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Heavy metals in fishes from coastal waters of Cochin, southwest coast of India

Maheswari Nair, K K Balachandran, V N Sankaranarayanan & Thresiamma Joseph
National Institute of Oceanography, Regional Centre, P B No 1913, Cochin 682 018, India

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The concentration levels of copper, zinc, manganese and iron have been determined in marine fishes from Cochin area which is one of the major fishing zones along the west coast of India. The concentration of heavy metals varied from species to species. Copper, Zn, Fe and Mn showed increased levels in the gills and alimentary canal compared to the muscle. Difference in heavy metal concentration in various species studied is attributed to the varying feeding habits. The observed levels were below the toxic limit.

Accumulation of certain toxic metals in different organs of marine organisms and their subsequent transfer to man through the food chain is of great concern[1]. Fish musculature is a major path through which heavy metals can enter the human body and therefore, it has been investigated more than other organs. The present study was confined to the assessment of the level of some heavy metals in the muscle, liver, alimentary canal and gills of fishes collected from the inshore waters of Cochin in the south west coast of India.

Fish samples for analysis were collected from the Chinese dipnets deployed off Cochin during the summer 1992. Most of these fishes were confined in their distribution to shallow waters which subsist on phytoplankton and zooplankton strained from the surrounding waters by the well developed and feathery gills[1]. The fish samples of same size were weighed individually and dissected to remove the various tissues which were washed in double distilled water. The alimentary canal was first removed carefully to avoid any contamination. The samples were dried to constant weight at 40 - 50°C, powdered and stored. The composite samples were digested in aquaregia using teflon bombs. Parallel replicate measurements were made on all the samples and the mean value has been tabulated. This method was calibrated by analysing one BCSS-1 standard reference material supplied by the National Research Council, Canada. The standard deviation found for each metal are Cd (±7%), Cu (±5%), Zn (±11%), Fe (±19%) and Mn (±15%) respectively. Determination of heavy metals were performed with a flame atomic absorption spectrophotometer (Perkin-Elmer 2380).

The details of the concentration of various metals in fourteen different species fishes are given in Table 1. Though the concentrations of metals in different tissues of fishes varied widely, the musculature which forms the edible part showed much lower concentration than other tissues. The concentration of Cu in the muscle tissue of *Sphyrna zygaena* was 1.54 $\mu g.g^{-1}$, while in the case of liver it was 35.49 $\mu g.g^{-1}$. This corresponds to an average enrichment ratio of about 1:23 in respect of liver as compared to the musculature. Similarly, the enrichment ratio for Zn and Mn in the same species were 1 : 26 and 1 : 3 respectively.

In the case of *Chirocentrus dorab* the liver to muscle ratio for Cu, Zn, and Fe were 11 : 1, 38 : 1 and 2 : 1 respectively. The enrichment ratio for each element between the pair of organs for different species of fishes varied considerably. The absolute increase of heavy metals in muscle tissue of contaminated fish is often much lower than in other organs and as mentioned earlier, it becomes enriched by metals only when the contamination is extremely high.

The estimated concentrations of Cu, Zn and Mn in the muscle tissue compared well with those of reported values in fishes from different parts of the western Indian Ocean[2-5]. Elevated levels of Zn were observed in the alimentary canal and gills of *Stolephorus devisi, Chirocentrus dorab, Sardinella longiceps, Rastrelliger kanagurta, Mini maculata* and *Mugil cephalus*. It is generally believed that fish activity regulates Zn concentration in their muscle tissue and as a result do not reflect changes in

Table 1—Heavy metal concentration in different tissues of fish from coastal waters of Cochin (μg. g^{-1} dry weight).

Species	Common name	Tissue	Cu (SD)	Zn (SD)	Fe (SD)	Mn (SD)
1 *Sardinella longiceps (14)*	Indian oil Sardine	M	1.54 (±0.09)	20.52 (± 1.80)	148.50 (± 32.0)	ND
		AC	6.94 (±0.41)	63.42 (±11.10)	2255.40 (±609.0)	6.14 (±1.10)
		G	2.72 (±0.11)	110.83 (±12.02)	428.39 (± 68.0)	16.39 (±2.40)
2 *Dussumieria auta (8)*	Rainbow sardane	M	1.59 (±0.06)	24.63 (± 1.66)	57.97 (± 9.5)	ND
		AC	9.92 (±0.65)	64.45 (± 9.20)	376.81(± 80.1)	8.19 (±1.10)
		G	ND	58.25 (± 6.67)	224.63(± 40.4)	2.73 (±0.60)
3 *Stolephorus devisi (18)*	Anhovy	M	2.20 (±0.15)	29.90 (± 3.20)	119.04(± 18.0)	ND
		AC	27.00 (±0.56)	123.15 (±16.09)	443.84(± 96.0)	ND
		G	ND	172.41 (±15.50)	1009.32(±122.0)	64.40 (±8.20)
4 *Rastrelliger kanagurta (4)*	Mackerel	M	2.01 (±0.12)	14.99(± 1.60)	127.59(± 21.0)	ND
		AC	9.28 (±0.32)	71.25(± 6.50)	3773.30(±540.0)	14.68 (±2.10)
		G	ND	117.87(±12.00)	419.25(± 85.4)	11.70 (±1.20)
5 *Chirocentrus dorab (3)*	Wolf herring	M	1.52 (±0.08)	6.56(± 0.42)	33.77(± 6.6)	ND
		L	16.53 (±0.74)	247.62(±31.00)	72.46(± 14.5)	4.39 (±0.62)
		AC	4.63 (±0.21)	462.64(±64.00)	144.92(± 36.0)	20.90 (±3.50)
		G	6.17 (±0.35)	396.96(±55.00)	318.84(± 72.0)	62.84 (±11.00)
6 *Mini maulata (6)*		M	4.63 (±0.21)	38.58(± 2.90)	250.00(± 51.0)	6.83 (± 1.02)
		AC	15.43 (±0.69)	159.68(±18.00)	536.25(± 98.0)	6.98 (± 1.50)
		G	4.92 (±0.32)	137.52(±16.00)	692.03(±125.0)	25.95(± 2.10)
7 *Megalaspis cordyla- (9)*	Torpedo trevally	M	1.43 (±0.07)	19.29(± 2.10)	362.32(± 70.0)	1.36 (± 0.22)
		AC	7.71 (±0.46)	90.72(± 8.70)	833.33(±178.0)	2.73 (± 0.50)
		G	4.60 (±0.25)	83.74(± 9.20)	347.82(± 68.4)	17.75 (± 2.11)
8 *Psuedosciaena dia-coantis (11)*	Sciaenids	M	1.55 (±0.06)	19.70(± 2.50)	79.71(± 11.2)	ND
		AC	6.17 (±0.29)	68.14(± 9.50)	166.66(± 33.3)	ND
		G	ND	82.58(± 8.70)	306.90(± 55.0)	ND
9 *Johnllies sp. (4)*	Jew fish	M	1.50 (±0.04)	18.06(± 1.80)	112.31(± 20.0)	ND
		AC	9.25 (±0.46)	67.73(± 8.00)	239.13(± 49.5)	ND
		G	ND	66.05(± 7.00)	306.32(± 61.5)	ND
10 *Sphyrna zygaena (2)*	Shark	M	1.54 (±0.08)	13.13(± 0.90)	90.58(± 16.2)	1.26 (± 0.19)
		AC	15.43 (±0.84)	58.55(± 5.20)	173.91(± 35.0)	4.29 (± 0.73)
		G	3.70 (±0.14)	54.67(± 2.50)	49.13(± 2.1)	3.27 (± 0.33)
		L	35.49 (±2.01)	341.97(±49.00)	94.20(± 11.5)	4.09 (± 0.80)
11 *Mugil cephalus (4)*	Grey mullet	M	1.51 (±0.04)	26.68(± 1.20)	72.46(± 17.9)	ND
		AC	24.69 (±1.89)	137.93(±18.60)	167.00(± 26.4)	17.75 (± 3.20)
		G	2.72 (±0.15)	140.53(±11.00)	479.54(± 86.0)	26.51 (± 4.00)
12 *Petrica filamentosa (3)*	Silver bellies	M	ND	33.66(± 4.40)	144.92(±22.5)	ND
		AC	40.12 (±3.11)	110.01(±20.10)	166.30(±40.4)	30.05 (± 4.40)
		G	1.54 (±0.08)	84.03(± 7.20)	262.14(±45.6)	2.41 (± 0.50)
13 *Gobius plassa (5)*	Goboid	M	ND	18.06(± 2.10)	101.44(± 17.0)	ND
		AC	12.34 (±0.78)	100.16(±13.00)	264.49(± 42.3)	4.09 (± 0.60)
		G	2.72 (±0.15)	138.36(±14.00)	1419.44(±320.0)	24.10 (± 3.19)
14 *Parastromateus niger (3)*	Black pomfret	M	3.08 (±0.16)	15.18(± 0.60)	45.29(± 5.5)	9.56 (± 1.50)
		AC	7.71 (±0.48)	12.15(± 0.90)	91.66(± 14.0)	20.49 (± 4.90)
		G	9.25 (±0.44)	91.54(±11.00)	398.55(± 70.4)	24.59 (± 3.20)

M - muscle, AC - alimentary canal, G - gill, L - liver (SD) - standard deviation for triplicate analysis
(Values in parantheses give the no. of samples analysed)

ambient available levels of this element in the environment[6]. Therefore, the high levels of Zn concentration reported here infers that the regulation of this element may not be complete. In all the species, Fe was found to be the most abundant of the metals analysed. Acceptable limits for other elements for human consumptions are: Zn (150ppm), Cu (10ppm) and Pb (1.5ppm) wet weight, respectively[7]. No maxima is specified for Mn.

Dussumiera acuta, Chirocentrus dorab, Mini maculata and *Megalaspis cordyla* contained trace metal levels in the order of alimentary canal > gill > musculature, while in the others the order was gill > alimentary canal > musculature. The possible explanation for the latter trend is that the principal mode of uptake of metal is through the gills. As the gills are constantly exposed, the mucus exposed to seawater acts as a surface adsorption sheet for either selective or general accumulation of metals[1].

The variation in concentration of metals in different tissues may be attributed to the feeding habits. In detrital feeders like *Mugil cephalus* which feed by grazing on submerged materials and plant surfaces or by sucking the surface layer of the mud, ingestion of sediment which could be enriched with heavy metals as a result of contamination, would probably lead to the ingestion of greater quantities of heavy metals by the fishes[8].

From the data it is clear that the concentration of all the metals analysed were within the prescribed limits for human consumption.

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