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Effect of body size on the concentration of two essential macro elements (Calcium and Magnesium) in wild Eutropiichthys vacha from Indus River, Taunsa Barrage, Pakistan

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Abstract

Fish is primary protein source for human being in the universe. Overall 50 fish specimen of *Eutropiithys vacha* were collected from Indus River, Head Tounsa, Pakistan to check the effect of calcium and magnesium in the fish by Atomic Absorption Spectrometry. Calcium (Ca) and magnesium (Mg) in fish showed highly significant correlation between size (weight and length) and body burden of *E. vacha*. Calcium and magnesium, showed isometric relationships with body weight of wild *E. vacha*, indicating increase of concentrations of Ca and Mg in direct proportion to an increase in body weight of *E. vacha*. While Ca and Mg showed negative allometric relation in increasing fish length suggesting that these metals accumulate at a smaller proportion compared to its excretion rate as the *E. vacha* increases in length. Condition factor for *E. vacha* ranged from 0.447 to 0.930 and remained constant with metal concentrations in wet weight of the fish. The result displayed that the concentration of macroelements (Ca and Mg) in the examined fish sample were significantly affected by fish size.

Keywords: Macroelements, Metal concentration, Atomic Absorption spectrometry

Introduction

Fish and fish products are an important source of macronutrients such as phosphorus, calcium or magnesium that is why the amount of these elements determines the quality of these products [1]. Magnesium and Calcium are indispensable nutrients for aquatic animals and plants. For instance, fish requires Ca for development of bones, because bone comprises principally of calcium phosphate. Aquatic animals acquire Ca and Mg both from the food and water [2].

Freshwater fish accrue Ca directly from the water by absorption across the gills [3] and in at least some species of fish this calcium accumulation approach is adequate to uphold standard growth, even when the fish are fed a diet, not enrich in calcium [4]. Actually, even when Ca is provided with the diet, direct absorption of Ca from the water via the gills prevails [5]. Moreover, Ca ions affect the toxicity of trace metals to fish and other aquaculture species. The occurrence of Ca blocks the uptake of metal ions across the gills, thereby increasing the dissolved concentration of metals required to cause a toxic effect [2].

Magnesium is vital for the stimulation of a many enzymes used in carbohydrate and protein metabolism [6] and for the maintenance of intra and extra cellular homeostasis in fish [7], [8]. Magnesium also plays an important role in numerous additional significant forms such as muscle relaxation, metabolism, and synthesis of protein and replication of cells [9].

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Eutropiichthys vacha, freshwater catfish species, belongs to family Schilbeidae and order Siluriformes. It is commonly known as Batchwa vacha [10], vacha, bacha or bachwa [11], while locally called Jhali in Pakistan. *E. vacha* is found in rivers, canals and tidal waters; and distributed in Pakistan, Bangladesh, India, Myanmar, Thailand and Nepal. This catfish is considered commercial and gamefish and feeds on small fish and insects. Maximum total length and body weight of this species is reported 38.2 cm and 1.4 kg, respectively [11], [10]. Its dwarf size earned its fame as fish of aquarium [12] and it has been transported from its native homeland to other parts of globe [13]. Its body features can be represented with elongated and laterally compressed body, broader upper jaw, four pairs of barbles and silver colored structure with grey colour back [14]. This fish has wealth of access amount of proteins, carbohydrates and lipids [15]. However, there are major threats for this member of family Schilbeidae like overfishing harvesting aquatic resources and construction of large dams [16].

The aim of this research was to supply the information about the Ca and Mg concentration and to study the effect of body size and condition factor on the accumulation of these macroelements in the wild *Eutropiichthys vacha*, procured from Taunsa Barrage (Indus River), Southern Punjab, Pakistan.

Materials and Methods

Fish sampling was carried out in Indus River at Head Taunsa Barrage, southern Punjab, Pakistan. Fish diversity of Indus River is high at Taunsa Barrage, it provides a diverse and huge macro-habitat in the form of deep waters, shallow waters, fast flowing water with high oxygen content and submerged vegetation to variety of fish fauna. But, unfortunately biodiversity and population of Indus River different fishes including *E. vacha* at Taunsa Barrage are continuously decreasing day by day [17].

On arrival of collected samples in the Applied Fisheries Research Laboratory, IP&AB, Bahauddin Zakariya University, Multan, fishes were measured and weight was recorded after cleaning the samples. Each fish specimen was dried and grinded to homogenize. 1 gram of powder of fish was measured at electric balance and placed in the pre-weighted crucibles to put it in a furnace at 500°C for 24 hrs to obtain ash. Obtained ash was dissolved in 1M HNO_3 to make 25ml solution. Sample solution of each fish specimen of *E. vacha* was analysed through Atomic Absorption Spectrometry. Concentration value for each specimen was recorded.

Condition factor (K) of wild *E. vacha* was evaluated by using standard formula:

Condition Factor = weight / (length)^3 × 100.

Regression equation in log transformed

(*Log Y = a +b Log W*)

was used to evaluate the relationship between size and accumulation of macro-elements like Ca and Mg in wild *E. vacha*, where "a" is regression coefficient, "b" is slope; metal concentrations were taken on "Y", while total length, body weight or condition factor was taken on "X". Data was considered significant at P<0.001, P<0.01 and P<0.05.

Results

A total 50 samples of wild *Eutropiicthys vacha* were analysed to detect the concentration of calcium and magnesium. Mean (± SE) total length and body weight was recorded 21.398±0.796 cm and 73.644±7.079 g with range 10.20 to 30.30 cm and 8.610 to 168.0 g, respectively, while condition factor was calculated and the mean value was found 0.658± 0.017 with a range 0.447 to 0.930. Value of mean concentration (µgg^{-1}) of Ca and Mg were observed 1450.43 ± 456.56 and 264.69 ± 80.59 in wet body weight, while it was 4873.63±1410.85 and 886.75 ± 225.06, respectively, in dry body weight of wild *E. vacha*, while values of concentration ranges of these metals are shown in **Table 1.**

Table 1: Element concentration in wet and dry body weight of wild *Eutropiicthys vacha* (whole fish).

Ele	**Concentrations (µgg^{-1}) in wet weight**		**Concentrations (µgg^{-1}) in dry weight**	
	Range	**Mean ± S.E.**	**Range**	**Mean ± S.E.**
Ca	737.12 to 2358.06	1450.43 ± 456.56	2562 to 7618.5	4873.63± 1410.85
Mg	131.02 to 490.29	264.69 ± 80.59	525.75 to 1529.50	886.75 ± 225.06

Regression analyses depicted strongly correlated relationships between fish size (weight and length) and metal concentration (Ca and Mg) with coefficient of correlation (r) values ranged from 0.771 to 0.921 for *E. vacha*. Slope (b) value represented isometric relationships for metal (Ca and Mg) concentration with an increase in body weight of *E. vacha*. Metal concentrations of studied metals represented negative

allomertic relationship with TL of the wild *E. vacha* (**Table 2**).

Results of regression analysis for condition factor with metal concentrations in wet weight are given in **Table 3.** Condition factor remained constant with Ca (r=0.093) and Mg (r=0.177) for *E. vacha*.

Inter-elemental regression parameters between Ca and Mg in wet body weight for *E. vacha* are represented in **Table 4**. Concentration of calcium showed significant correlation with the concentration of magnesium in *E. vacha*.

Table 2: Regression analysis of log wet weight (W, gram) and log total length (TL, centimeter) versus log body burden of element body (µg) for wild E. vacha (n=50).

Relation	r	a	b	SE(b)	*t*-value (when b=1 for W and b=3 for TL)
W-Ca	0.916***	3.069	1.039	0.066	-14.113
W-Mg	0.921***	2.449	0.975	0.059	-15.974
TL-Ca	0.811***	1.624	2.498	0.260	-9.040
TL-Mg	0.771***	1.267	2.212	0.264	-9.152

***=P<0.001

Discussion

Values of mean concentrations of studied metals (Table 1) in *Eutropiicthys vacha* represented the trend as, Calcium > Magnesium. The same trend was also reported by [18] in *Oncorhynchus mykiss* and [19] in *Aristichthys nobilis*. Results of this study are in agreement with report of [20], who had studied the effect of graded levels of dietary protein on elemental concentration of hybrid (*Catla catla* ♂ x *Labeo rohita* ♀) from Pakistan and reported that Ca concentration 992.05±48.94, 1015.89±31.43 and 1145.53±40.53 while Mg concentration 1145.53±40.53, 403.19±30.71 and 484.18±27.99 µg/g by feeding 15, 20 and 25% CP, respectively. Values of magnesium and calcium in present study found higher than [19], lower by [21] in *Cirrhinus mrigala* as values of present study obtained. Study dry weight value of magnesium are higher and values of calcium are lesser than findings of [18] in *Oncorhynchus mykiss*. While [22] have reported higher magnesium concentration **(**1201.20 ± 60.6927 µg/g) in wild catfish (*Mystus bleekeri*). Moreover, [5] have studied the concentration of calcium and magnesium and reported the range 9.88-17.42 and 10.00-20.00 ppm, respectively in wet weight of farmed *Labeo rohita*. The variations might be due to various factors including size, condition factor [22] and feed [20]. This is further verified by [23], who have studied bioaccumulation of heavy metals in some tissues of *Tilapia zilli, Heterotis niloticus* and *Clarias anguillaris* from a lake of Nigeria and concluded that metal accumulation varied depending on feeding behavior, species-specific factors, age, and fish size.

In the present work, the allometric approach [24] was adopted to evaluate the effect of body size on the metal concentration, in which slope (b) of log-log regression analyses between total metal body burden and body weight or total length is considered a good predictor for allometric (negative or positive) or isometric increase of calcium and magnesium with increasing body weight or length of *E. vacha*.

Table 3: Regression analysis of condition factor with concentration of metal (wet weight, µg/g) in wet weight for E. vacha (n = 50).

Elem	r	a	b	SE(b)	t-value (b = 0)
Ca	0.093 n.s	1383.2	94.76	146.34	0.647
Mg	0.177 n.s	194.6	109.85	87.89	1.249

ns=nonsignificant

Table 4: Inter-elemental regression parameters in wet body weight for E. vacha (n=50)

Element	r	a	b	S.E (b)
Ca-Mg	0.388**	165.260	0.069	0.023
Mg-Ca	0.388**	868.135	2.200	0.753

****=P<0. 01**

As the value of slope (b) was not significantly different from 1.0, hence, both studied metals, calcium and magnesium, showed isometric relationships with body weight of wild *E. vacha*, indicating increase of concentrations of Ca and Mg in direct proportion to an increase in body weight of *E. vacha*. These findings can be linked to the report of [25], who have found Ca metal to increase in direct proportion to an increase in body weight showing isometry in *Puntius chola*. However, [20] have reported positive allometric relation between metals (Ca and Mg) concentrations

and size of hybrid fish (*Catla* x *Labeo*). Naeem *et al*., [18] documented negative allometry (b<1.0) in Ca and Mg with weight; whereas isometry (b = 3.0) in Mg and negative allometry in Ca with length of farmed rainbow trout (*Oncorhynchus mykiss*). Total length, in the present study, showed negative allometric relationships (b value significantly lower than 3.0), indicating a decrease in Ca and Mg concentration with increase in length which suggests that these metals are possibly accumulate at a smaller proportion compared to its excretion rate as the *E. vacha* increases in length. These variations verify that metal concentrations are affected by fish size in different fish species.

In the present study, Ca and Mg concentrations did not affected by condition factor in wild *E. vacha*. Similar findings have also reported in wild catfish *Mystus bleekeri* [22] and in female Nile Tilapia [19]. Thus, these findings verify the results that condition factor stayed constant for the concentrations of Ca and Mg in the body of *E. vacha*.

Conclusion

It is concluded wild *E. vacha* captured from Head Taunsa, River Sindh, Pakistan, is non-toxic for human intake, and can be a healthy source of calcium and magnesium (essential metals). Size of *E. vacha* represented a definite impact on calcium and magnesium bioaccumulation in the fish body, nevertheless condition factor remained unaffected with concentration of Ca and Mg in wild *E. vacha*.

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