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Inorganic Elemental Concentrations of Wild *Catla catla* in Relation to Growth

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Forty nine *Catla catla* samples of variable sizes caught from the River Chenab, Pakistan were studied for inorganic elemental concentrations in relation to body size. It was observed that the total quantity of elements i.e. sodium, potassium, calcium, magnesium, manganese, iron, nickel, copper, zinc and lead was found to increase isometrically with body weight. Whereas only sodium, potassium, magnesium, zinc and lead showed positive allometry and the remaining elements showed isometry with increasing length. Cobalt, chromium and cadmium were not quantifiable.

Key words: *Catla catla,* Inorganic elemental concentrations, Growth

Introduction

Metals enter the aquatic ecosystem as a result of the weathering of soils and rocks and from a variety of human activities like mining, processing or use of metals or substances that contain metal contaminants. Although some metals such as manganese, iron, copper and zinc are essential micronutrients, others such as mercury, cadmium and lead are not required even in small amounts by any organism. All metals including the essential metal micronutrients are toxic to aquatic organisms as well as humans if exposure levels are sufficiently high (Laws 1981).

Many studies on body composition of fish have been reported in the literature (Elliot 1976; Caulton and Bursell 1977; Jobling 1980; Weatherley and Gill 1987; Salam and Davies 1994) but little attention has been focussed on the inorganic elemental concentrations of wild and cultured food fishes (Rottiers 1983; Shearer 1984; Salam *et al* 1993; Shackley *et al* 1994). *Catla catla* is the fastest growing carp and is very popular for fish culture in ponds and rivers in Pakistan (Talwar and Jhingram 1991). The purpose of the present study is to examine changes in the proportion of inorganic elements in relation to body size of a riverine *Catla catla* and to compare the accumulation of various inorganic elements with other fish species found in Pakistan.

Experimental

Forty nine samples of wild *Catla catla* ranging from 11.6 to 37.7 cm and 10.29 to 696.7 gm in length and weight respectively were collected from River Chenab of the Punjab province, Pakistan. They were transported live to the laboratory for analysis of body composition parameters in relation to body size. They were killed, blotted dry, weighed to nearest 0.01 gm on an electronic digital balance and their length was measured to nearest 0.1 cm on a fish measuring tray. Each fish was dried whole to a constant weight in a drying oven at 50-60°C. The dry carcasses were crushed in a pestle and mortar and powdered in an electric blender.

A R Grade chemicals supplied by Merck were used without further purification for the purpose of elemental analysis. Deionised water was used to prepare standard and sample solutions. Stock standard solutions 1 mg l^{-1} of each element were prepared by dissolving required amounts of the respective salts in water. Dilutions of the stock solutions were made to prepare working acidic standards (0.1M HNO_3 final molar concentration) in the measuring ranges.

Officially calibrated pyrex glassware and instruments i.e. Electrical Balance H-80 (Mettler, Switzerland), Muffle Furance RJM 1.8-10 (China), Atomic Absorption Spectrophotometer A-1800 (Hitachi, Japan) and Heating Oven (Memmert, West Germany) were used throughout this work.

Sample solutions were prepared through ashing one gram of dried fish powder sample in a muffle furnace at 500°C for 5 h. The ash contents were digested in aqua regia (3 ml) and solution was heated to dryness. Then 5 ml of 1M HNO_3, was added; the solution was filtered when necessary, and diluted to 50 ml with water (Further dilutions were made in some cases). These solutions were aspiratd into Atomic

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Absorption Spectrophotometer and absorbance measurements were made for each element using specific instrumental conditions for flame atomisation mode. Analysis of each sample was made in duplicate.

Elemental concentrations were computed by a computer program CPFAAS (Ansari and Iqbal 1993). Regression analysis and calculation coefficients were carried out with the help of a computer package (Louts 1-2-3).

Results and Discussion

The mean and standard deviation values of various inorganic elements i.e. sodium, potassium, calcium, manganese, iron, nickel, copper, zinc and lead found in the carcasses of wild *Catla catla* (whole fish) on dry and wet weight basis are presented in Table 1. Cobalt, chromium and cadmium were not quantifiable. Since elemental concentrations change with the change in body weight or length, regression analysis involving log body burden element (g) and log body weight (g) or log total length (cm) was also performed. Parameters of these relationships are given in Table 2 & 3. It was observed that all ten elements showed significant positive correlations ($p<0.001$) with body weight or total length (Table 2 & 3). All elements except cobalt, chromium and cadmium which were not quantifiable were found to increase linearly in direct proportion to increase in body weight showing isometry (where the value of slope b is either equal to 1.0 or not significantly different from 1.0) (Table 2). The regression analysis showed that each element if expressed in $\mu g g^{-1}$ dry weight or wet weight remained fairly constant indicating independence to increasing body weight.

Sodium, potassium, magnesium, zinc and lead significantly increased (positive allometry) ($b>3.0$) while calcium, manganese, iron, nickel and copper showed isometry (i.e. remained fairly constant, $b=3.0$) with increasing total length (Table 3). The regression analysis also showed that sodium, potassium, magnesium, zinc and lead were accumulating at a faster rate than other elements where the rate of their accumulation remained fairly constant with increasing total length (Table 3).

The values of inorganic elemental concentrations, obtained with *Catla catla* were compared with the values already reported in the literature for various freshwater fishes whether cultured or wild (Table 4). It was observed that interspecific variations in elemental concentrations exist which could possibly be due to the nature of their habitat, meat quality or gradual accumulation of pollutants entering the aquatic ecosystem. *Catla catla* had the lowest sodium content as compared to *Labeo rohita* which had the highest. This observation is further supported by the general preference for *Labeo rohita* over *Catla catla* in Pakistan due to saltish taste of its meat. *Catla catla* and *Tor putitora* generally possess more skeleton than rainbow trout and *Labeo rohita* which is clearly indicated by the presence of high calcium, magnesium and postassium contents. Nickel, copper, zinc and lead appear to get accumulated at a greater rate in *Catla catla* than in other

Table 1

Grand mean and standard deviation values of inorganic elemental concentration in carcasses of *Catla catla* (whole fish)

Element	Elemental concentration*					
	($\mu g\ g^{-1}$ Dry weight)			($\mu g\ g^{-1}$ Wet weight)		
	Mean		S.D	Mean		S.D
Na	2530.0	±	420.9	537.0	±	107.0
K	9636.0	±	1913.5	2046.0	±	470.0
Ca	45885.0	±	8116.5	9736.0	±	2019.0
Mg	2236.0	±	237.0	475.0	±	70.0
Mn	40.3	±	12.2	8.5	±	2.5
Fe	669.4	±	196.1	145.0	±	44.0
Ni	7.3	±	3.3	1.5	±	0.6
Cu	45.6	±	46.9	9.5	±	9.6
Zn	106.5	±	9.2	23.0	±	3.2
Pb	14.9	±	2.5	3.2	±	0.6
Co NQ						
Cr NQ						
Cd NQ						

*n= 49, NQ=Not Quantifiable; S.D= Standard deviation.

fish species which may be due to species specific of river water pollution. Accumulation of Na, K, Ca, Mg, Mn, Fe, Ni, Cu, Zn, and Pb remained fairly constant with increasing body weight in *Catla catla*. However, in *Tor putitora* and *Labeo rohita*, some elements increased or decreased while others remained fairly constant with increasing body weight (Salam *et al* 1993). Similarly decreases in Na or Ca in growing fish were also observed in the bones or muscles of various freshwater fishes (Khwaja and Jafri 1967a, 1967b, 1968; Shearer 1984; Weatherley and Gill 1987; Rottiers 1993; Shackley

Table 2
Regression parameters for determining the burden of an element in *Catla catla*

Wet body weight (g)	Element	a	b	S.E(b)	r
	Na	-3.33	1.03	0.03	0.970...
	K	-2.83	1.07	0.07	0.893...
10.29	Ca	-3.41	1.04	0.02	0.981...
	Mg	-3.41	1.04	0.06	0.910...
	Mn	-5.02	0.96	0.06	0.818...
	Fe	-4.07	0.98	0.41	0.710..
to	Ni	-5.79	0.97	0.06	0.896...
	Cu	-4.99	0.92	0.12	0.745...
696.74	Zn	-4.73	1.05	0.02	0.983...
	Pb	-5.59	1.05	0.03	0.971...

Log body burden element (g)=a+b (Log wet body weight (g) for *Catla catla*. Underlined values are not significantly different from b=1.0 (P<0.05) and n = 49

....P < 0.001; a = Intercept; b = Slope; S.E = Standard; r=Correlation coefficient.

Table 3
Regression parameters for determining the burden of an element in *Catla catla*

Total length (cm)	Element	a	b	S.E(b)	r
	Na	-5.72	3.41	0.13	0.964...
	K	-5.28	3.51	0.27	0.880...
11.6	Ca	-4.43	3.37	0.23	0.904...
	Mg	-5.80	3.44	0.13	0.967...
	Mn	-7.21	3.15	0.21	0.905...
	Fe	-6.23	3.14	0.48	0.684...
to	Ni	-7.98	3.16	0.25	0.877...
	Cu	-7.02	2.95	0.41	0.719...
	Zn	-7.14	3.44	0.12	0.969...
37.7	Pb	-8.01	3.46	0.14	0.962...

Log body burden element (g)=a+b (log total length (cm) for *Catla catla*. Underlined values are not significantly different from b=3.0(P< 0.05) and n=49

...P<0.001; a = Intercept; b = Standard error; r = Correlation coefficient.

Table 4
Comparative data of elemental concentration of various freshwater fish species (whole fish)

Element	Elemental concentration* (µg g^{-1})						
			a		b		c
	Catla catla		*Tor putitora*		*Labeo rohita*		Rainbow trout
	Dry wt.	Wet wt.	Dry wt	Wet wt.	Dry wt.	Wet wt.	Wet wt.
Na	2530.0 ± 420.9	537.0 ± 107.0	3996.0 ± 546.5	1149.0 ± 320.1	5352.98 ± 1299.75	1557.62 ± 409.08	1326 ± 300
K	9636.0 ± 1913.5	2046.0 ± 470.0	8966.2 ± 973.9	2587.6 ± 684.9	4941.34 ± 213.84	1425.90 ± 615.87	3154 ± 469
Ca	39885.0 ± 8116.5	9736.0 ± 2019.0	25652.2 ± 2177.0	7338.4 ± 1647.1	6002.79 ± 119.55	1744.67 ± 369.68	5164 ± 1160
Mg	2236.0 ± 237.0	475.0 ± 70.7	1786.5 ± 192.8	512.9 ± 127.9	1535.61 ± 282.74	446.30 ± 93.44	333 ± 163
Mn	40.3 ± 12.2	8.5 ± 2.5	9.7 ± 7.7	3.0 ± 2.6	18.19 ± 5.01	5.29 ± 1.58	1.81 ± 0.88
Fe	669.4 ± 196.1	145.0 ± 44.0	187.7 ± 123.2	55.0 ± 38.7	228.64 ± 161.68	66.38 ± 47.39	12.0 ± 3.8
Ni	7.3 ± 3.3	1.5 ± 0.6	6.0 ± 2.0	1.7 ± 0.7	NQ	NQ	------
Cu	45.6 ± 46.9	9.5 ± 9.6	9.0 ± 3.4	2.5 ± 1.1	15.17 ±	4.41 ± 1.88	1.2 ± 0.46
Zn	106.5 ± 9.2	23.0 ± 3.2	74.0 ± 9.6	1.4 ± 6.0	68.19 ±	19.75 ± 3.817	25.0 ± 1.60
Co	NQ	NQ	NQ	NQ	NQ	NQ	NQ
Cr	NQ	NQ	NQ	NQ	---	---	0.20 ± 0.20
Cd	NQ	NQ	NQ	NQ	0.95 ± 0.12	0.27 ± 0.04	
Pb	14.9 ± 2.5	3.2 ± 0.6	5.6 ± 4.1	1.4 ± 1.1	2.02 ± 0.42	0.58 ± 0.01	

*Mean ± Standard deviation; NQ = Not Quantifiable; a Salam *et al* 1994); b (Salam *et al* 1993); c (Shearer 1984).

et al 1994). Inter specific comparison showed that concentration of some elements remained constant while others increased or decreased linearly with increase in fish size. However, it is concluded that the equations derived in this study can provide reliable estimates of the whole body inorganic elemental concentrations at various body sizes of *Catla catla* within the range used.

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