemicals, insecticides and herbicides together with inputs from the atmosphere, are the major sources of heavy metals contamination in the river, sea and subsequently fish obtained from such water **(Mason, 1991)**.Theseheavy metals come in contact with our bodiesvia food, drinking water and air. Heavy metals aredangerous, because they tend to bio-accumulate (increase in concentration in biological cellsover time).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 offals of the food animals **(Gracey and Collins, 1992).**

The heavy metal may be attributed to presence in muscles of fish as well as lead, cadmium, copper and mercury present in Oreochromis niloticus **(Adeosun et al., 2015),** Claries lazera **(Ayeloja et al., 2014),**Imported mugil cphalus **(Shreadah et al., 2015)**and Mackerel **(Saad et al.,2014)**

Lead has hepatotoxic effects and showing significant increase in liver function test parameters**.(Adeyemi et al. 2009).**

Cadmium is nephrotoxic, initially causing kidney tubular damage. Cadmium can also cause bone damage, either via a direct effect on bone tissue or indirectly as a result of renal dysfunction. **(Wang et al., 2008).**

Copper is an essential trace element that is extremely toxic to organisms and organs at high doses. Copper sulfate toxic dose shows oxidative damage in liver in forms of granular degeneration, necrosis of hepatocytes and impairment to the cell lining of the remark cords that are confirmed biochemically by the changes in malondialdehyde and glutathione levels **(Emin et al., 2010).**

Mercury exist in various forms: elemental or (metallic), inorganic (e.g mercuric chloride) and organic (e.g methyle and ethyle mercury). All these forms have different toxicities and implications for health**.**Eating contaminated fish and shellfish is the main source of methyl mercury exposure, especially in populations that rely heavily on consumption of predatory fish**(IPCS, 2000).**

Therefore, the aim of this study is to determine some heavy metals residues (lead, cadmium, copper and mercury) in some native fish (Oreochromis niloticus and Claries lazera) and imported fish (Mugil cephalus and Scomber scombrus) in Fayoum Governorate .The public health importance and the hazardous toxic effects of these heavy metals was discussed as well as the suggestive recommendations to minimize fish contamination with these heavy metals were mentioned.

MATERIAL AND METHODS

Collection of samples:

A total of 100 random muscle samples of Oreochromis niloticus, Claries lazera, imported mugil cephalus and Scomber scombrus fish. (25 of each) were collected from different markets in Fayoum City for determination of lead, cadmium, copper and mercury levels.

Preparation of samples

The samples were prepared according to **(EL-Mowafi, 1995).**

Digestion procedure

The samples were digested for detection of Lead, Cadmium and Copper according to **(Julshamn, 1983).**

The samples were digested for detection of mercury according to **(Diaz et al, 1994).**

Quantitative determination

The determination of heavy metals was carried out by "Buck scientific 210VGP Atomic Absorption Spectrophotometer.

The metal residual levels were directly recorded from the digital scale of A.A.S and they were calculated according to the following equation:

Element (ppm) = R*D/W

Where; R= Reading of element concentration by ppm from digital scale of A.A.S

D= Dilution of prepared sample.W= Weight of the sample

RESULTS AND DISCUSSIONS

Table (1) The mean values of heavy metal residues in examined local and imported fish samples .

	Oreochromis niloticus	Claries lazera	Imported mugil cephalus	Scomber scombrus
Lead	0.2497±0.03542[a]	0.4276±0.04382[ab]	0.3226±0.05108[ab]	0.4773±0.07348[b]
Cadmium	0.0518±0.01105[a]	0.04988±0.01207[a]	0.04628±0.01931[a]	0.119±0.06006[a]
Copper	2.497±0.224[a]	2.331±0.3257[a]	2.229±0.2945[a]	2.061±0.2286[a]
Mercury	0.03793±0.01157[a]	0.07496±0.01707[a]	0.05696±0.01459[a]	0.05816±0.01208[a]

Result expressed as mean ± S.E

Means with no common superscripts are significantly different at P< 0.05

Figure (1) The mean values of heavy metal residues (ppm, wet weight) in examined Local and imported fish samples

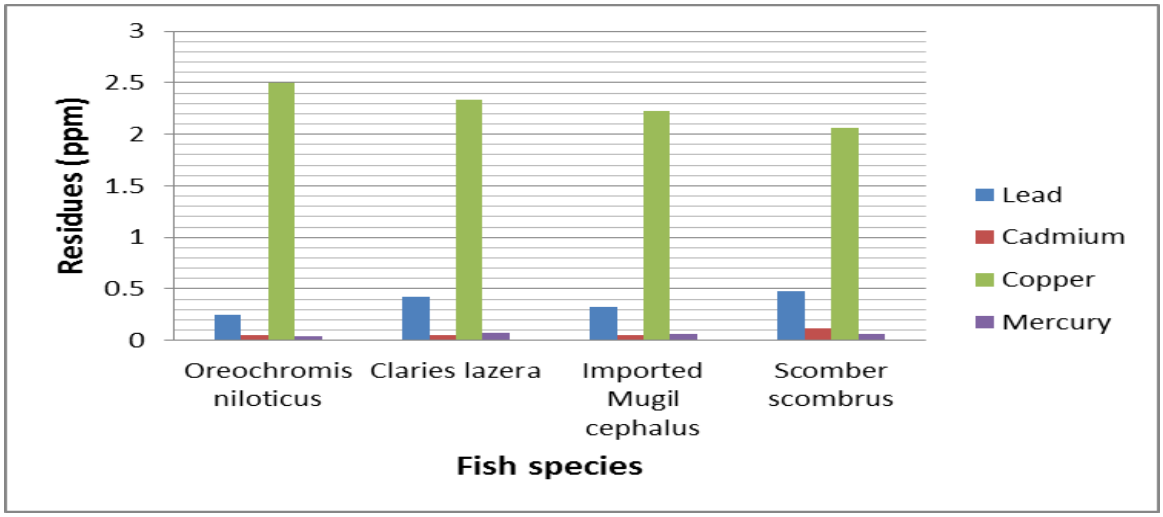

Table (2) The residual levels of heavy metal in examined fish samples as compared with the permissible limit

metal	fish	FAO/WHO (1989)	Commission Regulation (2006)	samples below&within permissible limit		samples above permissible limit	
				No	%	No	%
Lead	Oreochromis niloticus	-	0.3 mg/kg	16	64	9	36
	Claries lazera	-	0.3 mg/kg	9	36	16	64
	Imported mugil cephalus	-	0.3 mg/kg	14	56	11	44
	Scomber scombrus		0.3 mg/kg	11	44	14	56
Cadmium	Oreochromis niloticus	-	0.05 mg/kg	14	56	11	44
	Claries lazera	-	0.05 mg/kg	17	68	8	32
	Imported mugil cephalus	-	0.05 mg/kg	19	76	6	24
	Scomber scombrus	-	0.05 mg/kg	14	56	11	44
Copper	Oreochromis niloticus	30 mg/kg	-	25	100	0	0
	Claries lazera	30 mg/kg	-	25	100	0	0
	Imported mugil cephalus	30 mg/kg	-	25	100	0	0

	Scomber scombrus	**30 mg/kg**	-	**25**	**100**	**0**	**0**
Mercury	Oreochromis niloticus		**0.5 mg/kg**	**25**	**100**	**0**	**0**
	Claries lazera	**-**	**0.5 mg/kg**	**25**	**100**	**0**	**0**
	Imported mugil cephalus		**0.5 mg/kg**	**25**	**100**	**0**	**0**
	Scomber scombrus		**0.5 mg/kg**	**25**	**100**	**0**	**0**

Table (3) Estimated weekly intakes of consuming fish for adult person based on mean level of heavy metal found in fish samples .

Heavy metal	Fish	Mean residual level (mg/kg)	EWI µ/adult person	EWIµ/kg b.w	Provisional permissible tolerable weekly intakes(PTWI)(µg/kg bw)
Lead	Oreochromis niloticus	**0.2497**	**84.898**	**1.41**	**25**
	Claries lazera	**0.4276**	**145.384**	**2.42**	
	Imported mugil cephalus	**0.3226**	**109.684**	**1.82**	
	Scomber scombrus	**0.4773**	**162.282**	**2.70**	
Cadmium	Oreochromis niloticus	**0.0518**	**17.612**	**0.29**	**7**
	Claries lazera	**0.0498**	**16.932**	**0.28**	

	Imported mugil cephalus	**0.04628**	**15.735**	**0.26**	
	Scomber scombrus	**0.119**	**40.46**	**0.67**	
Copper	Oreochromis niloticus	**2.497**	**848.98**	**14.14**	
	Claries lazera	**2.331**	**792.54**	**13.209**	**3500**
	Imported mugil cephalus	**2.229**	**757.86**	**12.631**	
	Scomber scombrus	**2.061**	**700.74**	**11.679**	
Mercury	Oreochromis niloticus	**0.03793**	**12.89**	**0.21**	
	Claries lazera	**0.07496**	**25.48**	**0.42**	**5**
	Imported mugil cephalus	**0.05696**	**19.36**	**0.32**	
	Scomber scombrus	**0.05816**	**19.77**	**0.329**	

EWI: estimated weekly intakes from consumption of 12 ounces (approximately 340 grams) of fish every week by adult person of 60 kg body weight according to US EPA (2004).

DISCUSSION

In the present study, the results in table (1) revealed that lead levels were 0.2497, 0.4276, 0.3226 and 0.4773(ppm), in Oreochromis niloticus, Claries lazera, imported Mugil cephalus and Scomber scombrus fish, respectively.

It is worth to mention that the lead residual level in Oreochromis niloticus was significantly (P< 0.05) lower than the Scomber scombrus fish,while, there was no significant differences (P< 0.05) with other fish species (Claries lazera and imported Mugil cephalus). On the other hand there was no significance difference (P<0.05) between the examined fish species in releation to cadmium, copper and mercury residual level. These results are nearly similar to that obtained by **EL-Kewaiey et al. (2011).** Low results recorded by **Sireli et al. (2006) and Ekpo et al. (2008).**The examined samples exceeded the permissible limits of **Commission Regulation (2006)** which mentioned that lead level should not more 0.3 ppm, (table 2).

The mean cadmium levels were 0.0518, 0.0498, 0.04628 and 0.119 (ppm), in Oreochromis niloticus, Clarieslazera, imported mugil cephalus and Scomber scombrus fish, respectively. These results are nearly similar to that obtained by **Ayeloja et al. (2014)**. These results were higher than that recorded by **Ekpo**

et al (2008) and **Badr et al. (2014).** Samples were exceeding the permissible limit (0.05 ppm) reported by **Commission Regulation (EC) (2006)**(table2).

The mean copper residual levels were 2.497, 2.331, 2.229 and 2.061 ppm in muscles of Oreochromis niloticus, Clarieslazera, imported mugil cephalus and Scomber scombrus fish, respectively. These results are nearly similar to that obtained by **AL-Kahtani (2009)** and **Kaoud and EL-Dahshan (2010).** High results recorded by **Ali and Fishar (2005).**Table (2) showed that none of the examined muscle samples exceeded the limit of **FAO/WHO (1989)** which stated that the permissible limit of copper should not exceed 30 ppm .

The mean mercury residual levels in muscles of Oreochromis niloticus, Claries lazera, imported mugil cephalus and Scomber scombrus fish were 0.0379, 0.0749, 0.0569 and 0.05816 ppm, respectively. These results are nearly similar to that obtained by **Hussein and Abd El-Rahaman (2008**). High results were detected by **Soliman (2006)** and **Shreadah et al. (2015).** None of the examined samples exceeded the limit of **Commission Regulation (EC) (2006)**which stated that the permissible limit of mercury should not exceed 0.5 mg/kg. On the other hand, the calculated weekly intake of lead (Pb) estimated by µg/kg .b.w for adult person of 60 kg body weight in this study from eating 12 ounces (approximately 340 g) of each Oreochromis niloticus, Claries lazera, imported mugil cephalus and Scomber scombrus are 1.41, 2.42, 1.82 and 2.70, respectively. These values were lower than the provisional tolerable weekly intake recommended by **JECFA (2004)** which is 25µg/kg b.w. while for cadmium it is 0.29, 0.28, 0.26, and 0.67 respectively. These values were lower than the provisional tolerable weekly intake recommended by **JECFA (2004)** which is 7µg/kg b.w.

It is obvious that the calculated weekly intake of copper (Cu) are 14.14, 13.209, 12.631, and 11.679 respectively, which were lower than the maximum provisional tolerable weekly intake recommended by **JECFA (2004)** which is 3500 µg/kg b.w. while for mercury it is 0.21, 0.42, 0.32, and 0.329 respectively .These values were lower than the maximum provisional tolerable weekly intake which is 5µg/kg b.w recommended by **JECFA (2004).** According to the estimated daily and weekly in take, there is no risk of normal fish consumption originating from the local market on Fayoum people's health. Although the residual level of copper and mercury is not high, care must be taken considering some people regulary consume large quantities of fish as heavy metals especially mercury have the ability of bioaccumulation and biomagnifications.

From the present data it could be concluded that the Scomber scombrus fish has the highest level of lead and cadmium comparing with other species, but there was no single type of fish that was consistently high for all metals. From the present data it was recommended that people should choose smaller fish within a species as they may have lower contaminant levels, while the larger fish may be more contaminated because they have had more time to accumulate contaminants in their bodies, especially the mercury which has the ability of bioaccumulation and biomagnifications through the food chain, also people should eat a diversity of sea food to avoid consuming unhealthy quantities of heavy metals.

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