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Elemental composition of Talang Queenfish (*Scomberoides commersonnianus* Lacépède, 1801) in relation to body size and condition factor from Pakistan

Composição elementar de Talang Queenfish (*Scomberoides commersonnianus* Lacépède, 1801) em relação ao tamanho do corpo e fator de condição do Paquistão

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Abstract

Fish is thought to be the most appropriate for indication of toxicity in water. So, purpose of present study was to determine the concentrations of few metals (Na, K, Ca, Mg, Fe, Cd, Pb and Zn) in relation to the body size and condition factor in *Scomberoides commersonnianus*. A total of 73 samples of marine fish, *S. commersonnianus* with various sizes that ranged from 93.4-1180 g of body weight and total length 20.5-56.9cm were randomly collected from the Arabian Sea of Karachi Pakistan, for examination of elemental composition. The concentration of Calcium found maximum while Cadmium found minimum in *S. commersonnianus.* Concentrations of Zn showed highly significant (P<0.001) negative, while Na and Ca exhibited strong positive correlation with the fish size. Correlations of Pb, K and Mg were found least significant (P<0.05) with the wet weight and total length of *S. commersonnianus.* Whereas, Fe and Cd were remained insignificantly correlated (P>0.05) with the fish size. Condition factor showed highly significant correlation (P<0.001) with all studied metals except cadmium and lead which were found insignificantly correlated (P>0.05) with condition factor of *S. commersonnianus*.

Keywords: marine fish, *Scomberoides commersonnianus,* metal concentrations, fish size, condition factor.

Resumo

O peixe é considerado o mais adequado para indicação de toxicidade na água. Assim, o objetivo do presente estudo foi determinar as concentrações de alguns metais (Na, K, Ca, Mg, Fe, Cd, Pb e Zn) em relação ao tamanho corporal e fator de condição em *Scomberoides commersonnianus*. Foi coletado um total de 73 amostras de peixes marinhos, *S. commersonnianus*, com tamanhos que variaram de 93,4 a 1.180 g de peso corporal e comprimento total de 20,5 a 56,9 cm, aleatoriamente do Mar Arábico de Karachi, Paquistão, para exame de composição elementar. A concentração de Ca foi máxima, enquanto a de Cd foi mínima em *S. commersonnianus*. As concentrações de Zn mostraram-se altamente significativas negativas (P < 0,001), enquanto Na e Ca apresentaram forte correlação positiva com o tamanho dos peixes. As correlações de Pb, K e Mg foram menos significativas (P < 0,05) com o peso úmido e o comprimento total de *S. commersonnianus*. Já o Fe e o Cd permaneceram pouco correlacionados (P > 0,05) com o tamanho dos peixes. O fator de condição apresentou correlação altamente significativa (P < 0,001) com todos os metais estudados, exceto Cd e Pb, que foram encontrados correlacionados insignificantemente (P > 0,05) com o fator de condição de *S. commersonnianus*.

Palavras-chave: peixes marinhos, *Scomberoides commersonnianus*, concentrações de metais, tamanho do peixe, fator de condição.

1. Introduction

Fishes are distinct from other species in that they have the capacity to absorb minerals from both their diet and the water through their skin and gills (Abbas et al., 2021). Fish is thought to be the most accurate indicator of water toxicity (Barse et al., 2007; Nasir and Al-Najar, 2015). When fishes are exposed to higher levels of toxic metals, these harmful contaminants are taken up by the fish body largely, affecting the human body's health directly because of eating polluted feed (Nasir and Al-Najar, 2015). As a result, the contamination of fish with these trace elements are being given considerable attention (Coetzee, 1998). The pollutant may enter in the body of fish and absorbed in the kidney and

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Gills, eventually become the parts of animal's body mass (Gasperi et al., 2018). Toxicity in the body of the fish is affected by its age, size, and sexual behavior. Metal evaluations in fish tissue are necessary to ensure that metal deposition in fish does not pass on to fish consumers, such as humans (Rahman et al., 2012). Once pollutants are released into the water, it does not stay in that location but spreads to other parts of water (Everaert et al., 2018). Heavy metals have an initial influence on the fish at a cellular or tissue level, but later on, major changes in fish physiology and to some extent, its behavior have been recorded (Asegbeloyi et al., 2010). Several elements such as Copper, Lead, Cadmium, Zinc, and Iron were found in the food and water (Staniskiene et al., 2009). The concentration responses of these elements in relation to their presence and harmful effects on human and other fish have been studied (Koelmans et al., 2017). Some organisms have great capacity for absorbing heavy elements in their bodies, whereas others have none or a low potential for doing so. Some fish absorb much from food, and the harmful substances become a part of their bodies as a result of their excessive consumption (Eisler, 1987). Concentration of hazardous heavy metal components in freshwater fish in Pakistan suggest that rapid mechanical and agricultural improvement in the past has posed significant threats to the country's water resources (Ahmad et al., 2021).

This research was performed to examine the relationship of fish size and condition factor with some mineral elements in marine Talang Queenfish *(Scomberoides commersonnianus).*

2. Materials and Methods

A total of 73 samples of a marine fish, *S. commersonnianus* with various sizes that ranged from 93.4-1180g of body weight and total length 20.5-56.9 cm were randomly collected from the Arabian Sea Karachi, Sindh, Pakistan, for examination of elemental composition. In plastic bags, these samples were delivered to Fish Research Lab, Institute of Zoology, Bahauddin Zakariya University, Multan, Pakistan. These fish samples were homogenized into fine powder after drying in the oven. One gram of powdered-sample was taken from each sample for ashing and kept on 500°C in muffle furnace for 1 day. Ashes were then dissolved into the 70% HNO_3 (10 ml); heated at 80 to 100°C on hot plate and diluted upto 25ml with deionized water. These samples were run on Atomic Absorption Spectrophotometer (Agilent, AA 200) at Institute of Zoology, BZU, Multan, Pakistan, for quantification of Zn, Cd, Fe, Ca, Na, K, Pb and Mg concentration in samples. Repeatedly calibrations were set on instrument after every ten metal samples during operation.

To access and evaluate the relationship of these metal concentrations with the body size and condition factor of fish samples, regression analysis had been performed with the help of following Equation 1:

$$Log\ Y = Log\ a + b\ Log\ X \quad (1)$$

Here:
Y stand for metal concentration ($\mu g g^{-1}$); *X* = Fish length (cm)/ Weight (g)/Condition Factor; *a* for constant and *b* for slope.

At *P*<0.001, P<0.01 and *P*<0.05, correlation coefficients had been considered as significant. Using b value, log data was used to analyze and explain the fish's allometric metal concentration pattern.

Multiple regression studies to access the relationships between fish size and metal concentration were calculated through following Equation 2:

$$Y = a + b_1 WW + b_2 TL \quad (2)$$

Where Y for metal concentration, and b_1, b_2 representing slope values, a is constant, WW for wet body weight and TL for total length. For statistical analyses, Microsoft Excel 2016 and MiniTab 18 were used.

3. Results

3.1. Determination of metal concentrations in wet and dry body weight of S. commersonnianus.

The concentration of Calcium found to be maximum while Cadmium found to be minimum in *S. commersonnianus.* Mean (±SD) concentrations of Zn, Fe, Cd, Pb, Na, K, Ca and Mg had been found 41.60±17.20, 59.32±53.06, 0.04±0.09, 0.20±0.29, 589.16 ± 247.20, 896.62 ± 268.85, 1577.90 ± 569.04 and 307.12 ± 118.73 µg/g, respectively, in wet body weight of *S. commersonnianus*. Descriptive statistics of metal concentration in wet and dry body weight of *S. commersonnianus* are shown in Table 1.

3.2. Correlation of various metals with total length and wet weight of S. commersonnianus

Different metals were examined in correlation with wet weight and total length of *S. commersonnianus*, and regression parameters are represented in Table 2 and 3, respectively. Zn showed highly significant negative correlation (P<0.001), while Na and Ca represented strong positive correlation (P<0.001) with fish size (wet weight and total length). Correlations of Pb, K, Mg were found least significant (P<0.05) with the total length and wet weight of *S. commersonnianus.* However, concentrations of Fe and Cd were remained insignificantly correlated (P>0.05) with the fish size.

Regression parameters of condition factor with metal concentration in wet body weight for *S. commersonnianus* are presented in Table 4. K, Zn, Na, Mg, Ca and Fe exhibited highly significant positive correlation with total body length (P<0.001) with values ranging from 0.441 to 0.711, while Cd and Pb exhibited non-significant positive correlation (P>0.05) in *S. commersonnianus*.

Multiple regression parameters of total length and wet weight with concentration of metal for *S. commersonnianus* are presented in Table 5. Concentration of K, Na, Mg, Ca, Cd and Fe exhibited highly significant positive correlation (P<0.001) with size of *S. commersonnianus* with multiple regression values ranging from 0.456 to 0.886; Zn showed least significant positive correlation (P>0.05) with value (r = 0.285); while, Pb showed insignificant positive correlation (P<0.05). Results of multiple regression analysis

Table 1. Descriptive analysis of element concentration (µg/g) in wet and dry body weight of wild *Scomberoides commersonnianus* (n = 73).

Elements	Range		Mean±SD	
	wet weight	dry weight	wet weight	dry weight
Fe	9.58-86.14	34.34-422.50	41.60±17.20	162.74±75.14
Zn	0.06-199.10	0.24-734.19	59.32±53.06	237.57±216.76
Cd	0.00-1.89	0.00-6.67	0.04±0.09	0.17±0.36
Pb	0.00-1.70	0.00-7.10	0.20±0.29	0.78±1.11
Na	218.98 - 1246.23	927.78-4139.58	589.16 ± 247.20	2245.95 ± 837.72
K	294.93-1421.38	1382.35-5666.67	896.62 ± 268.85	3453.49 ± 1016.20
Ca	566.78-2780.44	2211.54-9927.50	1577.90 ± 569.04	6060.37 ± 2048.63
Mg	156.55-660.98	572.37-2360.00	307.12 ± 118.73	1172.86 ± 396.21

SD=Standard deviation

Table 2. Regression analysis of log wet body weight (g) versus log body burden element (µ/µg) for *Scomberoides commersonnianus.*

Elements	R	a	b	S.E (b)	t value (b = 1)
Fe	0.197^{ns}	64.840	-8.751	5.145	-8.946
Zn	0.522***	248.692	-71.322	13.810	-71.394
Cd	0.044^{ns}	0.213	0.092	0.247	-3.957
Pb	0.283*	-0.844	0.800	0.322	-14.961
Na	0.405***	-94.727	257.565	68.993	257.550
K	0.262*	414.942	181.407	79.197	181.394
Ca	0.386***	75.860	565.694	160.209	565.688
Mg	0.287*	74.256	87.701	34.717	87.672

*** = P<0.001. ** = P<0.01. * = P<0.05. $^{n.s.}$ = > 0.05. R =Regression cofficient, a=constant, b=Slope and SE=Standard error.

Table 3. Regression analysis of log total length (TL, cm) versus log body burden element (µ/µg) for *Scomberoides commersonnianus.*

Elements	R	a	b	S.E (b)	t value (b = 3)
Fe	0.206^{ns}	78.373	-23.180	13.065	-23.409
Zn	0.521***	346.354	-180.947	35.158	-181.033
Cd	0.051^{ns}	0.033	0.268	0.628	-4.509
Pb	0.284*	-1.962	2.044	0.819	-1.619
Na	0.391**	-414.411	632.649	176.634	632.632
K	0.258*	174.468	455.239	201.628	455.224
Ca	0.384***	-690.161	1429.776	407.926	1429.768
Mg	0.280*	-38.514	217.888	88.482	217.854

*** = P<0.001. ** = P<0.01. * = P<0.05 $^{n.s.}$ = > 0.05. R =Regression cofficient, a=constant, b=Slope and SE=Standard error.

Table 4. Regression analysis of condition factor versus metal concentration (µgg^{-1}) in wet body weight for *Scomberoides commersonnianus.*

Elements	R	a	b	S.E (b)	t value (b=0)
Fe	0.628***	83386.35	-73664.9	10832.82	-6.800
Zn	0.441***	-61.951	151.420	36.514	4.146
Cd	0.057^{ns}	0.072	-0.035	0.072	-0.482
Pb	0.095^{ns}	0.345	-0.176	0.218	-0.805
Na	0.603***	1483725	-1353911	212321.3	-6.376
K	0.711***	2025078	-1819365	213106.2	-8.537
Ca	0.676***	3572088	-3188308	412219.4	-7.734
Mg	0.609***	709200.5	-636912	98322.75	-6.477

*** = P<0.001. $^{n.s.}$ = > 0.05. R =Regression cofficient, a=constant, b=Slope and SE=Standard error.

of condition factor and wet body weight with concentration of metal for *S. commersonnianus* are presented in Table 6.

Concentration of K, Na, Mg, Ca and Fe showed highly significant positive correlation with total body length

Table 5. Multiple regression analysis of wet body weight (W, g.) and total length (TL, cm) with metal concentration (wet body weight, µgg^{-1}) for *Scomberoides commersonnianus.*

Relationship	R	a	b_1 ± S.E	b_2 ± S.E	VIF
$Fe = a + b_1W + b_2TL$	0.810***	16930.07	72.78 ± 19.07	-898.45 ± 546.72	0.343
$Zn = a + b_1W + b_2TL$	0.285*	-56173.8	-121.37 ± 56.29	3800.56 ± 1613.18	0.918
$Cd = a + b_1W + b_2TL$	0.456***	-0.286	-0.001 ±0.0002	0.018±0.004	0.792
$Pb = a + b_1W + b_2TL$	0.173^{ns}	-0.232	-0.001±0.001	0.021±0.014	0.970
$Na = a + b_1W + b_2TL$	0.872***	654762.6	2139.95 ± 303.948	-38067.2±8710.11	0.237
$K = a + b_1W + b_2TL$	0.886***	190365.7	1408.11 ± 328.183	-11655.3±9404.59	0.213
$Ca = a + b_1W + b_2TL$	0.827***	7286.755	1815.28 ± 735.31	-2150.58 ± 21071.54	0.315
$Mg = a + b_1W + b_2TL$	0.816***	182041.1	733.50 ± 167.38	-10480.7 ± 4796.78	0.332

a = Interceptb1 and b2 = Regression Coefficients for many factor to correlate among eachother. *** = P< 0.001. * = P<0.05. $^{n.s}$ = P>0.05.

Table 6. Multiple regression analysis of wet body weight (W, g.) and condition factor (K) with metal concentration (wet body weight, µgg^{-1}) for *Scomberoides commersonnianus*

Relationship	R	a	b_1 ± S.E	b_2 ± S.E	VIF
$Fe = a + b_1W + b_2K$	0.804***	-15099.7	47.087± 6.631	13713.16 ± 14852.47	0.352
$Zn = a + b_1W + b_2K$	0.160^{ns}	70434.85	-9.474 ± 19.893	-49342.1±44557.87	0.974
$Cd = a + b_1W + b_2K$	0.335**	0.408	-0.0002±0.0001	-0.333±0.122	0.888
$Pb = a + b_1W + b_2K$	0.127^{ns}	0.606	-0.0001±0.0002	-0.408±0.391	0.984
$Na = a + b_1W + b_2K$	0.849***	-753816	1069.806 ± 112.738	631263.3 ± 252515.2	0.278
$K = a + b_1W + b_2K$	0.884***	-215720	1071.364 ± 113.479	168699.2 ± 254174.7	0.217
$Ca = a + b_1W + b_2K$	0.827***	-178019	1792.99 ± 252.212	138832.9 ± 564914.5	0.315
$Mg = a + b_1W + b_2K$	0.808***	-217757	443.194 ± 58.530	185496.1 ±131097.6	0.345

a = Intercept; b_1 and b_2 = Regression Coefficients; SE = standard error; R = Regression cofficient. *** = P<0.001. ** = P<0.0. $^{n.s.}$ = P>0.05.

(P<0.001) in *S. commersonnianus* with multiple regression values ranging from 0.804 to 0.884; Cadmium showed least significant positive correlation; while Zn and Pb exhibited non-significant correlation (P>0.05) with value.

4. Discussion

Accumulation of metals in fish was as in following order Ca>K>Na>Mg>Zn> Fe>Pb> Cd. Regression analysis of these metals were statistically analyzed with respect to condition factor and body size.

Metal concentrations in body of *S. commersonnianus* fish varied considerably. A minimum concentrations of heavy metal were found in Cd (wet and dry body weight) and Calcium in maximum concentration found the fish (wet and dry body weight) as the concentration of Calcium found maximum and cadmium in minimum concentration in *Oncorhynchus mykiss* (Naeem et al., 2010) and *Aristichthys nobilis* (Naeem et al., 2011). As this data on Calcium are also well-matched with study by Ansari et al. (2000) and Salam et al. (2002). Zhang et al. (2017) studied that concentration of Pb, Zn and Cd as 0.011, 17.2 and 0.003 mg/kg, respectively in *Ctenopharyngodon idella* as almost similar values were reported in our study. Iron in present study were found agreement with previously reported studies (Canli&Atli 2003; Obasohan et al. 2006).

Permissible limit of Cadmium as recommended by the FAO (2011) as 0.05 as in present study within range. This implies Cd as not taken above as limit as by Ashraf and Nazeer (2010) and Chatta et al. (2016). Accumulations of Pb in study found below than maximum permissible limit as (FAO, 1984) reported similar concentration of lead in *Ctenopharyngodon idella* as in the present study. Zinc concentration in present study found within normal range by FAO (1989). The analyzed concentrations as noticed values agree with those reported by Shearer (1984) in *Oncorhynchus mykiss,* Salam et al. (1998) in *Catla catla*, Naeem et al. (2011) in *Oreochromis niloticus*, Naeem et al. (2011) in *Mystus bleekri* and Yousaf et al. (2012) in *Wallago attu* .

Sodium in dry and wet weight shown that concentration within normal range. Earlier, the mean concentration of

sodium documented in *Puntius sophore* 3335µg/g and *Trevor baim* 3746µg/g as (Rashid et al., 2012). Naeem et al. (2010) examined Potassium and described similar concentration in *O. mykiss* and *A. nobilis* (Naeem et al., 2011). The condition factor in this investigation remained consistent irrespective of the metal concentrations studied. Farkas et al. (2002) and Naeem et al. (2008)found similar results in other fish species. These findings demonstrate that the condition factor has no effect on the body size of the fish. According to the results of multiple regression analyses Cd, Zn, Fe, Na, Pb, K, Ca and Mg were shown to be substantially associated with total length, wet body weight and condition factor, as stated by (Naeem et al., 2011).

5. Conclusion

Conclusion of present study is that all the concentrations of various studied metals were found in permissible limit. Hence, the fish is safe for human consumption in these localities and it is likely to be an excellent source of vital metals. Moreover, condition factor of the fish body and fish size has a significant impact on metal accumulation. Findings of the study can be helpful for different organization for monitoring in future.

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