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ORIGINAL ARTICLE

Heavy Metals (Mercury, Lead and Cadmium) Determination in 17 Species of Fish Marketed in Khorramabad City, West of Iran

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KEYWORDS

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ABSTRACT: Heavy metals entrance to fish body tissues and transferring to human body systems after their consuming makes numerous undesirable effects and health problems. The aim of this study was to determine some heavy metals (lead, cadmium and mercury) in fresh fishes marketed in Khorramabad City, west of Iran. In this descriptive study, five samples of 17 fish species with high consumption were purchased randomly in 2014. Measurement of mercury, lead and cadmium was performed using atomic absorption spectrometry. All measurements were performed three times for each sample. Lead mean levels in fish samples was in the range 0.736 -1.005 ppm, cadmium range was from 0.196 to 0.015 ppm and mean content of mercury was 0.431 - 0.107 ppm. At present mean concentration of lead, mercury and cadmium in supplied fishes muscle is lower than maximum recommended levels according to WHO, EC and FDA guidelines. Based on the obtained results of this study and the importance of heavy metals in foods and their impacts on human health, continuous monitoring of heavy metals levels in foods is necessary.

INTRODUCTION

Nowadays, environmental pollution with toxic metals has increased and raw foods are in high risk with chemical contaminations. Heavy metals are classified as major chemical food contaminants, and their presence

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cause various health concerns (acute or chronic diseases) in the world as a result of their accumulation ability, toxicity (even at low concentration) and the nature of the non-biodegradability and stability [1]. Commonly heavy metals are chromium, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, antimony, mercury, thallium and lead. Heavy metals have harmful effects on vital cellular components and interfere with functioning of enzymes, nucleic acids and structural proteins [2]. The most dangerous heavy metals for human nutrition are lead, mercury and cadmium [3, 4]. Heavy metals are persistent pollutants that cause significant changes in biogeochemical cycles, and each of them has specific effects on living organisms [5, 6].

Environmental contamination sources for heavy metals are quite different including industrial agents, traffic, purification of sludge, agricultural practices such as organic mercury fungicides, lead and arsenic containing insecticides and cadmium containing fertilizers [7-9].

Heavy metals may accumulate in the bodies of aquatic organisms such as fish. They can be considered as a potential risk to the health of ecosystems and live organisms. Industrial wastes, geochemical composition and mining of metals are potential sources of aquatic environmental contamination with heavy metals [10]. Heavy metal contamination may have detrimental effects on the ecological balance and biodiversity of aquatic ecosystems [11].

Seafood products have significant role in food production in the world. For example, fish is a digestible food contains proteins, vitamins, minerals and omega-3 fatty acid that have many positive effects on human physical and mental health. It is estimated that 15% to 20% of the animal protein is of aquatic resources origin [12].

Heavy metals entrance to fish body tissues and transferring to human body cause undesirable effects on the human body systems and are result of numerous health problems [13]. Symptoms in human appear shortly after consuming contaminated fishes.

Regarding to harmful effects of heavy metals accumulation in fishes and growing consumption of fish in people diet, many researches were done on heavy metals bioaccumulation in fish body tissues especially on Persian Gulf and Caspian Sea fishes [14-23]

Due to the toxic effects of heavy metals and their detrimental effects on health of the public, as well as the growing production and widely consumption of fish meat in daily diet, the aim of this study was to determine mercury, lead and cadmium levels in different fish species of Khorramabad City, Lorestan Province and west of Iran.

MATERIAL AND METHODS

Sampling

In this descriptive study, five samples of 17 fish species with high consumption, marketed in Khorramabad City was purchased randomly during summer of 2014. Fish samples were transferred in polystyrene boxes containing ice to food control laboratory of Lorestan Province. Samples were stored frozen until testing at –20 °C.

Heavy metal determination in fish

The samples were washed with water, muscle and edible meat was removed and chopped. To stabilize the weight, samples were placed in the oven (Memmert, Germany) at 65°C for 120 - 150 minutes. Samples were digested by wet method:

0.5 g of stabilized weight samples was placed in a 250 ml flask. Twenty-five ml of concentrated sulfuric acid, 20 ml of 7 M nitric acid and 1 ml of 2% sodium molybdate were added to flask. Some boil stones were thrown to haemogenizing the boiling solution, then sample was cooled and 20 ml of a mixture of concentrated nitric acid and concentrated perchloric acid in a ratio of 1: 1 were added to samples slowly.

The mixture was heated to dissolve completely the acid white vapor, mixture was cooled and while shaking flask, 10 ml of distilled water was added slowly on the top of the refrigerant.

By heating (about 100 min) a complete clear solution was obtained. After cooling, solution was transferred to a 100 ml volumetric flask and was reached to volume [6, 24-28].

For measurement of metals, at first 5 ml of 5% ammonium carbamate pyrrolidine was added to 10 ml of digested sample and stirred for 20 min to converting elements to organometallic form in complex solution. After that, 2 ml methyl isobutyl ketone was added and stirred for 30 min. Samples were centrifuged at 2500 rpm for 10 min and the elements were transferred to the organic phase.

Measurement of mercury, lead and cadmium was performed using atomic absorption spectrophotometer (Perkin Elmer, American). Mercury was measured by CVAAS (cold vapor atomic absorption spectroscopy), lead, and cadmium with a graphite furnace system. To increase accuracy and minimize errors in measurements, all preparation steps for each sample was measured three times [6, 24-28].

Statistical analysis

Descriptive statistical analysis of data was carried out using Minitab 17 software and one way analysis of variance (ANOVA) was performed for determine statistically significant difference.

RESULTS

Obtained results of heavy metals (mercury, lead and cadmium) for 255 samples of 17 different species of fish by atomic absorption spectrometry are showed in Table 1. Maximum content of lead was seen in carp fish and the lowest lead content was determined in mullet samples.

Cadmium in fish samples ranged from 0.196 to 0.015 ppm. The lowest and the highest levels of cadmium were determined in Kilka and tuna samples, respectively.

Mercury content was also varied from 0.107 to 0.431 ppm. The highest and the lowest levels of mercury were determined in mullet and rabbit fish's samples, respectively.

Table 1. Mean±SD of lead, mercury and cadmium in 17 Include for each metals range of obtained results types of fish (mg/kg)

Scientific name	English name	Farsi name	Mercury	Cadmium	Lead
			Mean ± SD	Mean ± SD	Mean ± SD
Cyprinus carpio	Common carp	Kapoor	0.141±0.03	0.026±0.04	1.005±0.02
Thunnus albacares	Tunas	Tone	0.414±0.03	0.196±0.01	0.831±0.02
Siganus javus	Rabbitfishes	Safi	0.107±0.02	0.051±0.01	0.879±0.03
guttatum munro	indo – pacific king mackerel	Ghobad	0.298±0.01	0.166±0.05	0.838±0.02
Oncorhynchus mykiss	Trout	Ghezel ala	0.297±0.04	0.123±0.03	0.741±0.02
Hypophtalmichthys nobilis	Bighead	Sargondeh	0.379±0.01	0.063±0.01	0.913±0.02
Otolithes ruber	Tigertooth croaker	Shourideh	0.299±0.03	0.166±0.02	0.899±0.03
Acipenser persicus	silver carp	Ghezele jonoob	0.136±0.03	0.056±0.03	0.758±0.02
Hipophthalmichthys molitrix	Pike Barb	Simreh Kapoor	0.353±0.06	0.124±0.01	0.951±0.02
Barbus Esocinus	Lizardfish	Hasoon, Kijar	0.174±0.05	0.0710.02±	0.751±0.03
Saurida tumbil	Lionfish	Shir mahi	0.243±0.03	0.033±0.05	0.834±0.04
Scomberomorus commerson	Persian or Kura Sturgeon	Tas mahi, gharaborun	0.153±0.03	0.156±0.03	0.957±0.03

Table 1. Continued

Acipenser persicus	Silver carp	Noghrehee kapoor	0.333±0.02	0.086±0.02	0.940±0.05
Hipophthalmichthys molitrix	Southern Caspian kutum	Mahi sefid	0.163±0.02	0.074±0.03	0.755±0.02
Rutilus frisii kutum	Blacrskspot snapper	Sorkhou	0.24±0.04	0.136±0.03	0.863±0.04
Lutjanus ehrenbergi	Mullet	Kefal	0.431±0.03	0.056±0.01	0.736±0.02
Liza persicus (Mugil cephalus)	Common kilka	Kilka	0.168±0.03	0.015±0.02	0.922±0.02

DISCUSSION

At present, marine products have a significant role in the world food supply and their consumption is enhanced due to identification of their composition and superiority to other protein sources [29]. Monitoring of heavy metals is an important issue in nutrition, environmental and medical sciences [30, 31].

Heavy metals content in various fishes is higher than recommended maximum levels according to WHO, EC and FDA guidelines [32-37]. Based on this background, we evaluated heavy metals content in various types of fishes marketed in Khorramabad City of Iran.

Our results confirmed that at present, mean concentration of lead, mercury and cadmium in supplied fish muscle tissues is lower than maximum recommended levels according to WHO, EC and FDA guidelines (Table 2)[38-41].

Rezaee et al. reported high content of lead and cadmium in mullets of Persian Gulf, which is different with the obtained results of this study [16]. Asgari and Kamarehei reported high content of heavy metals such as lead and cadmium in farmed fish's tissue of Khorramabad City in Lorestan province of Iran [42]. Jafari and Sobhanardakani reported mercury concentration in common carp muscles of Zeriwar Lake about 30-110 ng /g [32]. Bioaccumulation of heavy metals in Barbus Xanthopterus fish of Karoon and Dez Rivers in Iran has been investigated that was higher than international standards levels of heavy metals [37]. Khoshnoud et al. in their study on two fish species (Scomberomorous commerson and Otolithes ruber) of Persian Gulf reported low concentrations of mercury, lead and cadmium [43]. Malakootian et al. reported lead and cadmium concentrations in tuna fish at lower level than permissible limit set by WHO in range 0.11-0.3 µg/g and 0.016-0.5 µg/g, respectively [37].

Heavy metals concentration has been investigated in other parts of the world. According to report of Cohen and coworkers in fish and invertebrates of Callifornia coastal wetlands in USA, cadmium and lead contents were 12000 and 650000 ng/g, respectively [33]. In Nigeria, lead concentration was reported 1-2 ng/kg [25]. Usero et al. reported mercury, lead and cadmium concentration in *Solea vulgaris*, *Anguilla nguilla* and *Liza aurata* in range of 10-222000, 2-250, 40-220 ng/kg, respectively [34]. In India lead and cadmium contents in two fish species (*Euthynnus affinis, Chanos chanos*) was reported in range of 233-324 and 20-1320 ng/kg, respectively [35].

All of these studies and other similar researches indicate different concentrations of heavy metals presence in the fish body. The level of heavy metals in fish is influenced by ecological, biological and metabolic conditions of fish, different location and duration of exposure in water to contaminant, feeding behavior, nutrient levels, fish age and size, shelf life of heavy metal, regulatory homeostasis activities on the fish [44-47]. The different types of chemical digestion, fish species and tissue type may also involve in the results [48].

Water resources, adjacent industries in coastal margin and waste disposal regulations and laboratory activities are other factors that can influence heavy metals content in fish [49].

Industrial waste, smoke, vehicle exhaust, volcanic activity, natural erosion of soil and chemical fertilizers can be sources of heavy metal pollution of agricultural products, fish and oysters [49].

Table 2. Maximum recommended levels (MRLs) of mercury, lead and cadmium according to the guidelines of WHO, EC, FDA and UKMAFF (mg/kg)

Heavy Metal	WHO	EC	FDA	UKMAFF
Mercury (Hg)	0.05-0.1	0.5	1.0	1.0
Lead (Pb)	0.5	0.3	0.5	1.5
Cadmium (Cd)	0.2	0.05	1.0	0.5

CONCLUSION

Mean concentration of lead, mercury and cadmium in fish muscles was not excessive in this study. However, non-proper management of water resources input can cause contaminants entrance such as heavy metals and bioaccumulation in fish tissues and in consequence threaten the health of consumers.

Other organic contaminants such as poly-aromatic hydrocarbons can accumulate in fish body. Therefore, it is essential that health authorities such as the Ministry of Health and other regulatory agencies have an annually comprehensive review of risk assessment on different groups of consumers including children and pregnant women, and accumulation level of carcinogen heavy metals etc., in high consumption fishes.

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