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Detection of residues of some heavy metals in fish fillets in Egyptian markets

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Fifteen samples of fish fillets were collected from different Egyptian markets to detect the residues of some heavy metals in them. The average weights of fish fillets samples were 250g. The samples were separately packed in polyethylene bag and sent to the laboratory for preparation and analysis. All equipment surfaces and utensils which used in this study were thoroughly cleaned with detergent, rinsed with water, dried and then rinsed with 2-propanol solution. The samples were stored at –2°C prior to analysis. The mean levels of lead and cadmium in fish fillets collected from the Egyptian markets were 1.51 ± 0.34 and 0.60± 0.0.25 mg/kg; respectively. The concentration of lead in fish muscle were less than the permissible heavy metal limit in fish meat (2.0 mg kg) as stated by the World Health Organization, also these results were in line with the corresponding EU regulations. However the level of cadmium concentration was over than the heavy metal limits in fish meat (0.5 mg/kg) for the World Health Organization.

Heavy metals such as cadmium and lead are common air pollutants and are emitted (predominantly into the air) as a result of various industrial activities WHO, (2007).

Many dangerous chemical elements, if they released into the environment, they were accumulated in the soil or sediments of water (Schuurmann and Markert 1998).

The low aquatic organisms absorb and transfer them through the food chain to higher trophic levels, including fish. Under acidic conditions, the free divalent ions of many metals may be directly absorbed by fish gills from the water (Part *et al.,* 1985). Hence, concentrations of heavy metals (HM) in the organs of fish are primarily determined by the level of pollution of the water and feed (Farkas *et al.,* 2000).

Heavy metal residues in fish flesh and its hazard effects on the health of people are a matter of great concern to food hygienists. The most non-essential heavy metals of particular concern to fish and surface water are cadmium (Cd) and lead (Pb); which have the way to fish flesh mainly via gills (Tao *et al.,* 1999; Tao *et al.,* 2000).

Health safety is a very important aspect of food quality (Oledzka, 1999). Hazardous substances enter the food chain through the soil, air and water and are the main sources of contamination for humans. Heavy metals are among the most dangerous contaminants. In spite of more and more rigorous norms concerning their presence in food, and despite the introduction of quality assurance systems, it is impossible to get rid of them from food. Their presence in food is a result not only of the contamination of raw materials, but they can also originate from machines and industrial plants, food additives, and materials used in cleaning and disinfection procedures (Skibniewska, 2003). Recently, various dumps have become sources of serious environmental contamination. Very often they were built without due care which allowed leaks to occur from the deposits (Skibniewska *et al.,* 2008). Every kind of waste, including pesticides, contains some quantity of heavy metals that can escape into the soil and ground water.

Contamination of fresh water fish with heavy metals is a recognized environmental problem. Increase in agricultural and industrial activities in an area directly influences the quality of water. In other words, water reservoirs are collectors of all materials spread by human industrial and agricultural activities. Heavy metals penetrate into water reservoirs via atmosphere, drainage, soil waters and soil erosion. As the concentration of heavy metals in the environment increases, the metals inevitably enter the biogeochemical cycle (Mansour and Sidky, 2002; Riget *et al.,* 2004). Having contaminated water, Heavy metals accumulate in organisms, which are consumed by fish or directly penetrate into fish through skin and gills later (Sinha *et al.,* 2002; Surec, 2003).

Heavy metals cause the mutation of fish inner organs, disturbance of immune reactions, change blood parameters, reduce an organism's adaptation qualities, vitality, resistance to diseases, loss of fry and degeneration and diminution of valuable varieties of fish are observed as a result of heavy metals pollution (Alabaster and Lloydr, 1994; Blasco *et al.*, 1999).

Use of agriculture and industry has been identified as a major source of wide dispersion into the environment and food. The major route of exposure to cadmium for the non-smoking general population is via food; the contribution from other pathways to total uptake is small (Goyer, 1991).

Lead pollution is multidimensional, including food processing techniques, traffic pollution and other factors. Lead poisoning is generally ranked as the most common environmental health hazard (Goyer, 1991). The most common routes of human lead exposure are inhalation of traffic exhaust fumes, inadvertent ingestion of lead paint and consumption of lead contaminated foods (Adekunle and Akinyemi, 2004). However, the uptake of lead through the food chain is of less importance since the concentration of lead in fish does not increase with trophic level and age but with increasing concentration in the water (Oehlenschlager, 2005).

Lead and cadmium are the most commonly distributed environmental metal poisons and each of these persistent contaminants has been blamed for large scale poisoning incidents. Several organizations such as Food and Agriculture Organization (FAO) and the World Health Organization (WHO) provide guidelines on the intake of trace elements by humans. The provisional tolerable weekly intake (PTWI) recommended by the Joint FAO/WHO Expert Committee for cadmium are 7 μg / Kg body weight per week (Anon, 2003) and 25 μg / kg body weight per week for lead (Anon, 1993).

Therefore, the aim of this study was to determine the concentration of lead and cadmium in fish fillets in different places in the Egyptian markets.

Materials and methods

Samples collection. Fifteen samples of fish fillets were collected from different markets in Egypt. The average weight of fish fillets samples was 250g. The samples were separately packed in polyethylene bag and sent to the laboratory for preparation and analysis. All equipment surfaces and utensils which used in this study were thoroughly cleaned with detergent, rinsed with water, dried and then rinsed with 2-propanol solution. The samples were stored at –2°C prior to analysis.

Samples preparation for heavy metals (Cadmium and lead) residues. Cadmium and lead were determined according to AOAC (1996). Fish fillets was minced and well mixed, and then approximately 25g were ignited in order to be converted into ash as a preliminary preparation for heavy metal analysis (ashing was carried out using muffle furnace at a temperature of 500 C^o overnight). To the ashed sample, 10 ml concentrated nitric acid were added with swirling. After a short soaking period, 5mL of 60% perchloric acid were added and the mixture was slowly heated on a hot plate until the conclusion of growth (approximately 2h). The mixture was then heated until the appearance of dense white fumes that indicate the nitric acid had evaporated and perchloric acid had reached its boiling point. The mixture was cooled, 10 ml of 25% hydrochloric acid were added and the solution was transferred to a 100 ml volumetric flask that was subsequently brought to volume with deionized water. Assessment of metals level in prepared samples were carried out using an atomic absorption spectrophotometer (*Model 3100, Perkin-Elmer, Norwalk, Conn , USA*) operated under conditions given by EPA, (1994). Instruments parameters were: flow rate, 1.5ml/min; sample pump tube, 0.48 ml/min; pump speed, 90 to 100 rpm; sample uptake time, 17 to 21s; flush time, 30s; integration time, 10s; wash time, 30s; background correction, on; and automatic blank subtraction, on. The low limits of detection were 0.10 ppm for cadmium and 0.50 ppm for lead.

Results and discussion

Table (1): Lead residues (ppm/wet weight) in fish fillets collected from Egyptian markets.

Item	Minimum	Maximum.	Mean ± S.E	P.L.*
Fish fillets	0.50	2.34	1.51 ± 0.34	2.00

P.L.* = Permissible Limit (WHO, 1990 and 1993)

Table (2): Cadmium residues (ppm/wet weight) in fish fillets collected from Egyptian markets.

Item	Minimum	Maximum.	Mean ± S.E	P.L.*
Fish fillets	0.10	1.03	0.60 ± 0.25	0.50

P.L.* = Permissible Limit **(WHO, 1990 and 1993)**.

Table (3): Main routes of lead exposure and critical effects identified with associated Blood lead levels for various population groups (ATSDR 2005).

Routes of intake	Population group (s)	Effects	Critical B-Pb (μg/l)
Placenta	Fetuses	Delays in neurological development	Probably no threshold
Mother's milk, Inhaled air,	Neonates and young children	Inhibition of δ-aminolevulinic acid dehydratase (an indicator of lead poisoning)	30–300
		Physical development	<70
Inhaled air, hand–mouth behaviour, ingestion	Children	Decreased nerve conduction velocity	200–300
		Cognitive development and intellectual performance	<100
		Hearing loss	<100
		Jaundice	350
		Anaemia	>200
Inhaled air, food ingestion	Adults	Decreased δ-aminolevulinic acid dehydratase (an indicator of lead poisoning)activity	30–340
		Blood pressure	<20
		Damage to renal function (decrease in glomerular filtration rate)	20–100
		Sperm count	400–500

The concentrations of lead measured in fish fillets (Table 1) varied from 0.5 to 2.34 mg/kg with a mean value of 1.51 ± 0.34 mg/kg.

The obtained results for the concentration of lead in fish muscle were less than the maximum heavy metal limits in fish meat (2.0 mg/kg) for the World health Organization (1990, 1993), also these results were in line with the corresponding EU regulations (Anonymous, 2005). These findings were in agreement with results obtained by Ahmed and Hussein, (2004). Low results were obtained by Zyadah, (1999), Al-Shawafi, (2002), Suppin *et al.,* (2005), Staniskiene *et al.,* (2006);Tansel *et al.,* (2006). High results were obtained by Mohamed and Abdel-Satar, (2005).

Health hazard characterization of lead. Lead is the well-studied toxic metal, and a wide range of biological effects dependent upon the level and duration of the exposure are known. The main health effects of lead exposure are summarized, together with routes of exposure, affected population groups and critical lead levels (Blood lead), in Table (3). Mortality in workers exposed to high levels of lead is increased, and adults who were poisoned by lead during childhood have increased blood pressure, which is a significant risk factor for cardiovascular diseases and mortality. Non-fatal mechanisms include renal effects; anaemia owing to the inhibition of several enzymes involved in haem synthesis; acceleration of skeletal maturation; alteration of hormone levels and immunity parameters. The encephalopathy (at high exposure) and various other diseases of the nervous system, among which cognitive and neurobehavioural deficits in children at low levels of exposure are of great concern. (ATSDR, 2005).

Table (2) showed the mean value of cadmium concentrations in analyzed samples which were 0.60 ± 0.25 with minimum value of 0.1 mg/kg and maximum value of 1.03 mg/kg. These findings were over than the maximum heavy metal limits in fish meat (0.5 mg/kg) for the World Health Organization (1990, 1993). The obtained results were similar to the results recorded by Parsons, (1999); Ahmed and Hussein, (2004). High results were obtained by Mohamed & Abdel-Satar, (2005); Vinodhini and Narayanan, (2008). Low parameters were obtained by Al-Shawafi, (2002); Suppin *et al.,* (2005); Staniskiene *et al.,* (2006).

Health hazard characterization of cadmium. Pulmonary absorption of inhaled cadmium ranges from 10% to 50% (WHO/ IPCS, 1992).

The average normal gastrointestinal absorption of ingested cadmium in humans ranges from 3% to 7%. Cadmium in the tissues is mainly bound to metallothionein. The synthesis of this protein probably represented the body's defense mechanism against the toxic cadmium ion.

Liver and kidney tissues are the two main sites of cadmium storage. The newborn infant is virtually free of cadmium but, over a lifetime, these organs accumulate considerable amounts of cadmium (about 40–80% of the body burden) (WHO, 2007).

In low-level environmental exposures, about 30–50% of the cadmium body burden is stored in the kidneys. Cadmium elimination from blood has been described, as having a fast-decay half-time of 15–120 days and a slow-decay half-time of 7–16 years. Cadmium is eliminated in urine and faeces; daily faecal and urinary excretion is estimated to constitute 0.007% and 0.009% of the body burden, respectively (ATSDR, 1999).

Important health end points include kidney and bone damage and cancer. The kidney is the critical organ with regard to long-term occupational and environmental exposure to cadmium, and all health-based recommendations relate to the early disturbance of renal function. (ATSDR, 1999).

Recommendations

To safeguard the fish consumers, the periodical evaluation of heavy metals residual level in the fish flesh and water from expected polluted area are of major importance **(**Kock and Hofer, 1998; Medani and Ahmed, 1999).

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الكشف عن بقايا بعض المعادن الثقيلة فى فيليه الأسماك فى الأسواق المصرية

تم تجميع خمسون عينة من فيلية الأسماك من أماكن مختلفة من جمهورية مصر العربية. وكان وزن العينة ٢٥٠ جرام وتم تغليف كل عينة على حدة وإرسالها الى المعمل للتجهيز والفحص. وتم قياس عنصرى الرصاص والكادميوم بواسطة جهاز الإمتصاص الذرى الضوئى وكانت نتيجة الفحص المعملى لمدى تواجد عنصرى الرصاص والكادميوم كالتالى:

متوسط مستوى تواجد الرصاص والكادميوم فى عينات فيلية الأسماك ١,٥١±٠,٣٤ و ٠,٦±٠,٢٥ملجرام/كيلوجرام. وكانت النتائج المدونة لتركيز عنصر الرصاص أقل من الحدود المسموح بها (٢ملجم /كج) المعلنة بواسطة منظمة الصحة العالمية وكانت متوافقة مع المستويات المدونة والقواعد المنظمة للإتحاد الأوروبى. وكانت نتائج تركيز عنصر الكادميوم أعلى من الحد المسموح به (٠,٥ملجم /كج) بواسطة منظمة الصحة العالمية.

وتم مناقشة مصادر التلوث بعنصرى الرصاص والكادميوم وكذلك الأهمية الصحية وتم وضع التوصيات اللازمة لتجنب التلوث بمثل هذه العناصر.