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Trace metals in the muscle tissue of nine marine fish species from Port Blair and Kochi

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Abstract

Trace metals in the muscle tissue of nine species of commercially important marine fishes collected from Port Blair (Andamans) and at Kochi (Kerala, southwest coast) were compared to study the level of bioaccumulation. Levels (µg per g dry weight) of Cd, Cu, Fe, Mn, Ni, Pb and Zn were estimated using ASS. Except Mn and Zn, all other metals were below detection levels in the samples collected from Port Blair. Compared to the same species and similar size from Kochi, Mn in *Saurida tumbil* (17.85 µg/g) and Zn in *Epinephelus tauvina* (97.11µg/g) from Port Blair were at higher levels. Samples from Kochi recorded accumulation of 1.42 µg/g Cd and 271µg/g Fe in *Rastrelliger kanagurta*, 11.3 µg/g Cu in *Sardinella gibbosa* and 83.3 µg/g Pb in *S. tumbil*. Baring Pb, the bioaccumulation of all other metals in the fish samples was within the WHO prescribed safe limits. Compared to the levels of Pb in sediment (59.76 µg/g) and water (1.8 µg/l) from Port Blair, lower value was recorded in the sediment (7.5 µg/g) and higher values in water (2.17µg/l) from Kochi. Significant correlation could not be established between the metal levels of Sediment and water samples neither from Port Blair nor Kochi. Significant correlation to 0.01level could be established positively between water and *Liza parsia, E. tauvina* and *S. longiceps* as well as *Pentaprion longimanus* and *R. kanagurta* with sediment from Kochi.

Keywords : Trace metals, marine fish, Port Blair, Cochin

Introduction

Metal pollution in an area depends mainly on the geochemical composition of the coast as well as the anthropogenic activities in the area. The seas around Andaman and Nicobar islands is considered comparatively cleaner to the peninsular Indian coasts as they are far away from the reach of industrial effluents from the mainland. Even the pristine environment in polar regions is found contaminated with aerosols and hydrocarbonated polyethylene derivatives (Smithwick *et al.*, 2005). Information on the bioaccumulation of heavy metals in marine organisms from open sea (Barber *et al.*, 1972; Kureishy *et al.*, 1981; Kureishy *et al.*, 1982) is not so common as is from coastal areas (Sankaranarayanan *et al.*, 1978; Lakshmanan and Nambisan, 1983; Krishnakumar *et al.*, 1990; Kaladharan *et al.*, 1999; Kaladharan *et al.*,2005; Kaladharan *et al.*,2005a; Patel *et al.*, 1985; Prema *et al.*, 2006). An attempt is made here to compare the levels of metals accumulated in nine fish species from Port Blair (Andamans) and from Kochi (Kerala, southwest coast) with reference to the ambient water and sediment aimed whether, these levels in fish samples from Andamans are comparable as reference levels for the coastal resources at the mainland.

Materials and methods

Fish samples, fresh and eight to ten animals per species selected from Port Blair fish landing center were collected during October 2003 and their counterparts from Cochin Fisheries Harbour, during November 2003 (Table 1). Muscle portion from each samples were removed separately and dried in an oven to constant weight at 70 ± 2°C. Sediment samples were collected from the intertidal area during the lowest low tide period using a corer. Metals from sediment and from the dry tissue samples were extracted using acid digestion procedure of Dalziel and Baker (1984). The metals extracted from the tissues and sediment were detected on a Perkin- Elmer AAS (Model 2380) in an air- acetylene flame. The precision of the analysis was found to be within 10% and the percentage recovery of metals from the spiked samples was found to be around 90%. Metals from filtered (0.45m) water samples were detected using differential pulse anode stripping voltametry (VA 757, Metrohm). Statistical analyses such as t-test and correlation matrix were carried out with SPSS 2000 software.

Results and discussion

Cadmium in the muscle tissue of nine fish species

Table 1. *Name and size of fish species studied from Kochi and Port Blair*

Name of Fish	Size range (mm)
Pentaprion longimanus (Cantor,1850)	70-85
Nemipterus japonicus (Bloch, 1791)	125-135
Sardinella gibbosa (Bleeker,1849)	80-95
Liza parsia (Hamilton-Buchanan, 1822)	110-125
Epinephelus tauvina (Forsskal, 1775)	160-200
Saurida tumbil (Bloch, 1795)	180-200
Rastrelliger kanagurta (Cuvier, 1817)	140-160
Sardinella longiceps (Valenciennes, 1847)	110-130
Decapterus russelli (Ruppell, 1830)	120-130

collected from Port Blair ranged from BDL to 0.09 μg/g and the maximum level was observed only in *Epinephelus tauvina*. While the similar species landed at Kochi showed Cd levels ranging from BDL to 1.42 μg/g and the maximum value was observed in *Rastrelliger kanagurta*. Cu, Fe, Ni and Pb were at BDL in all the nine species studied from Port Blair (Table 2). However, Cu and Fe were present in appreciable quantities (Cu – BDL to 11.3 μg/g; Fe BDL to 271μg/g) in species like *Nemipterus japanicus, S. gibbosa, Saurida* and *R. kanagurta* landed at Kochi. Mn and Ni levels in all the fish species collected from Kochi were at BDL, while, their counterparts from Port Blair showed appreciable quantities of Mn (BDL- 17.85 μg/g). The Zn levels in all the fishes from Kochi and from Port Blair registered considerable quantities (11.06 to 49.62 μg/g at Kochi and 1.23 to 54.77 μg/g at Port Blair).

In general Mn and Zn in muscle tissues of nine fishes from Port Blair and Fe, Pb and Zn were quite prominent in fishes landed at Kochi. Although Cu, Fe, Ni and Pb were not detected from any of the nine species studied from Port Blair, considerable levels of these metals were observed from the sediment (Table 2). Krishnakumar *et al.* (1990) could not find any significant differences between the whole soft tissue for Pb and Cd contamination in *Perna viridis* from a relatively clean and contaminated area

Our present results on the levels of Pb and Cd in fish samples from Port Blair are lower than those levels reported by the earlier workers (Kureishy *et al.*, 1981; Kureishy *et al.*,1983) indicating a decreasing trend in the bioaccumulation of Cd and Pb in fish samples in the Andamans. Similarly Kaladharan *et al.* (2005) have also

Table 2. *Levels of metals in seawater (μg/l), sediment (μg/g dry wt) and fish muscle tissue (μg/g dry wt) collected from Port Blair and Kochi.*

No. Samples	Location	Metals					
		Cd	Cu	Fe	Mn	Ni	Pb	Zn
P. longimanus	PortBlair	0.0	0.0	0.0	1.1	0.0	0.0	16.9
- do-	Kochi	0.0	0.0	68.8	0.0	0.0	0.0	28.8
N. japonicus	Port Blair	0.0.	0.0	0.0	0.0	0.0	0.0	5.8
-do-	Kochi	0.0	4.6	29.6	0.0	0.0	72.6	11.1
S. gibbosa	Port Blair	0.0	0.0	0.0	0.7	0.0	0.0	45.6
-do-	Kochi	0.0	11.3	35.2	0.0	0.0	0.9	31.8
L. parsia	Port Blair	0.0	0.0	0.0	1.7	0.0	0.0	1.2
-do-	Kochi	0.0	0.0	0.0	0.0	0.0	0.0	22.7
E. tauvina	Port Blair	0.09	0.0	0.0	0.0	0.0	0.0	97.1
-do-	Kochi	0.0	0.0	0.0	0.0	0.0	0.0	14.1
S.tumbil	Port Blair	0.0	0.0	0.0	17.8	0.0	0.0	39.7
-do-*l*	Kochi	0.0	2.9	12.9	0.0	0.0	83.3	16.4
R. kanagurta	Port Blair	0.0	0.0	0.0	0.0	0.0	0.0	6.1
-do-	Kochi	1.4	0.89	271.0	0.0	0.0	0.0	46.1
S. longiceps	Port Blair	0.0	0.0	0.0	4.1	0.0	0.0	54.8
-do-	Kochi	0.0	0.0	0.0	0.0	0.0	0.0	49.6
D. russelli	Port Blair	0.0	0.0	0.0	0.0	0.0	0.0	14.9
-do-	Kochi	0.0	4.2	25.4	0.24	0.0	75.3	33.3
Water	Port Blair	0.22	3.89	0.0	0.0	0.0	1.8	0.0
-do-	Kochi	0.35	1.60	0.0	0.0	0.0	2.2	17.1
Sediment	Port Blair	3.78	5.53	2921	94.6	23.7	59.8	6.5
-do-	Kochi	5.33	19.0	90. 20	136.5	38.8	7.5	97.8

Table 3. *Correlation and significance (2-tailed) of fish tissue samples, sediment and water collected from Port Blair.*

		P. longimanus	*S. gibbosa*	*L. parsia*	*N. japonicus*	*E. tauvina*	*S. tumbil*	Mackerel	Oil sardine	*D. russelli*	Sediment	Water
P. longimanus	P. Correlation	1										
	Significance											
	N	7										
S. gibbosa	P. Correlation	0.999**	1									
	Significance	0.000										
	N	7	7									
L. parsia	P. Correlation	0.542	0.500	1								
	Significance	0.209	0.254									
	N	7	7	7								
N. japonicus	P. Correlation	0.998**	1.000**	0.486	1							
	Significance	0.000	0.000	0.269								
	N	7	7	7	7							
E.tauvina	P. Correlation	0.998**	1.000**	0.486	1.000**	1						
	Significance	0.000	0.000	0.269	0.000							
	N	7	7	7	7	7						
S. tumbil	P. Correlation	0.928**	0.909**	0.816*	0.902**	0.902**	1					
	Significance	0.005	0.005	0.025	0.005	0.006						
	N	7	7	7	7	7	7					
Mackerel	P. Correlation	0.998**	1.000**	0.486	1.000**	1.000**	0.902**	1				
	Significance	0.000	0.000	0.269	0.000	0.000	0.005					
	N	7	7	7	7	7	7	7				
Oil sardine	P. Correlation	1.000**	0.998**	0.549	0.997**	0.997**	0.931**	0.997**	1			
	Significance	0.000	0.000	0.201	0.000	0.000	0.002	0.000				
	N	7	7	7	7	7	7	7	7			
D. russelli	P. Correlation	0.998**	1.000**	0.486	1.000**	1.000**	0.902**	1.000**	0.997**	1		
	Significance	0.000	0.000	0.269	0.000	0.000	0.005	0.000	0.000			
	N	7	7	7	7	7	7	7	7	7		
Sediment	P. Correlation	-0.188	-0.180	-0.238	-0.177	-0.177	-0.177	-0.177	-0.189	-0.177	1	
	Significance	0.687	0.700	0.608	0.704	0.704	0.704	0.704	0.684	0.704		
	N	7	7	7	7	7	7	7	7	7	7	
Water	P. Correlation	-0.268	-0.254	-0.379	-0.249	-0.250	-0.352	-0.249	-0.271	-0.249	-0.255	1
	Significance	0.561	0.583	0.402	0.590	0.589	0.438	0.590	0.557	0.590	0.580	
	N	7	7	7	7	7	7	7	7	7	7	7

Table 4. *Correlation and significance (2-tailed) of fish tissue samples, sediment and water collected from Kochi.*

		P. longimanus	*S. gibbosa*	*L. parsia*	*N. japonicus*	*E. tauvina*	*S. tumbil*	Mackerel	Oil sardine	*D. russelli*	Sediment	Water
P. longimanus	P. Correlation	1										
	Significance											
	N	7										
S. gibbosa	P. Correlation	0.895**	1									
	Significance	0.007										
	N	7	7									
L. parsia	P. Correlation	0.247	0.575	1								
	Significance	0.593	0.177									
	N	7	7	7								
N. japonicus	P. Correlation	0.168	0.070	0.095	1							
	Significance	0.719	0.881	0.839								
	N	7	7	7	7							
E.tauvina	P. Correlation	0.247	0.575	1.000**	-0.095	1						
	Significance	0.593	0.177	0.000	0.839							
	N	7	7	7	7	7						
S. tumbil	P. Correlation	-0.052	0.079	-0.001	0.963**	-0.001	1					
	Significance	0.911	0.867	0.998	0.000	0.998						
	N	7	7	7	7	7	7					
Mackerel	P. Correlation	0.969**	0.778*	0.002	0.195	0.002	-0.056	1				
	Significance	0.000	0.039	0.996	0.675	0.996	0.905					
	N	7	7	7	7	7	7	7				
Oil sardine	P. Correlation	0.247	0.575	1.000**	-0.095	1.000**	-0.001	0.003	1			
	Significance	0.593	0.177	0.000	0.839	0.000	0.998	0.996				
	N	7	7	7	7	7	7	7	7			
D. russelli	P. Correlation	0.174	0.190	0.213	0.950**	0.213	0.960**	0.124	0.213	1		
	Significance	0.709	0.684	0.647	0.001	0.647	0.001	0.791	0.647			
	N	7	7	7	7	7	7	7	7	7		
Sediment	P. Correlation	0.917**	0.673	-0.161	0.205	-0.161	0.058	0.987**	-0.161	0.085	1	
	Significance	0.004	0.097	0.731	0.659	0.731	0.902	0.000	0.731	0.856		
	N	7	7	7	7	7	7	7	7	7	7	
Water	P. Correlation	0.197	0.548	0.990**	-0.003	0.990**	0.102	-0.047	0.990**	0.304	-0.208	1
	Significance	0.671	0.583	0.000	0.994	0.000	0.827	0.920	0.000	0.508	0.654	
	N	7	7	7	7	7	7	7	7	7	7	7

Table 5. *Paired samples test for fish tissue, sediment and water from Port Blair (P) and Kochi (K)*

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Significance (2-tailed)
Pair 1	*P.longimanus* P - *P.longimanus* K	-11.377	25.753	9.734	-35.195	12.441	-1.169	6	0.287
Pair 2	*Nemipterus* P - *Nemipterus* K	-16.021	27.109	10.246	-41.093	9.051	-1.564	6	0.169
Pair 3	*S.gibbosa* P - *S.gibbosa* K	-4.703	15.304	5.784	-18.856	9.451	-.813	6	0.447
Pair 4	*L. parsia* P - *L. parsia* K	-2.829	8.267	3.125	-10.474	4.817	-.905	6	0.400
Pair 5	*Epinephelus* P - *Epinephelus* K	11.87857	31.38808	11.86358	-17.15056	40.90770	1.001	6	0.355
Pair 6	*S.tumbil* P - *S.tumbil* K	-8.279	35.351	13.362	-40.973	24.416	-0.620	6	0.558
Pair 7	*Mackerel* P - *Mackerel* K	-44.76000	100.846	38.11649	-138.02769	48.50769	-1.174	6	0.285
Pair 8	*Oil sardine* P - *Oil sardine* K	1.317	2.271	0.858	-0.783	3.417	1.535	6	0.176
Pair 9	*Decapterus* P - *Decapterus* K	-17.630	27.346	10.336	-42.921	7.661	-1.706	6	0.139
Pair 10	Sediment P - Sediment K	-776.29958	2151.212	760.5682	-2574.758	1022.1584 2	-1.021	7	0.341
Pair 11	Water P - Water K	-1.90833	6.19163	2.18907	-7.08467	3.26800	-.872	7	0.412

found decreasing trend in Zn, Cd and Cu levels and increasing trend in Pb levels in the fish tissues from Kochi during 1990-1998.

No traces of Fe, Mn and Ni could be detected from water samples in Kochi as well as Port Blair. Cu in water from Port Blair was higher(3.89 μg/l) than that of Kochi (1.59 μg/l). However, Pb (2.17μg/l) and Zn (17.09 μg/l) levels were higher from Kochi than that of Port Blair (Pb 1.82 μg/l and Zn- BDL). Our results on levels of Ni, Cd, Mn, Fe and Pb in seawater from Port Blair are agreeing with the previous study (Sanzgiry and Braganca,1981). Pb levels in the sediment from Port Blair is considerably higher than that of Kochi, although corresponding increase in Pb levels was not observed in any of the fish samples studied (Table 2). Earlier reports show higher content of dissolved rare earth elements in Andaman Sea and in the serpentine soils of Andaman (Paul *et al.*, 2006).

Correlation could not be established between water and sediment neither from Port Blair nor from Kochi samples. Similarly none of the metals in any of the nine fish tissues collected from Port Blair did correlate with water or the sediment (Table 3). However strong and positive correlation significant at 0.01 level could be established between metal levels in *L.Parsia, E. tauvina* and *S.longiceps* with water as well as *P.longimanus* and *R. kanagurta* with sediment from Kochi (Table 4). Positive correlation of Cd and Pb content in zooplankton with muscle tissues of fish and significant increase in their liver is reported by Kureishy *et al.*(1983). Kaladharan *et al.* (2005) reported significant correlation between Cu levels in *Otolithus ruber* and that of sediment from Kochi. Similarly Senthilnathan and Balasubramanian (1999) reported a linear relationship between Cu and Cd of phytoplankton with the ambient water. Results of paired *t* test for fish tissue, sediment and water are presented in Table 5. Except for *S. tumbil,* distrbution of metals in

all the other fish species, sediment and water from Port Blair and Kochi were not significant.

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