Studies on Heavy Metal Accumulation in selected Edible Fish species of Vishakapatnam Entrance Channel

M.Vijaya Bhavani
Department of Environmental Sciences
Andhra University
Visakhapatanam, India

B.Vinaya Sagar
Department of Environmental Sciences
Andhra University
Visakhapatanam, India

Boni Anil Kumar
Department of Environmental Sciences
Andhra University
Visakhapatanam, India

Dr.K.Kameswara Rao
Department of Environmental Sciences
Andhra University
Visakhapatanam, India

***Abstract*—Heavy metals discharged into the marine environment can damage both biodiversity and ecosystem, due to their toxicity and accumulative tendency in the aquatic biota and pose a risk to fish consumers, such as human beings and other wildlife. Major sources of toxic metals arising from human activities are domestic and industrial wastewaters and their associated solid wastes. Metals like, arsenic, chromium, mercury, nickel and lead exhibit toxicity at certain levels. Marine fishes exposed to heavy metals have been consumed as sea foods and, hence are a connecting pathway for the transfer of toxic heavy metals into human beings. This paper makes an attempt to identify the toxicity levels in some of the fish species in the VEC (Visakhapatnam entrance channel) which is one of the most vulnerable systems for pollution of different types. Metal accumulations of nickel, barium, cadmium, iron, manganese, zinc, chromium, copper, lead in the five species of fish was studied.**

Keywords—Heavy Metals, Bio accumulation, Aresnic, Chromium, Copper, Nickel, Lead, Toxicology

I. Introduction

Industrial wastes and mining can create a potential source of heavy metal pollution in the aquatic environment (Gumgum et al., 1994). Metals like iron, copper, zinc and manganese are required for metabolic activities for life, whereas arsenic, cadmium, chromium, mercury, nickel and lead exhibit toxicity so, these metals have been included in the regulations for hazardous metals (EC, 2001; USFDA, 1993).

Industrial wastes and mining can create a potential source of heavy metal pollution in the aquatic environment (Gumgum et al., 1994). Metals like iron, copper, zinc and manganese are required for metabolic activities for life, whereas arsenic, cadmium, chromium, mercury, nickel and lead exhibit toxicity so, these metals have been included in the regulations for hazardous metals (EC, 2001; USFDA, 1993). various studies have been carried out worldwide on the metal contamination in different edible fish species (Kamaruzzaman et al., 2010; Raja et al., 2009; Rauf et al., 2009; Yilmaz 2009; Ahmed and Nain, 2008; Nawal, 2008; Raychaudhuri et al., 2008; Sivaperumal et al., 2007; Bhattacharya et al., 2006; Chatterjee et al., 2006). Components, incorporating the applicable criteria that follow. In view of the above, the present study is proposed on the VEC waters and their fish, with the following objectives.

- To study the concentrations of the heavy metals in the VEC waters, and their status at the Upstream and Downstream points;
- To study accumulations of heavy metals, if any, in selected dominant fish species inhabiting VEC waters.

II. Study Area

Visakhapatnam Entrance Channel (VEC) which extends for several kilometers and the channel is so wide and deep that even major ships can be harbored in the channel. The VEC has three major arms extending towards inland, and each of these arms is connected with the Visakhapatnam storm water drainage network.

A small riverine stream called Meghadri gedda opens in to the VEC; similarly most of the city sewage enters in to the sea through two major storm water drains namely, Yerrigedda and Gangulagedda, at the downstream a sewage treatment plant with 20 mld capacity run by Visakhapatnam Port Trust releases treated water into the VEC.

After the emergence of sea port in 1920s and after the establishment of several industries around the port area abutting the VEC, the natural ecosystem of the VEC tidal waters had altered and several marsh mangroves along the VEC arms were converted for the industrial purposes. All these have compounded the ecological and environmental state of the VEC. However, still some subsistence and poor fishermen folk use this creek for fishing and support their livelihoods.

The VEC channel and the two zones selected for this study were shown in Fig. The two stations selected were based on the extereme points at the upstream and downstream ends of the fishing zone in the VEC, whereas the upstream zone is close to the freshwater flows from the land side, and the downstream zone is close to mouth of the VEC and is greatly influenced by the tide.

Fig. 1. Study Area.

III. Using the Template

Fish species collected were subjected to pre-treatment before they are used for analysing for heavy metals. Samples were thoroughly washed with Mili-Q water after removing the scales, and muscle portion, which was taken for further processing. Muscle tissue was oven dried at 1100C, powdered with pestle and mortar and stored until chemical analysis. Heavy metals (Cu, Zn, Mn, Fe, Cd, Hg and As) were analyzed after digesting the homogenized samples in a mixture of nitric and perchloric (Kumar et al., 2010). Digestion was carried out after 0.5 gm homogenized powdered sample was placed in a Teflon beaker and digested with few drops of sodium chloride solution (30%) and a 10 ml mixture (1:5) of concentrate Nitric acid (65%) and concentrated Perchloric acid (70%). The free chlorine developed loosens the chemical bonds in organic compounds after gentle heating (at 70±5oC) in a water bath for 12 hrs and destroys the organic matter in order to transfer the metals into the solution. The digested samples were centrifuged and the supernatant was analyzed. The results were expressed in µg g-1 metal dry weight.

A. *Instrumental Analysis*

Determinations of copper, zinc, manganese, iron and cadmium were carried out using Flame Atomic Absorption Spectrometry (FAAS, Thermo, UK). Hydride generator (HG) coupled to atomic absorption spectrophotometer was used to analyzed total mercury (cold vapor mode) and arsenic (heating mode). Background corrections were applied whenever required during in the analysis and the method of standard additions was used to compensate for matrix effects.

IV. Results

Five fish species were selected for the study as test species to study metal accumulations, as all these species are edible species and therefore metal accumulations in the edible tissues were estimated. Based on the water quality, the analyses were limited to 9 heavy metals (Ba, Cd, Co, Cr, Fe, Mn, Ni, Pb and Zn) and 8 of these metals were found accumulated, while Co was not found in any of the fish species. The total metal content in the edible parts of the fishes had ranged from 23.132 mg/kg in NI to 58.364 mg/kg in PL.

A. *Heavy Metal Accumulations in Ariomma indicum*

Arioma indicum has a total metals concentration of 29.6 mg/kg, of this Fe content accounts for nearly 50.38% (14.688 mg/kg). Iron was followed by Ba, which was recorded at 6.284 mg/kg. The remaining metals had relatively low concentrations, of which Zn ranks high with a concentration 4.376 mg/kg.

TABLE I. Heavy Metal Accumulations In Arioma Indicum Collected From VEC Waters

Metal	Con.(mg/kg)	SD	% of Total Metal
Ba	6.284	± 0.182	21.23
Cr	0.949	± 0.153	3.20
Cu	1.239	± 0.238	4.19
Fe	14.688	± 3.267	49.62
Mn	1.379	± 0.186	4.66
Ni	0.019	± 0.008	0.07
Pb	0.666	± 0.288	2.25
Zn	4.376	± 2.189	14.78
Total	**29.599**		

B. *Heavy Metal Accumulations in Pentaprion longimanus*

Pentaprion longimanus has a total metals concentration of 58.364 mg/kg, of this Fe content accounts for nearly 39.53% (35.290 mg/kg). Iron was followed by Ba and Zn whose concentrations were recorded at 9.828 mg/kg and 7.213 mg/kg. The remaining metals had relatively low concentrations, of which Cu ranks high with a concentration 3.235 mg/kg.

TABLE II. Heavy Metal Accumulations In Pentaprion Longimanus Collected From VEC Water

Metal	Con.(mg/kg)	SD (±)	% Metal
Ba	9.828	3.243	16.84
Cr	1.099	0.198	1.88
Cu	3.235	0.550	5.54
Fe	35.290	7.411	60.46
Mn	1.313	0.144	2.25
Ni	0.181	0.022	0.31
Pb	0.206	0.053	0.35
Zn	7.213	2.380	12.36
Total	**58.364**		

C. *Heavy Metal Accumulations in Nemipterus japonicus*

Nemipterus japonicus has a total metals concentration of 23.132 mg/kg, of this Fe content accounts for nearly 43.35% (13.104 mg/kg). Iron was followed by Zn whose concentrations was recorded at 5.208 mg/kg. The remaining metals had relatively low concentrations, of which Pb ranks high with a concentration 2.554 mg/kg.

TABLE III. Heavy Metal Accumulations In Nemipterus Japonicus Collected From VEC Waters

Metal	Con.(mg/kg)	SD (±)	% Metal
Ba	0.532	0.064	2.30
Cr	0.277	0.072	1.20
Cu	1.273	0.420	5.50
Fe	13.104	4.324	56.65
Mn	0.139	0.025	0.60
Ni	0.045	0.008	0.20
Pb	2.554	0.536	11.04
Zn	5.208	0.573	22.51
Total	**23.132**		

D. Heavy Metal Accumulations in Rastrelliger kanagurta

Rastrelliger kanagurta has a total metals concentration of 48.476 mg/kg, of this Fe content accounts for nearly 66.83% (32.395 mg/kg). Iron was followed by Ba whose concentrations was recorded at 8.668 mg/kg. The remaining metals had relatively low concentrations, of which Zn ranks high with a concentration 3.535 mg/kg.

TABLE IV. HEAVY METAL ACCUMULATIONS IN NEMIPTERUS JAPONICUS COLLECTED FROM VEC WATERS

Metal	Con.(mg/kg)	SD (±)	% Metal
Ba	8.668	2.860	17.88
Cr	0.384	0.081	0.79
Cu	1.330	0.160	2.74
Fe	32.395	8.423	66.83
Mn	1.088	0.359	2.24
Ni	0.198	0.034	0.41
Pb	0.879	0.097	1.81
Zn	3.535	0.636	7.29
Total	**48.476**		100.00

E. Heavy Metal Accumulations in Sphyraena obtusata

Sphyraena obtusata has a total metals concentration of 18.705 mg/kg, of this Fe content accounts for nearly 59.64% (7.550 mg/kg). Iron was followed by Pb and Zn whose concentrations were recorded at 4.888 mg/kg and 4.211 mg/kg, respectively. The remaining metals had relatively low concentrations, of which Cu ranks high with a concentration 1.013 mg/kg.

TABLE V. HEAVY METAL ACCUMULATIONS IN SPHYRAENA OBTUSATA COLLECTED FROM VEC WATERS

Metal	Con.(mg/kg)	SD (±)	% Metal
Ba	0.460	0.078	2.46
Cr	0.300	0.033	1.60
Cu	1.013	0.182	5.41
Fe	7.550	2.492	40.36
Mn	0.240	0.050	1.28
Ni	0.044	0.005	0.23
Pb	4.888	1.271	26.13
Zn	4.211	1.390	22.51
Total	**18.705**		100.00

V. DISCUSSION AND CONCLUSION

As found in the present study, the metal concentrations in the five fish were in the permissible limits, with the only exception in case of Lead (Pb) which is beyond the permissible levels in the edible parts of Ariomma indicum(AI), Rastrelliger kanagurta(R.K) and Sphyraena obtusata (S.O) ,species. However, other metals like zinc, iron, cadmium and others may soon pass on to the food chain. Thus it is essential that the pollution levels in the VEC need to be studied in more detail, to understand the pollutions accumulated in different strata of the biota and also the pollution impact on the species breeding in the VEC waters. The pollution levels may also affect the regenerating mangroves in the region.

Further, the impact on the humans, who are consuming these fish caught from the VEC waters need to study urgently, as the people who consume these fish from the VEC are often the marginalized sections of the society.

TABLE VI. COMPARISON OF METAL CONCENTRATIONS IN FIVE FISH SPECIES WITH USHFDA STANDARDS

Metal	ORAL PDE µg/day	ORAL CONC. µg/g	Conc. In fish species (mg/kg)				
			AI	PL	NJ	RK	SO
Chromium (Cr)	**11000**	**1100**	0.949	1.099	0.277	0.384	0.300
Copper (Cu)	**3000**	**300**	1.239	3.235	1.273	1.330	1.013
Nickel (Ni)	**200**	**20**	0.019	0.181	0.045	0.198	0.044
Lead (Pb)	**5**	**0.5**	0.666	0.206	2.554	0.879	4.888

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