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Measurement of Heavy Metals in Fish from the Tajan River

[1]S. Zare and [2]A.G. Ebadi
[1]Department of Biology, Urmia University, Urmia, Iran
[2]Department of Biology, Islamic Azad University of Qaemshahr,
Qaemshahr Branch, Iran

Abstract: In this study samples of three commonly consumed fish (Sefid, Kafal and Koli) were analysed for concentrations of heavy metals (Pb, Cd and Cu). Fish were captured using electric fishing on four sites along the Tajan River (Mazandaran province). The concentrations of heavy metals were determined by atomic absorption spectrophotometer. Samples contained detectable concentrations of heavy metals but at concentrations below the Maximum Residue Limit (MRL). Cadmium concentrations were below the MRL. Lead contamination showed no significantly different. Copper contamination was correlated with the localization of industrial plants. With respect to concentrations of pollutants in the Tajan river should not pose a serious threat to the fishes and public health.

Key words: Fish, heavy metals, pollution, Tajan River, Iran

INTRODUCTION

Fish are the major part of the human diet and it is not surprising that numerous studies have been carried out on metal accumulation in different fish species[1-3]. Fish also have been popular targets of heavy metal monitoring programs in marine environments because sampling, sample preparation and chemical analysis are usually simpler, more rapid and less expensive than alternative choices such as water and sediments[4]. Industrial wastes, geochemical structure and mining of metals create a potential source of heavy metals pollution in the aquatic environment[5,6].

Under certain environmental conditions, heavy metals might accumulate up to a toxic concentration and cause ecological damage[7,8]. Metals such as iron, copper, zinc and manganese, are essential metals since they play an important role in biological systems, whereas lead and cadmium are non-essential metals, as they are toxic, even in traces. The essential metals can also produce toxic effects when the metal intake is excessively elevated. Heavy metal discharges to the marine environment are of great concern all over the world and have a great ecological significance due to their toxicity and accumulative behavior. Thus, it can both damage marine species diversity and ecosystems[9]. Heavy metals in aquatic environment can remain in solution or in suspension and precipitate on the bottom or be taken up by organisms. The analysis of metal concentrations in biota samples at the same locations can indicate the transfer of metals through food chains[10].

Tajan River Originates from Tizabad Mountain and after receiving many other small rivers (e.g, Lajim, Garmab-rood nad Farim river) passes through the city of Sari (the center of the province) and then enters the sea through Farahabad city. It is about 170 km long and is one of the most important rivers of Mazandaran province. Its catchment area is about 4,000 km^2 with an annual average water flow of 207.4 km^2 along the coast of Tajan, there are agricultural lands, industrial plants (iron-steel plants, beverage, oil transfer docks, other industrial plants). Therefore, mainly untreated agricultural, municipal and industrial wastes affect this river direct or indirectly. The present study has been undertaken to determine lead, cadmium and copper concentrations in the three species of fishes (Sefid, Kafal and Koli) that consumed more than others in this province (Mazandaran).

MATERIALS AND METHODS

Monitoring sites: The study area is located in the Sari city (Mazandaran province) region. A total of 4 sites (T_1-T_4) were selected along the river Tajan. The sites were selected according to the localization of principalsources of pollution (upstream and downstream from the main urban and sewage discharge points).

Fish sampling: Three commonly consumed fish (Sefid = Rutilus frisikutum, Kafal = Mugila auratus and

Corresponding Author: A.G. Ebadi, Department of Biology, Islamic Azad University of Qaemshahr, Qaemshahr Branch, Iran

Koli = Clupeonella) were selected among fishes that had captured using electric fishing (powered by a 220 V electric generator) in during July 2003. Collected fish (3 species) were weighed, measured for total length and classified by species and size. Each batch (same species, same size) was ground and kept frozen (-20°C) until further analysis.

Heavy metal analyses: Concentrations of lead and cadmium were determined for each sample. The grinded samples were dried for 1 h at 110°C followed by 5 h at 180°C. After drying, 0.3 g of sample was manually ground in a small dish and diluted in 1 mL of 50% sulfuric acid. The samples were digested for 16 h; digestion temperatures went from 20 to 700°C over the first 10 h, then were held at 700°C for 6 h. The digests were diluted in 2 ml of 50% nitric acid and gently dried on a hot plate. After cooling, the digests were diluted in 1 mL of 10% nitric acid and transferred to polypropylene tubes where they were diluted in ultrapure milliQ water. Metal concentrations were analyzed with a Zeeman atomic absorption spectrometer (UNICAM 989 QZ, Thermo Optek, Roissy France) using element-specific lamps. Metal concentrations were calculated using a standard curve and the results were expressed in μg kg^{-1} of dry weight.

Statistical analysis: Data were analysed using the one-tailed variance test.

RESULTS AND DISCUSSION

Heavy metal contaminations: The concentration levels of each heavy metal were significantly different from one another among sites except for lead levels.

For lead, there no significantly different among sites: one group upstream (site T_1) had the maximum level and one group downstream (site T_4) showed the minimum ($p<0.05$). For cadmium, there were significant differences among sites. Max and Min level was similar to lead level. For copper, there are three Sites (T_1, T_2 and T_3) that are significantly different from one another (site T_4). Lead pollution has a difference from other metals. This is correlated with urbanization and density of population. The concentration is higher in the upstream area and could be associated with the localization industrial plants (iron-steel plants, beverage, oil transfer docks and other industrial plants) where the utilization of copper is common.

Considering the results in Table 1, it seems that the lead and cadmium contamination levels in fish are lower than those found in fish in different studies and the copper contamination is higher. Therefore the concentration of lead and cadmium for each sample of each site was compared with the MRL (EU Food Standard) in the muscle. No sample analysed had values exceeding the set limits (lead 200 g kg^{-1} wet weight; cadmium 50 lg kg^{-1} (wet weight), European Regulation R466/2001 of 16/03/2001).

Table 1: Concentrations of heavy metals (lg kg^{-1} dry weight) in fish collected from the monitoring sites along the Tajan River

Site	n	Lead	Cadmium	Copper
1	15	14.3(9.9–90.1)	36.6(13.1–64.4)	9536.0(2813.7–22291.0)
2	17	11.0(10.0–22.5)	11.5(8.4–18.2)	13998.3(10627.6–18911.1)
3	18	13.0(10.0–167.1)	20.3(10.3–38.0	13292.0(6676.7–19977.5)
4	17	10.0(10.0–10.0)	4.2(2.5–11.5)	7065.4(4251.2–8253.1)

All values [median (minimum–maximum)]; n = number of individuals analysed

There are a small number of analyses for cadmium, lead and copper in tissues of fishes from several parts of Europe[11]. Most of them give concentrations of cadmium, lead and copper in liver and kidney[12]. In general, all these concentrations are considered to be of no concern for fishes, compared with other mammal species. But nothing is known specifically on toxicological effects of low tissue levels of others heavy metals such as cadmium, lead and copper on fishes particularly in combination with other contaminants[12,13].

It is assumed, therefore based on MRL limits and our data, that the current concentrations of pollutants in the Tajan river should not pose a serious threat to the fishes and that chemical contamination should not be a limiting factor[14,15].

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