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ASSESSMENT OF HEAVY METAL IN LOCAL AND IMPORTED FILLETED FISH IN ASSIUT CITY, EGYPT

(With 3 Tables)

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تقييم العناصر الثقيلة فى السمك الفليه المحلى والمستورد بمحافظة أسيوط – مصر

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هذه الدراسة أجريت لتحديد تركيزات بعض العناصر الثقيلة (الرصاص، الكادميوم، المنجنيز، النيكل والحديد) فى السمك الفليه المحلى (البلطى النيلى وقشر البياض) والمستورد (السابا) فى محافظة أسيوط. أستخدم جهاز المطياف الذرى لقياس هذه العناصر بعد تجفيفها. كان متوسطات التركيزات لعناصر الرصاص، الكادميوم، المنجنيز، النيكل والحديد كالأتى: 5.17± 4.91، 2.15± 1.95، 3.61± 4.35، 3.74± 3.52 و 30± 12.56 مجم / كجم وزن جاف فى السمك الفليه المحلى، بينما كان فى السمك الفليه المستورد كالأتى: 6.90 ±4.035، 2.44±1.52، 4.74± 2.89، 1.88± 2.57 و 24± 14,15 مجم / كجم وزن جاف على الترتيب. تبين من النتائج أنه لم يوجد أختلاف واضح بين نتائج تركيزات المعادن فى السمك الفليه المحلى والمستورد وأيضا بين البلطى النيلى الفليه وقشر البياض الفليه عند مقارنتهما بعد أجراء التحليل الأحصائى.

SUMMARY

Heavy metal (Pb, Cd, Mn, Ni, and Fe) concentrations in the local (*Tilapia nilotica* and *Nile perch*) and imported (Saba) filleted fish were investigated in Assiut city using Atomic Absorption Spectrophotometer (AAS)**.** The mean values of Pb, Cd, Mn, Ni and Fe were 5.17±4.91, 2.15±1.95, 3.61±4.35, 3.74±3.52 and 30±12.56 mg/kg dry weight in local filleted fish, while in imported fish they were 6.90±4.035, 2.44±1.52, 4.74±2.89, 1.88±2.57 and 24±14.15 mg/kg dry weight, respectively. There was no significant difference in heavy metals concentrations between local filleted and imported filleted fish and also between filleted *Tilapia nilotica* and *Nile perch* in case of Ni and Fe, but *Tilapia nilotica* higher than *Nile perch* in case of Pb, Cd and Mn after statistical analysis.

Key words: *Heavy metal, filleted fish.*

INTRODUCTION

Fish is a valuable source of high quality protein, polyunsaturated fatty acids, minerals and vitamins, the health benefits of which are widely recognized. Recently, public confidence has been shaken by reports that highlighted the risks associated with dietary exposure to environmental contaminants, such as trace elements which are known to accumulate in fish. Heavy metal residues in fish flesh and its hazard effects on the health of people are a matter of great concern to food hygienists. There was a seasonal variation in heavy metals concentration and also heavy metals accumulate differentially in fish organs (Mansour and Sidky, 2002).

The pollution of water with heavy metals has become a worldwide problem during the last decade, because most of pollutants have toxic effects on organisms (MacFarlane and Burchett, 2000). Studies from the field and laboratory experiments showed that accumulation of heavy metals in a tissue is mainly dependent upon water concentrations of metals and exposure period; although some other environmental factors such as salinity, pH, hardness and temperature play significant roles in metal accumulation. Ecological needs, sex, size and molt of marine animals were also found to affect metal accumulation in their tissues (Kalay *et al.*, 1999).

Metals are considered as major environmental pollutants causing cytotoxic, mutagenic and carcinogenic effects in animals (More *et al.*, 2003). The essential metals can also be toxic when the metal intake is more than needed (Tüzen, 2003). Heavy metals including both essential and non-essential elements have a particular significance in ecotoxicology (Storelli *et al.*, 2005). Metal ions can be incorporated into food chains and concentrated in aquatic organisms to a level that affects their physiological state. Metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in tissues (Censi *et al.*, 2006). Heavy metals such as copper, iron, chromium and nickel are essential metals, but cadmium and lead are non-essential metals, as they are toxic, even in trace amounts (Fernandes *et al.*, 2008).

Cadmium toxicity resulted in osteomalacia (Friberg, 1984). Lead toxicity resulted in anemia, disorders of C.N.S. including hyper-activity and in severe cases headache, muscular tremors and loss of memory, kidney failure, convulsion, coma and death (Shibamoto and Bjeldanes, 1993). High doses of copper may lead to Wilson's disease characterized by destruction of nerve cells, liver cirrhosis, ascites, edema and hepatic failure (Guven *et al.*, 1999).

Khaled (2004a) investigated heavy metal (Cd, Cr, Cu, Fe, Mn, Ni, Pb nd Zn) concentration in five fish species collected from El-Mex Bay, Alexandria. The author reported that metal concentrations were lowest in muscle and highest in gill and liver tissues due to their physiological roles in fish metabolism where the metabolic activity is higher. So there is no risk yet for human consumption of flesh of these fishes.

The objective of this study was to determine the heavy metals concentrations (Pb, Cd, Mn, Ni, and Fe) in filleted fish using Atomic Absorption spectrophotometer (AAS) technique and compare between local and imported fish fillet, also to compare between *Tilapia nilotica* and *Nile perch.*

MATERIALS and METHOD

Samples collection:

Fifty samples of local (*Tilapia nilotica* (13) and *Nile perch* (12)) and imported (Saba) (25) filleted fish were collected from Assiut city retail markets during first half of year 2010 and analyzed for determine the concentration of several types of metals (Pb, Cd, Mn, Ni and Fe). The collected samples were transferred to the laboratory were kept under freezer at -18°C until analyzed.

Preparation of samples for analysis:

Fifty gm of fish fillet were weighted from each dried in a hot air oven (100 - 105°C) till the wet tissues reached to a constant weight According to (AOAC, 2006). Moisture content of each sample was calculated, so our results are related to the dry weight of the samples and/or wet weight.

One gram was taken from the dried grinded sample into a flask. 5 ml of nitric acid was added. The digestion flasks were kept overnight, and then putted on the hotplate at 80 °C until all the tissues were dissolved and the brown fumes of NO_3 escaped, filtered and diluted till 25 ml with distilled water. A blank was carried out in the same way.

Preparation of the standard solutions:

All metals were determined against aqueous standards. Standards prepared at dilutions 0, 0.5 and 1 ppm. The elements analyzed were Mn, Cd, Pb, Ni and Fe. Stock standard solutions (Merck, Germany) of each element were used to prepare calibration solutions to obtain calibration curves.

The metal analyses of samples were carried out in the Central laboratory of the Faculty of the Veterinary Medicine, Assiut University using a ZEEnit 700 P atomic absorption spectrophotometer. The contents of heavy metals are expressed as mg/kg of the sample based on dry weight. Statistical analysis carried out by using Paired-Sample T Test to compare and describe results.

RESULTS

Table 1: Concentration (mg/kg dry weight) of the tested heavy metals in the examined imported and local filleted fish samples:

Heavy metals	Imported filleted fish			Local filleted fish			Significance
	Min	Max	Mean ± SD	Min	Max	Mean ± SD	
Lead	0.28	15.29	6.90±4.035	0	13.51	5.17±4.91	N.S.
Cadmium	0	6	2.44±1.52	0	6.29	2.15±1.95	N.S.
Manganese	0.7	8.38	4.74±2.89	0.12	15.11	3.61±4.35	N.S.
Nickel	0	6.70	1.88±2.57	0	12.41	3.74±3.52	N.S.
Iron	0	38.95	24±14.15	20.74	54.31	30±12.56	N.S.

N.S. not significant

Table 2: Concentration (mg/kg dry weight) of the tested heavy metals in the examined flitted *Tilapia nilotica* and *Nile perch* fish samples:

Heavy metals	Flitted *Tilapia nilotica*			Flitted *Nile perch*			Significance
	Min	Max	Mean ± SD	Min	Max	Mean ± SD	
Lead	6.99	13.5	10.50±2.69	0	6.995	3.34±3.49	*
Cadmium	4.33	6.29	4.60±0.63	0	3.375	1.64±1.10	*
Manganese	7.56	15.11	11.79±3.13	0.123	1.312	0.73±0.49	*
Nickel	5.95	8.94	7.596±1.29	0	12.41	4.22±4.86	N.S.
Iron	21.79	54.31	31.164±9.36	9.08	47.05	27.96±12.75	N.S.

* Significant at *p* 0.001

Table 3: Frequency distribution and comparing between concentration of heavy metals in imported and local fish according to permissible limit of EOSQC (1993).

Heavy metals	Imported fish				Local fish				*P.L. (ppm)
	**M. P. L.		***L.P.L.		M. P. L.		L.P.L.		
	No.	%	No.	%	No.	%	No.	%	
Lead	4	16	21	84	6	24	19	76	0.1
Cadmium	5	20	20	80	7	28	18	72	0.1
Manganese	6	24	19	76	8	32	17	68	0.5
Nickel	0	0	25	100%	0	0	25	100%	10
Iron	0	0	25	100%	0	0	25	100%	30

***** P.L. = permissible limit according to EOSQC (1993)
******M. P. L. = More than the permissible limit
*******L.P.L. = Lower than the permissible limit

DISCUSSION

In the literature, heavy metal concentrations in the tissue of fish vary considerably among different studies (Chattopadhyay *et al*., 2002; Papagiannis *et al*., 2004), possibly due to differences in metal concentrations and chemical characteristics of water from which fish were sampled, ecological needs, metabolism and feeding patterns of fish and also the season in which studies were carried out. In the river, fish are often at the top of the food chain and have the tendency to concentrate heavy metals from water (Mansour and Sidky, 2002).

Lead could contaminate water from industrial and agricultural discharges, high ways or motor traffic and from mine (Sorensen, 1991). Lead residues could result in haematological, gastrointestinal and neurological dysfunction. Severe or prolonged exposure to Pb may also cause chronic nephropathy, hypertension and reproductive impairment. Pb inhibits enzymes, alters cellular calcium metabolism and slows nerve conduction (Elinder, 1985a).

The mean values ± S.D. of Pb were 5.17±4.91 and 6.90±4.035 mg/kg dry weight in local and imported filleted fish, respectively (Table 1). The concentration of the analyzed elements in relation to wet weight can be obtained by dividing its concentration in dry bases by five by using moisture content of the analyzed samples. This formula agree with (Khaled, 2004b), who reported that the concentration of dry weight can be obtained by multiplying the concentration of wet weight by five. This result was nearly harmony to those reported by Saleh (2004) and Ahmed and Hussein (2004). The result was higher than that recorded by El-Nabawi *et al.* (1987) who found that the mean level of Lead was 0.42 µg/g , Zauke *et al.* (1999) who found Pb concentrations below the limit of detection (< 0.3 mg kg-1 dry wt), and Labib *et al.* (2008) who found that the Pb concentration ranged from 0.12 to 0.53 ppm wet weight in *Tilapia nilotica*, and *Claris Lazera* collected from five districts of Qena governorate, Upper Egypt, Metwally and Fouad (2008) who found that the mean lead levels in *Tilapia nilotica* caught from Nag-Hamady, Qena, Kous, Luxor and Esna in Egypt were 0.530±0.085, 0.690±0.170, 1.124±0.209, 0.598±0.087 and 0.446±0.079ppm wet weight, respectively. The level of Pb was lower than that found by Mohamed and Gad (2008).

Hodson *et al.* (1984) indicated that the Canadian Pb limit of 10 ppm was discontinued, but that of the British limit remains at 2 ppm for fish. Abou-Arab *et al.* (1996) indicated that the FAO limit (1983) is 2.0 ppm. WHO (1990) indicated that Pb permissible limit is 2.0 ppm for seafoods. Obodo (2002) reported the case of polluted species of fish from the lower course of the River Niger at Onitsha. His work showed that tilapia was polluted with Pb having a bio-concentration of 68.36 mg/kg. The mean residuals level of lead detected by Ahmed and Hussein (2004) was 1.51 and 1.74 ppm/wet weight for *M. cephalus* and *T. nilotica*, respectively. Oze *et al.* (2006) detected lead in a level of 25.58 ± 1.2 mg/kg against the WHO safety limit of 2.5 mg/kg.

Maximum level for Pb must not exceed 0.1 ppm wet weight, respectively (EOSQC, 1993). According to EOSQC (1993) 16% of imported filleted fish and 24% of local exceed the permissible limit (Table 3).

From this study it was found that no significant difference in Pb level between local and imported filleted fish as shown in Table (1) but slightly higher in Pb, Cd and Mn in *Tilapia nilotica* than *Nile perch* as recorded in Table (2) and this may be attributed to sensitivity of *Tilapia nilotica* for toxicity.

Cadmium can be found in all foodstuffs, and particularly high amounts occur in organs of cattle, seafood, and some mushroom species. Although the absorption of cadmium is low in the GI tract, it has a long biological half-life because it accumulates in the body. The International Agency for Research on Cancer has determined that cadmium is probably carcinogenic to humans (Stanley 2004). The sources for cadmium pollution are mining company, many industrial companies as those of pigments and stabilizers for plastics, sewage sludge applied to land and fertilizers

(Mason, 1991). Extremely wide ranges of Cd concentrations have been reported in foodstuffs from various countries.

As shown in Table (1) cadmium mean levels were 2.15±1.95 and 2.44±1.52 mg/kg dry weight in local and imported filleted fish, respectively, while the levels in *Tilapia nilotica* and *Nile perch* were4.601±0.63 and1.641±1.10 mg/kg dry weight, respectively (Table 2**).** Gutenmann *et al.* (1988) showed that a frequently used food safety limit for Cd in food is 2 ppm. In 1993, Food and Agriculture Organization (FAO) limit for Cd is 0.5 ppm. WHO, (1990) indicated that Cd permissible limit is 2.0 ppm for seafood. Data from reliable analyses performed in several countries (Elinder, 1985b; WHO/FAO, 2003) indicate that most foodstuffs have Cd concentrations in the range 0.005–0.100 mg/kg (mean values, wet weight). Atta *et al.* (1997) detected Pb and Cd in a concentration of 12.1 and 1.92 mg/kg dry weight respectively in raw flesh *Tilapia nilotica* fish. Cadmium was detected in a mean residuals levels of 0.60 and 0.77 ppm wet weight for *M. cephalus* and *T. nilotica*, respectively (Ahmed and Hussein, 2004). Al-Kahtani (2009) detected Cd in *Oreochromis niloticus* in a total average of 0.28 mg/kg dry weight. Maximum level for Cd must not exceed 0.1 ppm wet weight, respectively (EOSQC, 1993). According to EOSQC (1993) 20% of imported and 28% of local filleted fish exceed the permissible limit (Table 3).

This result agreed with Labib *et al.* (2008) who found that the Cd concentration ranged from 0.32 to 0.42 ppm wet weight, but higher than El-Nabawi *et al.* (1987) who reported that the Cd level in the examined muscle tissues of *Tilapia nilotica* caught from Abo-Qir Bay, Edku and Maruit lakes ranged from 0.018 to 0.023 µg/gram. Also higher than Sorensen, (1991), Oehlenschlarger (1990) and Zauke *et al.* (1999) who found Cd concentrations was below 0.1 mg kg-1 dry wt**,** while less than Tariq *et al.* (1994) and Saleh (2004).

Manganese is essential for formation of thyroxin, vit. K production and is effective in increasing copper excretion from the body (Committee on Dietry Allowance, Food and Nutrition Board, 1980).

Mean levels of Mn were 3.61±4.35 and 4.74±2.89 mg/kg dry weight in local and imported filleted fish sample, respectively (Table1). The mean levels in filleted *Tilapia nilotica* and *Nile perch* were11.793±3.13 and 0.73±0.49 mg/kg dry weight, respectively (Table 2). 24% of imported filleted fish and 32% of local had Mn content exceeded the permissible limit proposed by EOSQC (1993) (Table 3).

Levels of Mn considered in harmony with Khaled (2004a, b). The result was lower than that found by Mohamed and Gad (2008), but higher than the result found by Rashed (2001).

Concentrations of Ni in local and imported filleted fish were 3.74±3.52 and 1.88±2.57 mg/kg dry weight, respectively (Table 1). Concentrations in filleted *Tilapia nilotica* and *Nile perch* were 7.596±1.29 and 4.217±4.86 mg/kg dry weight respectively (Table 2). According to EOSQC (1993) all samples were lower than the permissible limit (Table 3). The result was lower than the result recorded by Khaled (2004a), but higher than that recorded by Zauke *et al.* (1999) who found Ni concentration below 1 mg kg-1 dry wt in muscle tissues of 15 marine fish species.

In local and imported filleted fish samples concentrations of iron were 30±12.56 and 24±14.15 mg/kg dry weight, respectively (Table 1). Concentrations in *Tilapia nilotica* and *Nile perch* were 31.164±9.36 and 27.96±12.75 mg/kg dry weight, respectively (Table 2). According to EOSQC (1993) the concentrations measured in all samples were lower than the permissible limit (Table 3). The result was lower than that reported by Mohamed and Gad (2008). These results agree with Abou- Arab *et al.* (1996) who found that Mn and Fe were lower than the permissible limits proposed by FAO.

Lead level in this study was lower than the permissible limit proposed by FAO (1983), while results of Mn and Fe were lower than that recorded by Mansour and Sidky (2002).

In Nasser Lake, Egypt two species (*Tilapia nilotica, named* Bolti, and Karmout) were used by Rashed (2001) as a biomarker for water pollution with metals. The result reveals that heavy metals in different water samples except Cu and Zn were more than the recommended permissible levels by EQSAC (1993). Iron level in Hawamdia and Kafer-El-Zayat *Tilapia nilotica* samples (63.4 and 54.7 µg/g respectively) was more than its permissible levels; these may be due to the discharge of the adjacent chemical factories that used Fe in their processing. Karmout fish from the same locations (Kafer El-Zayat and Hawamdia) had lower concentration of Cu, Zn, Ni, Cd and Pb than bolti, while Fe present in higher concentration in bolti than in Karmout Fish of farms exhibit lower concentrations of Cu, Ni, Zn, Fe and Co than those from River Nile. This indicates that the fish especially Bolti was a good indicator for metal pollution.

From this study, it was concluded that there was no significant difference in analyzed heavy metal concentration between the examined local and imported fillet fish. The concentrations of Pb, Cd and Mn were slightly higher in filleted *Tilapia nilotica* than *Nile perch*.

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