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Determination of Mercury in Mullet Fish (*Liza abu*) from Arvand River, Iran

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Abstract: This study was conducted to determine the concentrations of mercury in muscles and gills tissues of high consumption mullet fish (*Liza abu*) from the Arvand River, Iran, during summer and winter. The samples were analyzed by cold vapor atomic absorption spectrometry (CVAAS) for mercury after digestion. The results were expressed as µg/g of dry weight. The resulted range of contamination in fish was between 0.056-1.851 µg g^{-1} for muscle; and 0.501-25.525 µg g^{-1} for gill mercury. Also study revealed that seasonal variation influenced the concentration of the metals in the fish samples. The highest concentration of mercury was found in Minoo station (25.525 µg g^{-1}) in summer. Our study demonstrates that estimated daily and weekly intakes of mercury via consumption of fish were below the Permissible Tolerable Daily Intake (PTDI) and Provisional Tolerable Weekly Intake (PTWI) values established by FAO/WHO.

Key words: Bioaccumulation % *Liza abu* % Mercury Contamination % Arvand River % Persian Gulf

INTRODUCTION

Fish are one of important sources of protein with Omega-3 polyunsaturated fatty acids, which are renowned globally for greatly reducing cholesterol levels and maintaining healthy human hearts, brains, joints and immune system [1]. Fish demand is increasing rapidly and worldwide [2]. Khuzestan province (Southwest Iran) is one of the most important fish culturing and consuming provinces in Iran, but traditional fishery in Rivers and Persian Gulf coastal water is still remained as one of the main ways for local people to earn their income. According to Annual Fishery Statistics of Iran [3], the annual per capita fish consumption has been reported 7.62 kg in 2009. It is very surprising that the per capita fish consumption in 1980 was only 1 kg. The biggest River in Khuzestan, Arvand, is the borderline between Iran and Iraq. Nearly two million people are living beside this River in three port cities. Very important industrial zones are located along Arvand and the main portion of these industries are oil refineries, petrochemical complexes, gas fields and marine transport facilities. Industrial activities have led to trace metal contamination in the environment [4]. These highly persistent and non-biodegradable contaminants have been reported to cause toxic effects in fish and may bioaccumulated via food web to hazardous level, thus posing potential health risk to human fish consumers [5]. It is found that the main targets of heavy metals are nervous system and the kidney [6, 7]. Heavy metal fluctuations in fish tissues might be influenced by several factors such as seasonal variation, nourishment source and biological differences [8, 9].

Mercury is recognized by EPA (Environmental Protection Agency) as toxic pollutants [10] and their effects on human are well documented [11]. In this study, we evaluated the concentration of mercury in Mullet fish (*Liza* abu) which is one of the most consumed fish in the region.

MATERIALS AND METHODS

General Procedure: Specimens were collected in winter and summer 2009 as indicators for cold and warm seasons. A total number of 90 individuals from three stations (Faisal, dairy farm and Minoo (Fig. 1)) along Arvand River was caught and transferred to laboratory using ice box. Samples were weighted, measured and dissected for their muscles and gills tissues. Obtained tissues were freeze dried, powdered and kept in freezer (-20°C) in a pre-cleaned capped glass vials prior to chemical analysis [12]. All glassware were immersed in 10% HNO_3 overnight and rinsed thoroughly by distilled water.

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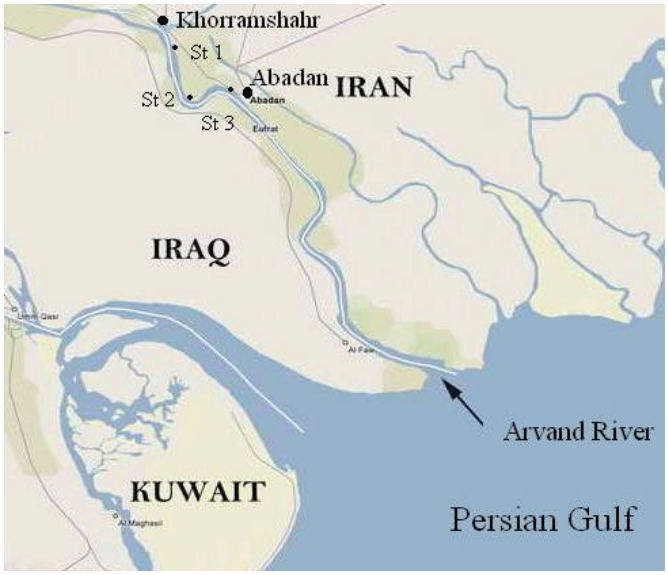

Fig. 1: Map showing study area (St 1: Faisal, St 2: Dairy Farm, St 3: Minoo)

Mercury Determination: Muscles and gills tissues (1.0 g) were digested using 10 ml HNO_3 and 15 ml $KMnO_4$ 5% w/v. The flask was well sealed and digestion was allowed to continue for 7-8 hours on a hot plate at 80°C then 150°C until the solution became clear.

Mercury levels were determined using the Cold Vapor Atomic Absorption Spectrometer (UNICAM 919) with $SnCl_2$ as a reducing agent. The spectrometer was equipped with mercury lamp capable of operation at 253.7 nm. The analyzer consists of an air circulation pump, a reaction vessel, $SnCl_2$ dispenser, an acidic gas trap and a four-way stopcock with tygon tubes to which a ball valve is attached. Mercury vapor was swept into the absorption cell and response was recorded in the form of a sharp peak as described earlier in Voegborlo [13]. All samples were analyzed in duplicate and the validity of measurements was checked using blanks and the reference material (CRM: DORM-3).

Data Analysis: Statistical analyses were performed using SPSS 11.5 software. Kolmogorov-Smirnov's method was conducted to test normal variable distribution and the paired *t*-test was used for comparisons and the results were defined as statistically significant for a given level of $P < 0.05$.

RESULTS AND DISCUSSION

Results indicated that mercury concentration in gill tissue was significantly higher (P<0.05) than muscle in both studied seasons (Table 1). Minoo site showed the highest values of 0.944 and 16.908 µg gG^{1} dry wt. of mercury for muscles and gills tissues, respectively. These values were both obtained in warm season (Summer 2009). The mercury concentration in summer was significantly higher (P<0.05) than winter season. Since Minoo station located closer to Abadan petrochemical complex and petroleum refinery, it was predictable that mercury content in this station is significantly higher (P<0.05) than other stations for both muscle and gill tissues.

Mercury is amongst the elements which considered as non-essential elements and may be accumulated in large quantities [14]. This study demonstrated that mercury accumulation in gills occurs in higher magnitude than what appeared in the muscle. This is a usual finding which is also reported by several investigations [15-17]. Gills are the main entrance for different contaminants such as mercury, so it is common to find higher concentrations of mercury in gills [18].

Since local people consume *Liza abu* as a fresh food, it is very important to assess the risk of consumption. In a report published by Siavash [19], the concentration of mercury in commercially valuable fish species is investigated. Table 2 shows the results reported by Siavash [19], also we added the results of this study for easier comparison.

In winter, mercury levels in *Liza abu* are in the same range for other reported fish species in Table 2, but in summer the muscle mercury content is higher than others. This is due to lack of precipitation for several

Table 1: Mean concentrations of Hg (µg gG^{1} dry wt.) in tissues of *Liza abu* during two seasons

		Sampling Site		
Season	Tissue	Faisal	Dairy Farm	Minoo
Winter	Muscle	0.095±0.055	0.170±0.151	0.510±0.338
	Gill	1.025±0.506	1.353±0.898	3.937±2.161
Summer	Muscle	0.305±0.144	0.355±0.162	0.944±0.696
	Gill	8.972±1.636	14.608±9.773	16.908±4.351

Table 2: Mercury concentrations (µg/g of wet weight) in fish species from the Persian Gulf (mean ± S.D)

Fish species	Summer	Winter
Scomberomorus commerson	0.243±0.041	0.371±0.080
Chirocentrus dorab	0.168±0.092	0.154±0.087
Sphyraena jello	0.207±0.011	0.192±0.087
Rachycentron canadum	0.163±0.041	0.257±0.051
Thunus tonggol	0.506±0.132	0.548±0.247
Trichiurus lepturus	0.142±0.046	0.099±0.028
Caranx sem	0.169±0.058	0.334±0.098
Pampus argenteus	0.183±0.106	0.071±0.031
Parastromateus niger	0.171±0.075	0.192±0.072
Liza abu	0.526±0.281[a]	0.258±0.101[a]

[a]Results of this study

Table 3: Estimated daily and weekly intakes of mercury in Liza abu from Arvand River

				EDI[d]		EWI[e]	
Element	PTWI[a]	PTWI[b]	PTDI[c]	Summer	Winter	Summer	Winter
Mercury	5	350	50	10.535	5.166	77.437	37.975

[a]Provisional tolerable weekly intake (lg/week/kg body weight)

[b]PTWI for an adult person (lg/week/70 kg body weight)

[c]Permissible tolerable daily intake (lg/day/70 kg body weight)

[d]Estimated daily intake (lg/day/70 kg body weight)

[e]Estimated weekly intake (lg/week/70 kg body weight)

months, high rate of evaporation in summer and unchanged flow rate of industries waste water that raise the concentration of mercury in water which in turn increased in fish tissue. However, the next step is to investigate whether consumption of *Liza abu* is safe for local people or not. The daily and weekly dietary exposure estimation by an adult person was carried out on basis of an average 21 and 147 g of fresh fish muscle consumption per day and week in Iran, respectively [20]. Provisional tolerable weekly intake (PTWI, µg/week/kg body weight), PTWI for an adult person (µg/week/70 kg body weight) and permissible tolerable daily intake (µg/day/70 kg body weight) are introduced by joint FAO/WHO expert committee on food additives [21]. Estimated daily intake (µg/day/70 kg body weight) and estimated weekly intake (µg/week/70 kg body weight) on basis of the results of this study are comprised with PTWI and PTDI in Table 3 for assessment of mercury levels in *Liza abu*.

Results indicated that EDI, EWI of mercury could be considered safe in comparison with respective legislation limits (PTWIs and PTDI); thereby there is no health threatening concern due to the consumption of fish caught from Arvand River in Iran.

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