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Full Length Research Paper

Effect of body size on elemental concentration in wild *Wallago attu* (Bloch and Schneider) from southern Punjab, Pakistan

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In this study, relationships of body size with metals; zinc (Zn), iron (Fe), copper (Cu), nickel (Ni), cobalt (Co), cadmium (Cd) and lead (Pb) in freshwater wild *Wallago attu* (whole fish) was studied. Mean concentrations (µg g^{-1} dry weight) of the metals in carcasses of wild *W. attu* were found to be 23.66 (Cu), 96.33 (Zn), 94.02 (Fe), 0.55 (Ni), 1.05 (Co), 0.31 (Cd) and 2.07 (Pb). Cr concentration was below the limit of detection of the technique. It was observed that all metals showed significant positive correlation (P<0.001) with total body weight or total body length. Metals such as Cd, Co, Cu and Fe were found to increase in direct proportion to an increase in body weight showing isometry (when b=1 or not significantly different from 1.0). Ni, Zn and Pb were found to decrease with the increase of body weight showing negative allometry. All the metals had decreasing trends with the increase of total length of the fish showing positive allometry (b value more than 3) except Zn.

Key words: Allometry, body weight, correlation, metals, *Wallago attu.*

INTRODUCTION

All living organisms need mineral elements. Some of these elements such as copper (Cu), iron (Fe), cobalt (Co), chromium (Cr), zinc (Zn) etc exist naturally in the environment and are essential for living organisms. However, these essential metals can also produce toxic effects at high concentration (Tyrrell et al., 2005). Among these toxins, heavy metals are particularly severe in their action due to tendency of bio-magnification in the food chain. So, the heavy metal contamination of aquatic ecosystems has been recognized as a serious global environmental problem (Khare and Singh, 2002). Industrial wastes, sewage disposal, soil leaching and rainfall are considered vital factors for disturbing the natural aquatic environment. The increase use of metal based fertilizers in agricultural revolution could also result in continued rise in the concentration of metal pollutants in fresh water due to the water run-off (Adefemi et al., 2008; Prasath and Arivoli, 2008).

Fish can accumulate contaminants from the environment and therefore, the use of fish as bio indicator of metals to study the pollution of the aquatic ecosystem is becoming popular (Jaffar et al., 1988; Papagiannis et al., 2004). Fish being at the end of aquatic food chain may clearly indicate the status of water quality. There is a growing interest in carrying out studies on elemental concentration of wild and cultured food fishes throughout the world (Shearer, 1984; Jaffar et al., 1988;). In recent years, much attention has been directed to study the concentrations of heavy metals in freshwater fish (Salam et al., 2002; Canli and Atli, 2003; Ansari et al., 2006; Al-Bader, 2008; Rauf et al., 2009).

Wallago attu is one of the large freshwater catfishes found in southern Punjab. It is distributed to the rivers, reservoirs and in connected watersheds of India, Pakistan, Bangladesh, Nepal, Burma, Sri Lanka, including Thailand, Vietnam, Kampuchea and Indonesia (Talwar and Jhingran, 1991; Mirza, 2003). It grows to about 2 m, weighing more than 45 kg (Talwar and

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Abbreviations: **Zn,** Zinc; **Fe,** ion; **Cu,** cupper; **Ni,** nickel; **Co,** cobalt; **Cd,** cadmium; **Pb,** lead; **Cr,** chromium.

Table 1.: Mean and standard deviation values of metal concentrations in carcasses of wild W. attu (whole fish) (n = 78).

Metal	Concentration (mean ± S.D)	
	Dry weight (μgg^{-1})	Wet weight (μgg^{-1})
Cu	23.663±2.012	5.440±0.250
Zn	96.327 ± 13.231	22.274 ± 2.028
Ni	0.549 ± 0.003	0.126 ± 0.025
Fe	94.017 ± 42.688	21.672 ± 7.133
Co	1.048 ± 0.026	0.241 ± 0.015
Pb	2.069 ± 0.425	0.475 ± 0.188
Cd	0.311 ± 0.135	0.072 ± 0.019

S.D, Standard deviation.

Jhingran, 1991) with a calculated life span of about 10 years (Goswami and Devraj, 1992).

Southern Punjab has an economic importance for fishery. But, on the other hand, this region is under the effect of pressure of pollution originating from agricultural and industrial activities, gradually disturbing the environment which is highly important for the survival and growth of commercially important fishes. The contaminated fish from this area may become a public health concern. Therefore, the aim of present work was to examine the accumulation of metals in relation to growth in wild *W. attu* of this area.

MATERIALS AND METHODS

78 wild *W. attu* of body length ranging from 16.70 to 50.20 cm and body weight from 14.54 to 648.82 g were collected from different localities of Indus river southern Punjab, Pakistan using a cast net and were transported live in plastic containers to the laboratory. Fishes were removed from plastic containers and anaesthetized using tricaine methanesulfonate (MS222). These were then blotted dry with filter paper and the weight of each fish was determined using an electrical balance (MP-3000 Chyo, Japan) to the nearest 0.01 g. Total body length were measured to nearest 0.1 cm using wooden measuring tray. These fish were placed in a pre-weighed aluminium foil tray in an electric oven (Memmert® 8540) at 70°C until a constant weight was obtained. The dry carcasses were then crushed and powdered in an electric blender (Moulinex).

Sample solutions were prepared as 1 g of dried fish powder; sample was ashed in a muffle furnace at 500°C for 12 h. The ash contents were digested in conical flask with 10 ml (70%) nitric acid (HNO_3) on a hot plate at 82 to100°C, heated to dryness and diluted up to 25 ml with deionized water. These solutions were aspirated into atomic absorption spectrophotometer (Hitachi, Japan) and absorbance measurements were made for each element using specific instrumental conditions for flame atomization mode. Analysis of each sample was carried out for three times. Calibration of the instrument was repeated after every ten samples during operation.

RESULTS AND DISCUSSION

The mean and standard deviation values of different metals quantified in the carcasses of wild *W. attu* (whole fish) on dry and wet weight basis are presented in Table 1. According to these results, the metals present in the highest concentrations were in the order of Zn > Fe > Cu >Pb > Co > Ni > Cd. Cr level was below the limit of detection of the technique used.

As metal concentrations were found to be related to body size, regression analysis was used to determine the size dependence of these metals. Parameters of these relationships are given in Tables 2 and 3. It was observed that all metals showed significant positive correlation (P>0.001) with total body weight and total body length. All the metals were found to increase in direct proportion to an increase in body weight showing isometry (when the value of slope b is either equal to 1.0 or not significantly different from 1.0). When total metal body burden was plotted against total length, it was found that all the metals (dry weight) had decreasing trend with the increase of total length of fish. When the allometric approach was applied, it was observed that Zn, Ni and Pb showed isometric growth with total length (where b = 3 or close to 3) while Cu, Fe, Co and Cd had positive allometric growth (b value more than 3).

In this study, it was found that Zn concentration was higher than any other metal followed by Fe and Cu. The higher concentration of Zn might be due to its essentiality in fish metabolism and nucleic acid synthesis. It is also an important part of enzymes in fish. The high concentration of iron is due to its direct involvement in haemoglobin formation in fish blood. The addition of untreated municipal and industrial waste water into rivers also might be the result of higher levels of these metals. This result is in general agreement with the findings of Dural et al. (2003) and Al-Bader (2008). The Cd and Ni concentrations were lower in this study. Low level of Cd was due to its non essentiality to the living organisms because it causes carcinogenic problems in human beings. However, the Cd concentration in the study coincides to that of cyprinid fish (0.1 to 2.8 μg g^{-1} dry wt) (Andres et al., 2000; Has-Schon et al., 2006).

Table 2. Relationship between log wet body weight (g) versus log metal concentrations (µg) in wild *W. attu* (n = 78 in each case).

Wet body weight (g)	Metal	a	b	S.E (b)	r
14.54 to 648.82	Cu	0.598	1.032	0.079	0.832***
	Zn	1.508	0.904	0.057	0.877***
	Ni	-0.799	0.940	0.045	0.923***
	Fe	1.212	1.033	0.061	0.889***
	Co	-0.654	0.997	0.055	0.900***
	Pb	-0.267	0.961	0.044	0.928***
	Cd	-1.321	1.063	0.056	0.909***

r, Correlation coefficient ; a, intercept ; b, regression coefficient; S.E, standard error; ***P>0.001, significance level.

Table 3. Relationship between log total length (cm) versus log metal concentrations (µg) in wild *W. attu* (n = 78 in each case).

Total length (cm)	Metal	a	b	S.E (b)	r
16.70 to 50.20	Cu	-2.354	3.444	0.253	0.842***
	Zn	-1.032	2.986	0.186	0.878***
	Ni	-3.400	3.079	0.154	0.916***
	Fe	-1.594	3.349	0.214	0.874***
	Co	-3.392	3.252	0.191	0.890***
	Pb	-2.947	3.161	0.148	0.926***
	Cd	-4.224	3.455	0.196	0.896***

As metal concentrations were found to be related to body size (body weight and body length), regression analysis was used to find the size dependence of these metals. All the parameters of these relationships are given in Tables 2 and 3. The allometric approach was applied in slope 'b' of log-log regression of the relationship between total metal body burden and total body weight or length, when compared with b=1 or b=3 (an isometric slope) is a good predictor for isometric or allometric increase of these metals with fish growth (Weatherley and Gill, 1987; Salam and Davies; 1994).

It was observed that all metals showed significant correlation (P>0.001) with total body weight and total body length. The metals such as Ni, Zn and Pb were found to decrease with the increase of body weight showing negative allometry while Cd, Co, Cu and Fe were found to increase in direct proportion to an increase in body weight showing isometry (when the value of slope b is either equal to 1.0 or not significantly different from 1.0).

This result is in general agreement with the findings of Farkas et al. (2000), Canli and Atli (2003) and Ansari et al. (2006). The high bioaccumulation of metals in this wild catfish is believed to occur due to rigorous anthropogenic activities.

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