Heavy Metals Contents in Kidney and Heart Tissues of *Scarus Ghobban* Fish from the Arabian Gulf

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Abstract:

Levels of selected heavy metals (Pb, Co, Cu, Ni, Zn, Mn and Cu) in the heart and kidney tissues of parrot fish, collected from the Arabian Gulf, Eastern Province of Saudi Arabia, were determined by wet-digestion based atomic absorption method. The results showed that accumulation pattern of analyzed metals in the kidney tissues followed the order; Zn > Cu > Co > Pb > Ni > Mn > Cd, with Pb at 1.05±0.63 ppm and Cd at 0.27±0.20 ppm. In the heart tissue the analyzed metals followed similar pattern of metal accumulation. The average Pb (0.85±0.50 ppm), Cd (0.12±0.07 ppm), Ni (0.92±0.35 ppm) and Mn(0.86±0.43 ppm) were significantly lower in the heart tissue whereas Zn (26.4±12.9 ppm) and Cu (3.29±2.18 ppm) were higher in the kidney tissues. In general, the data indicated that marine fish from the sampling site of the Arabian Gulf contain relatively less burden of heavy metals in their tissues.

Keywords: Arabian Gulf; Fish; Kidney & Heart Tissue; Heavy Metals

Introduction

Marine organisms accumulate pollutants from the surroundings and therefore, have been extensively used in marine pollution monitoring programs. In many developing countries increase in industrial agglomerations has led to an increased discharge of chemical effluents into the ecosystem. Owing to their toxicity and accumulative behavior, heavy metal discharges into the marine environment can damage both specie diversity and ecosystem. Over a few decades there has been growing interest to determine heavy metal levels in the marine environments and attention was drawn to find the contamination level of public food supplies particularly fish. Therefore, marine environments are occasionally monitored for heavy metal contamination in water, sediment and animals. It is well known that heavy metals accumulate in tissues of aquatic animals and therefore, the levels measured in tissues of aquatic animals can reflect the past exposure. The accumulation patterns of metals in fish depend both on their uptake and elimination rates. These heavy metals are taken up through different organs of the fish and many are concentrated at different levels in different levels of the body (Endo et al., 2008; W.Ashraf 2005). Tissue concentrations of heavy metals can also be a reasonable measurement for public health standards and for animal's health point of view (Kalay et al, 1999). The environment of the Arabian Gulf region has been a subject of study in recent years due to the accidental oil spills in 1991, the uncontrolled discharge of the sewage and industrial waste waters as well as human activities. Refineries and petrochemical industry wastes contribute significantly to metal pollution of the Arabian Gulf marine environment. Total fishery production of Saudi Arabia in 1997 was 53170 metric tons where the catches in the Arabian Gulf was 22875 metric tons (Fisheries Statistics of Saudi Arabia, 1997).Several papers have indicated the possible extent of heavy metal build up or accumulation in marine organisms taken from Red Sea and Arabian Gulf (Sadiq et al 1982; Kureishy 1993; Al-Ghais 1995; Kalay et al. 1999; Al-Saleh & Shinwari 2002).

In the present paper, the levels of the heavy metals Pb, Cu, Co, Ni, Zn, Mn and Cd in the kidney and heart tissues of blue barred orange parrot fish (scarus ghobban) were examined after the long term environmental effects of the 1991 Gulf War to determine whether these levels constitute a threat to health of the consumers. Scarus ghobban *(parrot fish)* fish are frequently and largely eaten in Saudi Arabia, so their toxic metal content should be of concern to human health. Kidney and heart tissues of fish are rarely studied for their heavy metal contents. Moreover, these tissues are expected to contain lower levels of metals as compared to liver and gills which are considered as storehouse of metals (Kalay & Canil 1999). The present study was therefore, carried out in view of the scarcity of information about heavy metals in the marine organisms from this region. The contents of these elements in marine fishes are often used as indicators of marine pollutants in addition to monitor the source points and site of dumping ground (Kendrick et al 1992).

Materials and Methods

Fish samples of both sex of scarus ghobban were collected from the Arabian Gulf (Dammam, Eastern province, Saudi Arabia). The samples were purchased from local fishermen at the spot as soon as their boats landed. Samples were packed in ice and brought to the laboratory on the same day. In the lab. their standard length and weight were recorded. The weight and length of samples lied within 500±100g and 100±5cms. No significant difference ($p>0.05$) regarding the size and weight of animals was found among the stations sampled. Samples were dissected with clean stainless steel equipment. The tissues (kidney or heart) to be analyzed were separated and grounded with stainless steel kits and glass equipment. Each sample analyzed was composed of several individuals at least 5-8 of fish tissues pooled together. Destruction of organic matter was carried out by wet digestion (Mason and Barak 1990). Exactly 3-4 gms of defrosted sample weights were placed in a 50mL Erlenmeyer flask and 10mL of concentrated nitric acid were added. After 15 minutes digestion at room temperature, 10mL mixture of concentrated HNO_3:$HClO_4$ (4:1 v/v) was added and the reaction was maintained on a hot plate stabilized at 70 ±5 ^{o}C for 24 hours with gentle shaking until the digestion was completed. The resulting residue was finally redissloved with deionized distilled water and transferred to 25mL measuring flask and diluted with deionized

water to the mark. For each series of ten samples two blanks were run to check the possible contamination.
The same digestion procedures were applied to standard reference material, TORT lobster hepatopancreas, NRC Canada. Metal concentrations in all the samples were measured using a Varian Spectra AA plus flame atomic absorption spectrophotometer. Average values and ±SD of reference material measured in this study lied within 10% ranges of the reference values. Statistical analysis of the data was carried out by using MSTAT program.

Results and Discussion

The results of trace metal analysis (mean ppm wet weight) in kidney tissues of Scarus Ghobban are summarized in Table 1. The data indicated that the accumulation pattern of the analyzed metals follows the order: Zn > Cu > Co > Pb > Ni > Mn > Cd. The high accumulation of Zn (26.4±12.9 ppm; wet weight) could certainly be based on specific metabolism process and coenzyme catalyzed reactions involving zinc taking place in kidney (Jaffar and Pervaiz, 1989). Zinc also acts as a catalyst in metal biomolecules bound to amino acid side chains containing N, O and/or sulfur donor legends (Vinikour *et al* 1980 and Kendrick *et al* . 1992) to form tetrahedral zinc metalloproteins and metalloenzymes in kidney tissues (Shriver *et al* 1994). Zinc is generally thought to be non-toxic except at very high concentrations.

The mean cadmium concentration was 0.27+0.20 ppm in kidney tissues (Table l). Cadmium species have low tendency towards the available active sites (N and/or O donor atoms) in kidney tissues to form tetrahedral or square planer cadmium(II) complex species (Shriver *et al*., 1994). The complex species of Cd are kinetically inert to ligand substitution and, therefore, its accumulation as metalloprotein complexes is expected to be low. However, the binding rate of sulphurhydryl groups, feeding habits, excretion rate, solubility of Cd species, the restricted relocations of different elements and the available number of coordinating sites in the fish kidney to form stable cadmium chelates are possible contributing factors accounting for such behavior (Jaffar and Pervaiz, 1989 and. Kendrick *et al*., 1992).

Cadmium levels reported in this study (Table 1) were found within the ranges reported by other investigators (Sharif *et al*., 1993 and Wood and Van Vleet, , 1996). In another similar study (Kalay & Canil, 1999), cadmium levels in liver of mullus barbatus caught from the coasts of Mediterranean sea has been found to be 1.98±0.49μg/g. Jaleel et al (1993) have reported Cd (0.35±0.09μg/g), Cu (0.89±0.12μg/g), Pb (0.59±0.07μg/g) and Zn (4.99±0.36μg/g) levels in chactadon jayakeri fish from the Arabian sea. The mean concentration of lead (1.05±0.63 ppm) in kidney was found high as compared to cadmium (0.27±0.20 ppm). Probable explanation for this trend is as follows; the metallothionein protein is ubiquitous and is in highest concentration in fish kidney (Amdur, 1991), and it is able to form stable chelates with lead as compared to cadmium. The solubility of lead species in natural water in the area of fish catching is also a factor in the observed trend. The excretion rate of lead is rapid and it has greater tendency to bioaccumulate in the nucleus at an early stage of fish growth as reported by Sharif *et al*. (1993); this behavior is not common for cadmium. In fish, cadmium is also less regulated and it can enter fish through food chains as solid granules (organometallic) which are then stored or excreted.

Lead and cadmium levels in kidney of the examined samples ranged from 0.27 ppm to 1.98 ppm and 0.05 ppm to 0.63 ppm respectively, on wet weight basis. Concentrations close to this value have been reported for tropical species from other areas of the world (Babji *et al*., 1979). However, much higher concentrations (4.73±2.74μg/g) have been reported for lead in liver of caranax crysos (Kalay & Canil,1999).

Copper, manganese, cobalt and nickel levels in kidney tissues (Table 1) reported in this study were significantly lower or within the ranges reported by other researchers (Sharif *et al*. 1993 and Kureishy, 1993) and followed previously reported trends: Zn>Cu>Ni>Co>Mn. Higher copper concentrations 1.25 - 8.56 ppm, have also been observed. This appears to be a result of fish kidney contains a cystine rich copper binding protein, which is thought to have either a detoxifying or storage function (Luckey and Venugopal, 1977).

The data on trace metals Zn, Cu, Mn, Ni, Co, Cd and Pb in the heart tissues of Scarus Ghobban has also been summarized in Table 1. The data indicated that the mean concentration of the tested elements in the heart tissues followed the order, Zn>Cu>Co>Pb>Ni>Mn>Cd. The higher accumulation of Zn (23.0±8.36 ppm) is possibly attributed to the fact that zinc is a bioessential element, so the fish tissues maintain the concentration within a specific range by homeostasis (Falconer *et al*., 1983). These data are in good agreement with the results reported by Law *et al*., (1991) for Zn (22.19-42.49 ppm) in the heart tissues in common fish. The reason for this behavior in the heart tissues could be based on specific metabolism process, a cystine-rich copper binding protein and enzyme catalyzed reactions involving Zn and Cu taking place in the heart tissues of *Scarus Ghobban* fish.

In the heart tissues the distribution of Pb (0.84±0.50 ppm) was found high as compared to Cd (0.12±0.07 ppm). Thus, the heart of parrot fish (scarus ghobban) accumulated more Pb than Cd. The prevalence of lead as compared to cadmium in the heart tissues is attributed to the ability of lead to form stable chelates with the available binding sites than cadmium. Cadmium contents showed a minimum level in the heart. This content was found to be lower than the corresponding value reported by Kureishy, 1993. The zinc, cobalt, nickel and copper content agreed well with the data reported by Kureishy, 1993 for *Epinephelus* fish in the same region. In another study (Yousaf & Shahavi, 1999) levels of Cu, Pb and Cd in heart tissue of *lethrinus lentjan* were found to be 3.87±1.26μg/g, 3.22±1.94μg/g and 0.34±0.23μg/g, respectively.

Figure 1 shows a comparison of the mean concentrations of the tested elements in kidney and heart tissues. All the determined metals showed high levels in kidney as compared to heart tissue, copper being the only exception. The prevalence of Pb as compared to Cd in both fish organs appears to be a result of the initial increase in lead during the first year of life followed by maintenance of a fairly constant concentration throughout the life span of the fish (Vinikour *et al*. 1980). Similarly, significant increase in zinc (26.43±12.9 ppm) and manganese (0.46±0.30 ppm) in kidney were found high as compared to zinc (23.0±8.36 ppm) and manganese (0.41±0.37 ppm) in heart tissues, respectively.

Similar distribution patterns of heavy metal accumulation have been reported in marine mammals and seabirds reported by other workers and followed previously published trends with mean metal concentrations decreasing in the order heart>kidney for all elements except zinc and manganese (Sharif et al 1993, and Wood and Van Vleet 1996).

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Table 1: Heavy metal levels (μg/g; wet weight) in pooled kidney and heart tissues of Parrot Fish*(scarus ghobban)*

Metal	Kidney X*	±SD	Std. Error	Heart X	±SD	Std. Error
Pb	1.05	0.63	0.19	0.85	0.50	0.23
Cd	0.27	0.20	0.05	0.12	0.07	0.02
Co	1.08	0.34	0.09	0.92	0.35	0.14
Ni	1.02	0.42	0.12	0.86	0.43	0.06
Mn	0.46	0.30	0.07	0.41	0.37	0.08
Zn	26.43	12.90	1.97	23.00	8.36	2.28
Cu	3.29	2.18	0.18	3.85	1.93	0.12

*X *average of quadruplet measurements*

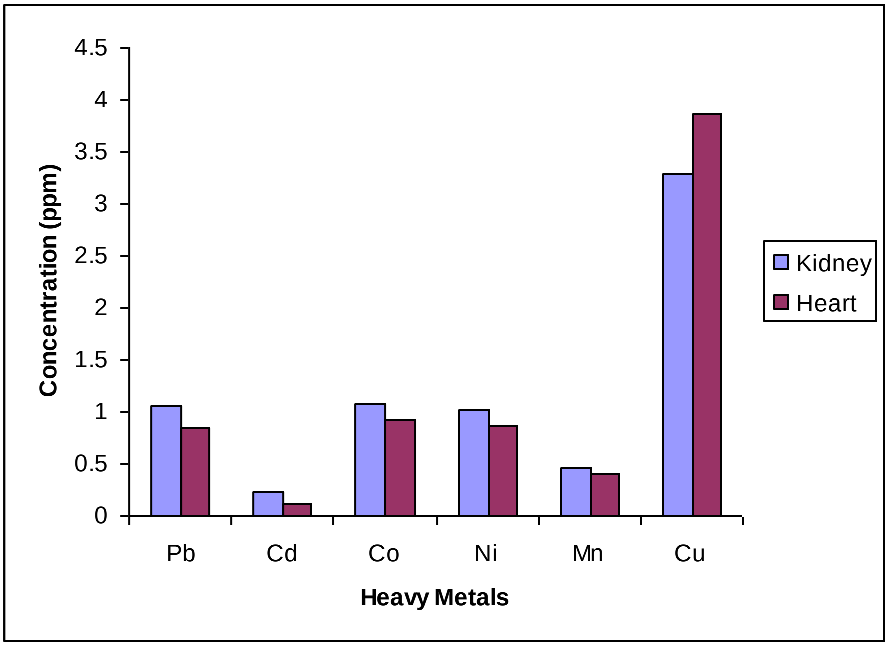

Figure 1: Comparison of heavy metal levels in the kidney and heart tissues of Parrot Fish *(scarus ghobban)*