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Trace metal concentration in some marine organisms from Gopalpur coast, India

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ABSTRACT

Concentration of the trace metals (lead, zinc, chromium and cobalt) in some representative commercially important marine organisms (shrimps, crabs and fishes) from Gopalpur coast in the east coast of India was studied during April 2002. Zinc accumulation was more compared to other metals. The concentration of lead varied between 0.001 – 0.41 ppm, zinc 0.31 – 4.3 ppm, chromium 0.02 – 0.15 ppm and cobalt 0.006 – 0.2 ppm, which showed that Gopalpur coastal water was less polluted by these heavy metals. The orders of accumulation of heavy metals in different tissues were carapace > muscle in shrimps and crabs and liver > gill > muscle in fishes. The pattern of accumulation of the metals was in order of Zn > Pb > Co > Cr.

In recent years there has been emphasis on monitoring of heavy metals in the aquatic system as the use of metals in the industry and domestic applications are increasing at a rapid pace (Bhowmik *et al.*, 2001). The heavy metal pollution in an aquatic environment has been a matter of great concern owing to the presence of metals in marine and freshwater organisms. Heavy metals, otherwise known as trace metals, the persistent inorganic chemicals that do not break down, stand to pose serious environmental problems. Of all the elements H, C, N, O., Na, Mg, P, S, Cl, K, Ca constitute 99.9 per cent of all living matter (Pillai, 1983). Included among the toxic elements are heavy metals such as

silver (Ag), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), mercury (Hg), molybdenum (Mo), nickel (Ni), lead (Pb), tin (Sn), and zinc (Zn), as well as lighter elements such as aluminium (Al), arsenic (As) and selenium (Se). Under certain environmental conditions, these elements may accumulate to a toxic concentration, and cause ecological damage.

Several works have been carried out in different countries on the levels of trace metals in seawater, marine organisms and their effects on human beings (Ray and Macknight, 1984; Byrne *et al.* (1985); Rainbow (1990); Grass *et*

al. (1993); Paez-Osuna *et al.* (1993); Sharif *et al.* (1993); Yusof *et al.* (1994) and Paez-Osuna and Fernandez (1995). Mercury concentration in fishes from Bombay and Thane region has been studied by Tejam and Halder (1975). Distribution of trace metals in Andaman Sea has been studied by Sanzgiry and Braganca (1981). Heavy metals in fishes from Andaman Sea was studied by Kurishey *et al.* (1981). Some workers like Zingde *et al.* (1976), Madhupratap *et al.* (1981) and Krishnakumar *et al.* (1990) have studied the heavy metal concentration in marine zooplankton and invertebrates. Few workers such as Kurishey *et al.* (1981), Diouss and Kasinathan (1992), Muralidharan and Raja (1997), Nair *et al.* (1997), Rajendran *et al.* (1998) and Krishnamurti and Nair (1999 a&b) have studied the heavy metal concentration in commercially important fin and shellfishes from Indian waters. Nayak (1999) studied the heavy metal concentration in two important penaeid prawns from Chilka lagoon. No work has been carried out on trace metal concentration in any marine organisms from Gopalpur coast in particular and Orissa coast in general. The present study is an attempt to study the concentration of the trace metals (lead, zinc, chromium and cobalt) in five representative commercially important marine organisms from Gopalpur coast in the south Orissa coast, India.

Gopalpur coast is situated on the south Orissa coast of the Bay of Bengal at 19°16' N and 84°55' E. There is inundation of freshwater into the coast of the Bay from the adjacent creek during monsoon/post-monsoon period. The south coast of the creek serves as a fish-landing centre.

Five representative species of commercially important marine

organisms (*Penaeus monodon*, *Penaeus indicus*, *Scylla serrata*, *Portunus pelagicus* and *Rastrelliger kanagurta*) were collected from the commercial gillnet catches from 3 centres at Gopalpur coast during April 2002. Carapace, muscle, gill and liver were removed. The tissues were prepared from five individuals for each species of different sizes. Samples of carapace, muscle, liver and gill in separate pre-cleaned petridishes, were dried at 70°C until a constant weight was obtained. Each of the samples was then ground to powder and re-dried. The analysis was done using the standard digestion procedure.

Roughly 0.5 g of dry powder was weighed by electronic monopan balance and digested with 15-20 ml of nitric acid in conical flasks at 100°C for 12 hours. Additional nitric acid was added if the sample was charred. Towards the end 1 ml perchloric acid was added and the flasks were brought to near dryness. The blanks were run with each set. The solutions were made to 100 ml each in a measuring flask with double distilled water. The samples were analysed using atomic absorption spectrophotometer. The concentration of lead, zinc, chromium and cobalt in ppm dry weight were determined.

The concentrations of four trace metals (lead, zinc, chromium and cobalt) in different tissues of five species belonging to different groups of marine organisms (shrimps, crabs and fishes) are presented in Table 1.

Lead

The highest concentration of lead was found in carapace of *Scylla serrata* having 0.41 ± 0.013 ppm followed by carapace of *Penaeus monodon* and *Penaeus indicus* being 0.29 ± 0.008 ppm in both.

Zinc

The concentration of zinc showed wide range of variation from 0.31 ± 0.021 ppm to 4.3 ± 0.012 ppm. The highest concentration of zinc was found in liver of *Rastrelliger kanagurta* being 4.3 ± 0.012 ppm followed by its gill having 1.08 ± 0.073 ppm.

Chromium

The highest concentration of chromium was found in liver of *Rastrelliger kanagurta* being 0.15 ± 0.029 ppm followed by its gill being 0.12 ± 0.035 ppm. However, the carapace of *Scylla serrata* had 0.1 ± 0.021 ppm of chromium.

Cobalt

The cobalt concentration was found to be highest in carapace of *Penaeus monodon* having 0.2 ± 0.008 ppm followed by liver of *Rastrelliger kanagurta* being 0.18 ± 0.011 ppm and muscle of *Penaeus monodon* having 0.17 ± 0.029 ppm.

The order of accumulation of Pb, Zn, Cr and Co is carapace > muscle in all the shrimps and crabs. In fish (*Rastrelliger*

kanagurta) the accumulation of all the four trace metals in different tissues is in the order of liver > gill > muscle. The pattern of accumulation of different metals can be expressed as Zn > Pb > Co > Cr.

Aquatic organisms inhabiting coastal waters are likely to accumulate trace metals from the environment. Heavy metal accumulation in living organisms can have adverse effects on growth and development (Bryan, 1971). Significant fractions of heavy metals in natural waters are believed to exist in complex forms together with miscellaneous organic ligands, which regulate availability of these metals in the system of nutrients or as toxic agents (Chau and Wong, 1976). It has been reported that there is a direct correlation between metals accumulated by organisms and the amount of metals present in the environment (Bryan and Uysal, 1978), apart from the seasonal variations, distance from the shore region and the size of the animals and their ability to accumulate in their body tissue.

TABLE 1: Concentration of trace metals (lead, zinc, chromium and cobalt) in different tissues of experimental marine organisms (values expressed as ppm d.w.)

Sl. No.	Species	Tissue	Trace metals			
			Pb	Zn	Cr	Co
1.	<i>Penaeus monodon</i>	Carapace	0.290 ± 0.008	0.970 ± 0.008	0.050 ± 0.001	0.200 ± 0.008
		Muscle	0.002 ± 0.000	0.430 ± 0.016	0.020 ± 0.008	0.170 ± 0.029
2.	<i>Penaeus indicus</i>	Carapace	0.290 ± 0.008	0.850 ± 0.016	0.080 ± 0.014	0.130 ± 0.021
		Muscle	0.001 ± 0.000	0.420 ± 0.008	0.060 ± 0.029	0.070 ± 0.002
3.	<i>Scylla serrata</i>	Carapace	0.410 ± 0.013	0.900 ± 0.040	0.100 ± 0.021	0.020 ± 0.001
		Muscle	0.003 ± 0.000	0.480 ± 0.016	0.040 ± 0.021	0.006 ± 0.002
4.	<i>Portunus pelagicus</i>	Carapace	0.160 ± 0.001	0.720 ± 0.008	0.080 ± 0.014	0.040 ± 0.021
		Muscle	0.004 ± 0.002	0.310 ± 0.021	0.050 ± 0.024	0.008 ± 0.002
5.	<i>Rastrelliger kanagurta</i>	Muscle	0.001 ± 0.000	0.630 ± 0.021	0.080 ± 0.014	0.090 ± 0.003
		Gill	0.005 ± 0.002	1.080 ± 0.073	0.120 ± 0.035	0.120 ± 0.010
		Liver	0.200 ± 0.008	4.300 ± 0.012	0.150 ± 0.029	0.180 ± 0.011

TABLE 2: Ranges of concentration of trace metals in some shrimps, crabs and fishes collected from different stations as reported by different authors

Authors	Stations	Species	Range of trace metals				
			Pb	Zn	Cr	Co	
Krishnamurti and Nair (1999b)	Thane Creek, Maharashtra	<i>Penaeus indicus</i>	0.02-0.09 ppm	41.9-72.0 ppm			
		<i>Scylla serrata</i>	0.008-0.02 ppm	148.0-644.2 ppm			
		<i>Portunus pelagicus</i>	0.007-0.04 ppm	43.7-260.8 ppm			
Kumarguru et al. (1992)	Rameswaram island	<i>Scylla serrata</i>		0.43 ppm			
Patel et al. (1985)	Bombay harbour	<i>Boleophthalmus boddaerti</i>		30.1±0.9 ppm	1.3±0.3 ppm	0.5±0.3 ppm	
Nair et al. (1997)	Coastal waters of Cochin, South west coast of India	<i>Rastrelliger kanagurta</i>		14.99±1.60 µg.g ⁻¹ d.w. (muscle) 117.87±12.0 µg.g ⁻¹ d.w. (gill)			
Krishnakumar et al. (1990)	Near a caustic soda plant at Karwar, India	<i>Rastrelliger kanagurta</i>	0.006±0.002 µg.g ⁻¹ w.w. (muscle)	6.66±0.75 µg.g ⁻¹ w.w. (muscle)			
Freedman (1989)	Typical marine	Marine fishes	0.001-15 ppm	9-80 ppm	0.03-2 ppm	0.006-0.05 ppm	
Nayak et al. (Present study)	Gopalpur coastal waters	Shrimps	0.001-0.29 ppm	0.42-0.97 ppm	0.02-0.08 ppm	0.07-0.2 ppm	
		Crabs	0.003-0.41 ppm	0.31-0.9 ppm	0.04-0.1 ppm	0.006-0.04 ppm	
		Fishes	0.001-0.2 ppm	0.63-4.3 ppm	0.08-0.15 ppm	0.09-0.18 ppm	
EPA (1973); Pickering & Henderson (1966)	Probable safe concentration (mg.l ⁻¹)	Fish	≤ 0.03	≤ 0.05	≤ 0.05	-	

Ranges of concentration of trace metals (Pb, Zn, Cr and Co) in some shrimps, crabs and fishes collected from different stations as reported by some authors are presented in Table 2. These observations showed that Gopalpur coastal water was less polluted by these trace metals.

In fishes from Thane and Bassein creeks of Bombay the maximum

concentration of heavy metals was found either in liver or in alimentary canal with lowest level in muscle tissue (Krishnamurti and Nair, 1999a). Nair et al. (1997) also showed increased levels of heavy metals in the gills and alimentary canal compared to the muscle. The present observations in *Rastrelliger kanagurta* show the order of accumulation of the trace metals in

tissues as liver > gill > muscle, which supports the observations of Krishnamurti and Nair (1999a).

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