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Trace Metals in *Lethrinus lentjan* Fish from the Arabian Gulf (Ras Al-Khaimah, United Arab Emirates): Metal Accumulation in Kidney and Heart Tissues

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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. Thus, several papers have indicated the possible extent of heavy metal build up or accumulation in marine organisms taken from Red Sea and Arabian Gulf (Kureishy 1993 and Al-Ghais 1995). Monitoring systems are essential to track long-existing pollution processes (Dassenakis *et al.* 1996) but the lack of them in many regions (Arabian Gulf region) make it difficult to draw certain conclusions about the long term results of human activities.

The Arabian Gulf is set in an extremely arid region of the world where the circular pattern of the water is counter-clockwise and it 2-4 years to turnover. Thus, in the present communication, the levels of the non-essential elements Pb and Cd in the kidney and heart tissues of *Lethrinus lentjan* fish was examined after the long term environmental effects of the 1991 Gulf War to determine whether these levels constitute a health hazard to consumers. 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 *Lethrinus lentjan* fish were collected from the Arabian Gulf at Ras Al-Khaimah District (Western Coast) of the United Arab Emirates (Figure 1). The fish samples were collected randomly in the months of April, May and June 1993 at an interval of two weeks. Each time about 25-30 fishes of varying sizes were collected, placed in an ice box, transported to the laboratory and kept in a freezer at -20°C prior to the analysis. At the time of metal analysis

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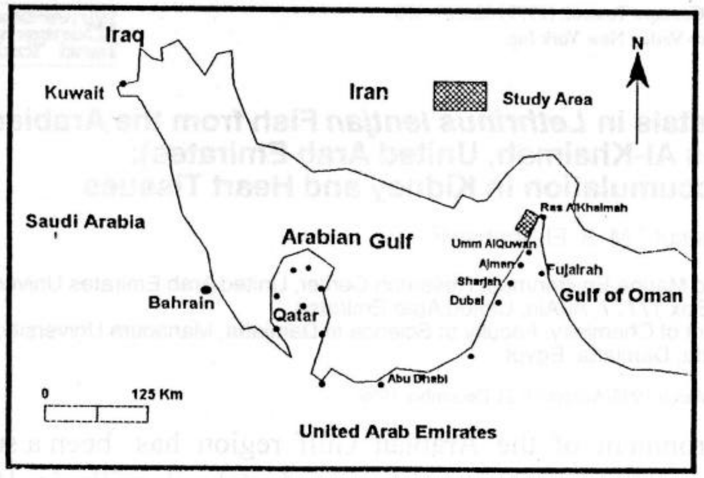

Figure 1. Sample stations where *Lethrinus lentjan* fish were collected along the United Arab Emirates coast on the Arabian Gulf.

the fish samples were defrosted and their standard length and weight were recorded. 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 6-8 of fish tissues (kidney or heart) pooled together.

Destruction of organic matter of samples was carried out by wet digestion (Mason and Barak 1990). The procedure supplied was as follows: exactly 4-5 gm of lyophilized (defrosted) sample weights were placed in 50 ml Erlenmeyer flask and 10 ml of concentrated HNO_3 added. After 15 min predigestion at room temperature, 10 ml 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°C for 24 hrs with gentle shaking until the digestion was completed. The resulting solid residue was finally redissolved with deionized distilled water and transferred to 25 ml measuring flask and diluted with deionized water to the mark. For each series of 10 samples two blanks were run to check the possible contamination. The digestion procedures were applied to standards (the quality control samples) of Cu, Zn, Mn, Co, Ni, Pb and Cd concentrations. The results obtained showed no losses of any metal occurred and the recovery percentage of the tested metals were found 99±2.62% under the experimental conditions. A double beam GBC 906 flame atomic absorption and GBC Graphite furnace spectrometers with fuel-rich equipped with background corrector, autosampler, recorder and air-acetylene flames were used. Air was supplied through Pu 9003 air compressor fitted with filter and regulator, moisture trap and oil free pump. Acetylene was delivered after passing through concentrated H_2SO_4 for purification.

RESULTS AND DISCUSSION

The results of trace metal analysis (mean ppm wet weight) in kidney tissues of *Lethrinus lentjan* fish are summarized in Table (1). The data indicated that, the accumulation pattern of the tested elements follows the order : Zn > Cu > Pb > Ni > Co > Mn > Cd. The high accumulation of Zn (43.26 ± 16.87 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 (Shiver *et al*, 1994). These data do not differ significantly with *Lethrinus nebuloses* and *Lethrinus mahsenoids* fish species of the same family in the same organ as reported (Kureishy, 1993).

The mean Cd (0.30±0.14 ppm) concentration was low in kidney tissues (Table 1). 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 (Schriver *et al.*, 1994). The complex species of Cd are kinetically inert to ligand substitution and therefore its accumulation as metalloprotein complexes is expected to 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 participating 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). The mean concentration of lead (2.48±1.45 ppm) in kidney was found high as compared to cadmium (0.30 ± 0.14 ppm). Kidney cadmium and lead concentrations were positively

Table 1. Total heavy metal concentrations (mean ppm wet weight) in pooled kidney and heart tissues of *Lethrinus lentjan* fish of the Arabian Gulf region. (x) represents the average of five measurements.

Element	Kidney (x)	Std. Dev.	Std. Error	Heart (x)	Std. Dev.	Std. Error
Cu	3.25	1.53	0.22	3.87	1.26	0.18
Zn	43.26	16.87	2.46	32.38	10.19	1.47
Mn	0.64	0.24	0.04	0.31	0.17	0.03
Co	1.23	0.22	0.08	1.67	0.50	0.12
Ni	1.58	0.47	0.13	1.58	0.45	0.12
Pb	2.48	1.45	0.31	3.22	1.94	0.35
Cd	0.30	0.14	0.02	0.34	0.23	0.04

correlated with liver cadmium and lead concentrations indicating that both organs act as storage sites for both metals. Many explanations have been offered for this trend in kidney (Table 1). 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 behaviour 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. Translocations of metal among tissues and fish habitats may also account for such behavior (Amdur, 1991).

Lead and cadmium levels in kidney of the examined samples were ranged from 2.28 ppm to 2.62 ppm and 0.28 ppm to 0.34 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). Considering the conversion factor of 4.8-5.0 for fresh weight and taking 6-10 g of fish as the maximum consumption per person per day in coastal areas of United Arab Emirates, the average intakes of lead and cadmium through fish will be in the range 10.98 -18.30 mg g^{-1} and 1.80-3.00 mg g^{-1}, respectively. These values of lead and cadmium are well below the provincial tolerable intake by human beings of total lead (7 mg Kg^{-1} body wt. day^{-1}) and cadmium

(1-1.2 mg Kg^{-1}) (FAO/WHO, 1972-1987). Thus, the results positively indicate that the marine fishes from the Arabian Gulf are comparatively clean and unpolluted.

Copper, manganese, cobalt, 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.*, 1991, 1993 and Kureishy, 1993) and followed previously reported trends: Zn>Cu>Ni>Co>Mn. Significantly higher copper concentrations 13.25±1.53 ppm, have also been observed. This appears to be a result of fish kidney contain a cystine rich copper binding protein, which in thought to have either a detoxifying or storage function (Luckey and Venugopal, 1977).

Table 1 summarizes data on trace metals Zn, Cu, Mn, Ni, Co, Cd and Pb in the heart tissues of *Lethrinus lentjan* fish. The data indicated that the mean concentration of the tested elements in the heart tissues followed the order : Zn > Cu > Pb > Co > Ni > Cd > Mn. The higher accumulation of Zn (32.38±10.19 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 behaviour 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 *Lethrinus lentjan* fish.

In the heart tissues the distribution of Pb (3.22±1.44 ppm) was found high as compared to Cd (0.34±0.23 ppm). Thus, the heart of *Lethrinus lentjan* fish 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. The potential surface of lead contamination to *Lethrinus lentjan* fish is also diet. Manganese 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 *Lethrinus lentjan* fish in the same region. These data again positively indicate that the marine fishes from the Arabian Gulf are comparatively clean and unpolluted.

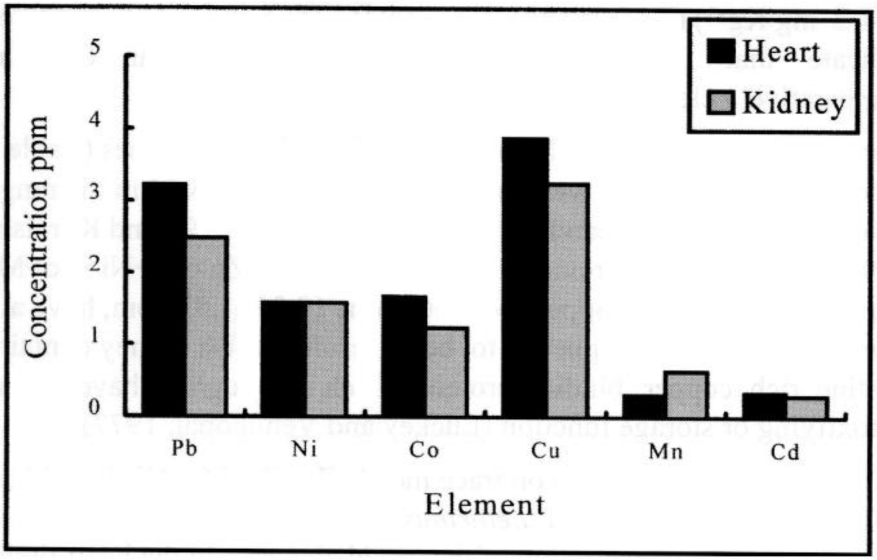

Figure 2. Uptake (mean ppm wet weight) of the trace metals Pb, Ni, Co, Cu, Mn and Cd by the heart and kidney tissues of *Lethrinus lentjan* fish. Data represent an average of five experiments of 25-30 fish pooled in each experiments.

Figure 2 and Table 1 show a comparison of the mean concentrations of the tested elements in kidney and heart tissues. The average lead (3.22±1.94 ppm), nickel (1.58±0.45 ppm), cobalt (1.67±0.50 ppm), copper (3.87±1.26 ppm) and cadmium (0.34±0.23 ppm) concentrations were found high in the heart tissues whereas zinc and manganese levels were found high in kidney (Table 1). 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 and Windson *et al.;* 1987). Similarly, significant increase in zinc (43.26±16.83 ppm) and manganese (0.64±0.24 ppm) in kidney were found high as compared to zinc (32.38±10.19 ppm) and manganese (0.31±0.17 ppm) in heart tissues, respectively. Similar distribution patterns of heavy metal accumulation have been reported in marine mammals and sea-birds reported by other researchers and followed previously reported trends with mean metal concentrations decreasing in the order heart > kidney for all elements except zinc and manganese (Sharif *et al.*, 1991, 1993 and Wood and Van Vleet, 1996).

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