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Full Length Research Paper

Proximate composition of *Mystus bleekeri* in relation to body size and condition factor from Nala Daik, Sialkot, Pakistan

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Proximate composition of small catfish, *Mystus bleekeri,* from Nala Daik, Sialkot, Pakistan was investigated and fluctuation in relation to body size and condition factor was carried out. Mean percentages for water, fat, protein and ash contents in the whole wet body weight of wild *M. bleekeri* were 77.87, 3.26, 15.01 and 3.87%, respectively. Body composition of the fish was effected by body size; however, condition factor remains constant with observed body constituents (% water, fat, protein, ash and organic contents). Highly significant (P<0.001) correlation Found between percentage water and percentage fat, protein, ash and organic contents in both wet and dry body weight. Investigation of body size on body constituents Reflected decrease in relative amount of water, skeleton (wet and dry weight), increase in fat (dry weight), protein, organic contents (wet and dry weight), and no effect on fat (wet weight) with growth of fish. Additionally, the first reference for proximate composition for *M. bleekeri* is provided.

Key words: Proximate composition, body size, condition factor, predictive equation, catfish, *Mystus bleekeri*.

INTRODUCTION

Mystus bleekeri (Day, 1877) is a small, freshwater catfish with a reported maximum length as 15.5 cm (Froese and Pauly, 2011) and belongs to order Siluriformes and family Bagridae. Among the small sized fishes, it has high economic importance and market value. Despite its small size, it is considered as a food fish (Musa and Bhuiyan, 2007; Shinde et al., 2009; Haniffa, 2009), having good taste and nutritional value (Faruk-Ul-Islam, 2007). It occurs in streams, rivers, side channels, tanks and reservoirs (Tiwana et al., 2007). In Pakistan, it is locally called Tingara (Mirza and Alam, 2002) and distribution is known from Khyber Pakhtunkhwa, Punjab and Sindh (Mirza, 2002).

Chemical body composition of fish could illustrate its physiological condition and health (Saliu et al., 2007). Although, it takes a lot of time to determine body composition but believed a good indicator for physiological condition of a fish. Proximate body composition is the analysis of water, fat, protein and ash contents of fish (Cui and Wootton, 1988; Aberoumad and Pourshafi, 2010). The water percentage is a good indicator of its relative lipid and protein contents, as with the decrease in water percentage, lipid and protein contents increase (Dempson et al., 2004). Generally, composition of live-weight, whole-body fish is 70 to 80% water, 20 to 30% protein, and 2 to 12% lipid (Love, 1980). However, in different environmental conditions, the values of body composition of the same fish may differ and are demonstrated to have a difference in water quality, feeding conditions, sex, state of maturity, (Brett et al., 1969; Craig et al., 1989; Javaid et al., 1992) and capture period of the fish (Oliveira et al., 2003). These variables are also influenced by other biotic and abiotic variables, such as hydrologic level, pluviometric index, food availability and others (Oliveira et al., 2003). Body composition may vary due to the regional variations, as higher values of lipid contents found in eutrophic waters than oligotrophic waters (Bailey and Robison, 1986;

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Stickney and Torres, 1989; Childress et al., 1990; Donnelly et al., 1990). Water temperature also affects the body composition of fish (Wassef and Shehata, 1991; Touhata et al., 1998), as the rate of fish metabolism decreases in winter and increases in summer season (Goddard, 1996; Guinea and Fernandez, 1997; Bureau et al., 2002). Proximate composition also changes with increasing depth (Drazen, 2007). Suseno et al. (2010) have reported high protein and low fat content in fish due to increasing depth.

Fish is consumed by a large percentage of population in the world due to its high quality of protein level (Foran et al., 2005). Therefore, it is important to estimate proximate composition of fish, prior to their consumption (Fawole, 2007). Moreover, the proximate composition of a fish can yield information about its energetic adaptations, locomotory habits (Childress and Nygaard, 1973; Childress et al., 1990) and commercial specifications (Waterman, 2000).

To the best of our knowledge, there is no information in either national or international literature on the proximate composition of *M. bleekeri*. Therefore, the aim of this study was to evaluate the proximate composition and how it fluctuates in relation to body size and condition factor in *M. bleekeri* caught from a stream, Nala Daik, Sialkot, Pakistan.

MATERIALS AND METHODS

Fish samples of *M. bleekeri* used for this study were collected from Nala Daik, a stream in Sialkot, Pakistan, with various fishing gear (hand net, cast net, etc.) during February and March , 2010. Collected fish were kept in plastic container and transported alive to the laboratory for further analysis. The fish specimens were washed immediately, on arrival to the laboratory, until it was free from adhering blood and slime after anaesthetizing with MS-222. They were measured for total length (TL) to the nearest 0.1 cm and weighed to the nearest 0.01 g (W, wet weight).

Proximate composition of fish samples was analyzed. Water content was determined by weighing differences before and after the Electrical oven drying (70°C for 48 h) of the sample to a constant weight.. Each dry specimen was powdered and homogenized for further analysis. Ash content was determined by taking the weighed sample powder of each fish in heat resistant china clay crucibles, using a muffle furnace (RJM 1.8-10, China) for 12 h at 450 to 500°C. Fat content was measured by extraction in a ratio of 1:2 mixture of chloroform and methanol (Bligh and Dyer, 1959 As fish usually contains carbohydrates in a negligible quantity (Elliott, 1976; Salam and Davies, 1994), protein content was estimated by difference from the mass of other main constituents, that is, ash, fat and water (Caulton and Bursell, 1977; Dawson and Grimm, 1980). Organic contents were determined indirectly by difference from the ash content.

The Fulton condition factor (K) for each fish was computed as K = (W/L3) X 100 by following the method of Weatherley and Gill (1987) and Wootton (1990, 1998). As the variations in body composition are related to body weight, total length and condition factor, the inter-relationships of these variables are examined using a multiple regression model having the general form:

$$Y = a + b_1 W + b_2 X$$

Where, a, b_1, b_2 are constants; W is the wet body weight; X is either total length (TL) or condition factor (K), and Y is water (%), fat (% wet weight) or protein (% wet weight).

Statistical analysis

Statistical analysis including regression analysis and calculation of correlation coefficients, standard error of the estimates, student's *t*-test, and plotting of data were carried out with the help of computer packages, MS-Excel and Minitab. Correlation coefficients were considered significant at $P<0.001$, $P<0.01$ and $P<0.05$ (Zar, 1996).

RESULTS

A total of 95 specimens of wild *M. bleekeri* (2.01 ± 0.386 cm TL [mean ± SD]) were evaluated for proximate body composition. Mean percentages for water, fat, protein and ash contents in the whole wet body weight of wild *M. bleekeri* are presented in Figure 1.

Relationship between water and body constituents

The relationship between percentage water and percentage of different body constituents (wet and dry weight) is presented in Table 1. Fat (wet weight), protein and organic contents (wet and dry weight) showed inverse relationships, while fat (dry weight) and ash (wet and dry weight) showed positive correlation. All these relationships were found to be highly significant at $P < 0.001$.

Relationship between body size and body constituents

Regression analysis between fish body weight (wet and dry) and each percent of body constituents yielded highly significant negative relationship with percentage of water and ash (wet and dry weight), while it yielded positive correlation with fat (dry weight), protein and organic contents (wet and dry weight). However, insignificant relationship was found with fat content (dry weight) to body weight. Similar results were found between fish total length and each percentage of these body constituents (wet and dry weight). Student's *t*-test shows that the slopes (b) of the regression lines are statistically different from b = 0 in all cases (Table 2).

On calculation of correlation and the total values of the parameters of body constituents (water, fat, protein, ash and organic contents) with wet body weight and total length, this value was strongly correlated positively ($P<0.001$), except ash content which was significant ($P<0.01$) with body weight and least significant ($P<0.05$) with total length in *M. bleekeri* whether untransformed or log transformed. In log transformed relationships of total values of body constituents with body weight, slope 'b' exhibited positive allometric in total fat, protein and

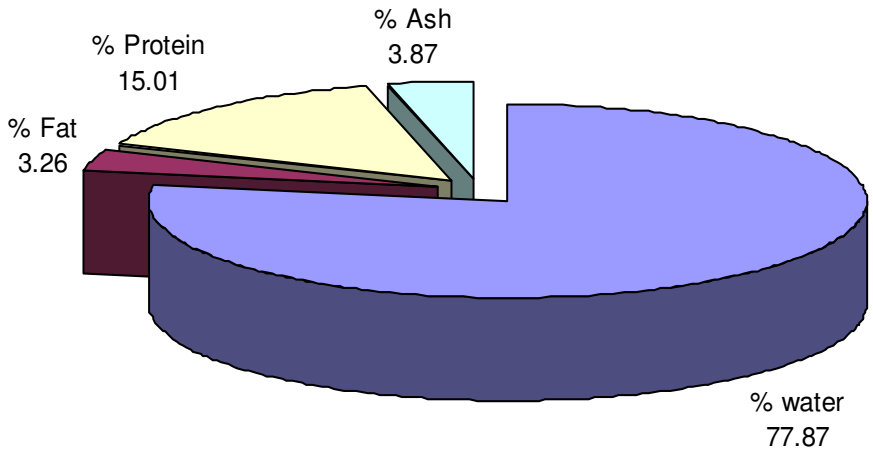

Figure 1. Mean percentages for water, fat, protein and ash contents in wet body weight of wild *Mystus bleekeri.*

Table 1. Statistical parameters of % water content versus % body constituents of wild *Mystus bleekeri* (n = 95).

Relationship	r	a	b	S. E. (b)	t value when b=0
% Water (x), %Fat wet weight (y)	0.512***	6.3720	-0.0400	0.0070	-5.7486***
% Water (x) %Fat dry weight (y)	0.837***	-21.8436	0.4703	0.0319	14.7510***
% Water (x) %Protein wet weight (y)	0.961***	109.9104	-1.2188	0.0362	-33.7053***
% Water (x) %Protein dry weight(y)	0.820***	258.5877	-2.4538	0.1776	-13.8137***
%Water (x) %Ash wet weight (y)	0.558***	-16.2824	0.2587	0.0399	6.4794***
% Water (x) %Ash dry weight (y)	0.729***	-136.7441	1.9835	0.1932	10.2680***
% Water (x) % Organic contents wet weight (y)	0.956***	116.2824	-1.2587	0.0399	-31.5214***
% Water (x) % Organic contents dry weight (y)	0.729***	236.7441	-1.9835	0.1932	-10.2680***

r = Correlation coefficient; a = intercept; b = slope; S.E= standard error; *** P<0.001.

organic contents, while it exhibited negative allometric in water and ash. Value of "b", in log transformed relationship of total values of body constituents with total length showed positive allometric relation with total protein and organic content, and negative allometric relation in water, fat and ash (Tables 3 and 4).

Relationship between condition factor and body constituents

The condition factor (K) was found as 0.74 ± 0.075 (mean ± SD) with a range of 0.60 to 1.02. Linear regression analysis revealed insignificant correlation between condition

Table 2. Statistical parameters of body weight (W, g) and Total length (TL, cm) versus % body constituents (wet and dry weight, g) of wild *Mystus bleekeri* (n = 95).

Relationship	r	a	b	S. E. (b)	t value when b=0
Body weight (x) % Water (y)	0.503***	82.1631	-2.1337	0.3801	-5.6138***
Body weight (x) %Fat wet wt. (y)	0.670***	2.8121	0.2220	0.0255	8.7104***
Body weight, (x) %Fat dry wt. (y)	0.178^{ns}	15.6360	-0.4246	0.2432	-1.7459^{ns}
Body weight (x) %Protein wet wt. (y)	0.709***	7.3321	3.8132	0.3930	9.7021***
Body weight, (x) %Protein dry wt. (y)	0.874***	45.1940	11.0892	0.6403	17.3197***
Body weight (x) % Ash wet wt. (y)	0.966***	7.6927	-1.9014	0.0525	-36.2092***
Body weight (x) %Ash dry wt. (y)	0.924***	39.1699	-10.6646	0.4574	-23.3172***
Body weight (x) % Organic contents wet wt. (y)	0.723***	10.1442	4.0352	0.4001	10.0859***
Body weight (x) % Organic contents dry wt. (y)	0.924***	60.8301	10.6646	0.4574	23.3172***
Total length (x) % Water (y)	0.425***	87.9539	-1.5577	0.3445	-4.5215***
Total length (x) %Fat wet wt. (y)	0.598***	2.1504	0.1712	0.0238	7.1867***
Total length (x) %Fat dry wt. (y)	0.134^{ns}	16.5712	-0.2764	0.2119	-1.3046^{ns}
Total length (x) %Protein wet wt. (y)	0.612***	-3.4317	2.8479	0.3814	7.4674***
Total length (x) %Protein dry wt. (y)	0.769***	12.8498	8.4428	0.7281	11.5958***
Total length (x) % Ash wet wt. (y)	0.858***	13.3274	-1.4614	0.0906	-16.1384***
Total length (x) %Ash dry wt. (y)	0.818***	70.5791	-8.1664	0.5957	-13.7085***
Total length (x) % Organic contents wet wt. (y)	0.625***	-1.2813	3.0191	0.3910	7.7221***
Total length (x) % Organic contents dry wt. (y)	0.818***	29.4209	8.1664	0.5957	13.7085***

*** $P<0.001$; $^{n.s}$ $p > 0.005$.

Table 3. Statistical parameters of wet body weight (w, g) versus total body constituents (wet weight, g) of wild *M. bleekeri* (n = 95).

Relationship	r	a	b	S. E. (b)	t value when b=1
Body weight (x) Water content (y)	0.995***	0.0718	0.7415	0.0078	94.7483***
Log body weight (x) Log water content (y)	0.995***	-0.0917	0.9424	0.0095	-6.0632***
Body weight (x) Fat content (y)	0.993***	-0.0079	0.0367	0.0004	81.7526***
Log body weight, g (x) Log fat content (y)	0.992***	-1.5302	1.1453	0.0150	9.6867***
Body weight (x) Protein content (y)	0.947***	-0.1365	0.2207	0.0077	28.5429***
Log body weight (x) Log protein content (y)	0.958***	-0.9908	1.5507	0.0484	11.3781***
Body weight (x) Ash content (y)	0.285**	0.0726	0.0012	0.0004	2.8658**
Log body weight (x) Log ash content (y)	0.288**	-1.1344	0.0315	0.0109	88.8532***
Body weight (x) Organic contents (y)	0.959***	-0.1444	0.2573	0.0078	32.8428***
Log body weight (x) Log organic contents (y)	0.967***	-0.8820	1.4755	0.0402	11.8284***

*** P<0.001; ** P<0.01.

Table 4. Statistical parameters of total length (TL, cm) versus total body constituents (g) of wild *M. bleekeri* (n = 95).

Relationship	r	a	b	S. E. (b)	t value when b=3
Total length (x) Water (y)	0.884***	-2.9382	0.7647	0.0420	18.2211***
Log total length (x) Log water content (y)	0.882***	-1.7350	2.3722	0.1317	-4.7669***
Total length (x) Fat content (y)	0.878***	-0.1155	0.0280	0.0016	17.6474***
Log total length (x) Log fat content (y)	0.872***	-3.5089	2.8603	0.1666	-0.8385 ^{ns}
Total length (x) Protein content (y)	0.826***	-0.7700	0.1665	0.0118	14.1282***

Table 4 Contd..

Log total length (x) Log protein content (y)	0.832***	-3.6333	3.8276	0.2649	3.1242**
Total length (x) Ash content (y)	0.257*	0.0690	0.0009	0.0004	2.5662*
Log total length (x) Log ash content (y)	0.259*	-1.1904	0.0807	0.0312	-93.5673***
Total length (x) Organic contents (y)	0.838***	-0.8856	0.1945	0.0131	14.8159***
Log total length (x) Log organic contents (y)	0.841***	-3.4008	3.6473	0.2430	2.6638**

*** P<0.001; ** P<0.01; * P<0.05; $^{n.s}$ P > 0.005.

Table 5. Statistical parameters of condition factor versus % body constituent (wet weigt, g) of wild *M. bleekeri* (n = 95).

Relationship	r	a	b	S. E. (b)	t value when b = 0
Condition factor (x) % Water (y)	0.147 ^{ns}	80.2153	-3.1862	2.2283	-1.4299 ^{ns}
Condition factor (x) % Fat (y)	0.128 ^{ns}	3.0989	0.2172	0.1744	1.2453 ^{ns}
Condition factor (x) % Protein (y)	0.162 ^{ns}	11.7282	4.4518	2.8180	1.5798 ^{ns}
Condition factor (x) % Ash (y)	0.147 ^{ns}	4.9577	-1.4828	1.0337	-1.4344 ^{ns}
Condition factor (x) % Organic contents (y)	0.163 ^{ns}	14.8271	4.6690	2.9254	1.5960 ^{ns}

^{ns} :P > 0.05..

factor and body constituents (water, fat, protein, ash and organic contents) of *M. bleekeri*. Results of these relationships are summarized in Table 5.

Multiple regression analysis

On calculation of multiple regression between different variables, wet body weight, condition factor and total length, it was found that this value was highly significant (P<0.001) in *M. bleekeri* (Table 6).

DISCUSSION

Values of the overall means of various parameters of composition (water, fat, protein, organic and ash contents), analyzed in the whole wet body weight of wild *Mystus bleekeri* have values that are very similar to those reported for the whole body composition of various species, whether farmed or wild (Salam et al., 1991; Pongchawee et al., 1995; Oliveira, 2003; Ball, 2007; Turan, 2007; Naeem et al., 2010a; Naeem and Salam, 2010).

Predictive equations using regression analysis were developed in this study, as many workers have found high degree of accuracy by using it. In this study, it was found that percentage fat, protein and organic contents showed highly significant (P<0.001) inverse relationship with water percentage in wet body weight. These results are in general agreement with other studies by Craig et al. (198 Salam and Janjua (1991), Salam and Davies 9),

Table 6. Multiple regression relationships between water, fat, protein, ash percentage and body weight (W, g.), condition factor (K); and body weight (W, g.), total length (TL, cm) of wild *M. bleekeri* (n = 95).

Relationship	r	a	$b_1 \pm$ S.E	$b_2 \pm$ S.E	r^2
% Water = $a - b_1 W - b_2 K$	0.511***	83.465	-2.0890±0.3831	-1.890 ±1.962	0.261
% Fat = $a + b_1 W + b_2 K$	0.672***	2.7565	0.2201±0.0258	0.0807±0.1319	0.452
% Protein = $a + b_1 W - b_2 K$	0.713***	5.873	3.7631±0.3958	2.117±2.027	0.509
% Ash = $a - b_1 W - b_2 K$	0.967***	7.9047	-1.8942±0.0528	-0.3076±0.2705	0.935
% Water = $a - b_1 W + b_2 TL$	0.505***	80.671	-2.4788±0.8159	0.3378±0.7059	0.255
% Fat = $a + b_1 W - b_2 TL$	0.670***	2.7825	0.2151±0.0548	0.0067±0.04738	0.449
% Protein = $a + b_1 W - b_2 TL$	0.710***	8.705	4.1306±0.8439	-0.3107±0.7301	0.504
% Ash = $a - b_1 W + b_2 TL$	0.966***	7.8420	-1.8669±0.1128	-0.0338±0.0976	0.934

r = Multiple correlation coefficient; a = intercept; b_1 and b_2 = regression coefficient; r^2 = proportion of variance due to regression; ***:P<0.001.

Salam et al. (1991), Salam and Khaliq (1991), (1994),Salam et al. (2001) and Naeem et al. (2010a), except ash content, which was positively correlated and was found to be in agreement with Naeem and Salam (2010). Actually, a decrease in water content and increase in fat content of fish is attributed with a good condition, while the water content of a non-fatty muscle rises during non-feeding or fasting conditions, due to utilization of protein for metabolic activities (Love, 1970).

Investigation of the effect of body size on percentage body constituents reflects decrease in relative amount of water and skeleton (wet and dry weight), increase in fat (wet weight), protein and organic contents (wet and dry weight), and no effect on fat (dry weight) with growth of fish. The results declared a definite effect of body size on percentage body constituents and various studies confirm these results (Salam et al., 1991; Ali et al., 2005, 2006a, b). Higher values of percentage protein and fat content in larger fish species (mean standard length and weight) have been reported in *Albacore tuna* (Perez-Villarreal and Pozo, 1992), *Oreochromis mossambicus* (Salam et al*.,* 2001) and *Clarias gariepinus* (Saliu et al*.,* 2007). Groves (1970) reported the close relationship of protein, water and ash on each other and on the fork-length of young sockeye ranging from 0.5 to 2500 g.

The value of slope "b" indicates isometric condition for weight-weight, when b=1on log transformed relationships. As "b" value is greater than 1 in total fat, protein and organic contents indicated positive allometry, that is, they increased with increasing wet weight, except total water and ash content, which has "b" value less than 1; thus, they decreased with wet weight showing negative allometry. Comparing the slope (with b = 3) in the log transformed relationships of total values of body constituents with total length indicated an increase in protein and organic contents, and a decrease in water, fat and ash with increase in total length.

Although, several workers have experienced success using condition factor (K) to estimate body composition (Salam and Davies, 1994; Salam et al*.,* 2001; Copeland and Carline, 2004; Ali et al., 2005; Pangle and Sutton, 2005), many researchers have also failed to find significant relationships between condition factor and body composition (Salam et al., 1991; Simpkins et al*.,* 2003; Trudel et al*.,* 2005). Insignificant relationships have also been found between condition factor with percent water and fat in the hatchery reared *Tor putitora* (Naeem et al., 2010a); with percent water, protein and fat in ♀ *Oreochromis niloticus* (Naeem et al., 2010b); and with percent water, fat and protein in wild *Colisa lalia* (Naeem et al., 2010c). However, Naeem and Salam (2010) reported significant relationships for the condition factor with percent water, protein and fat in *Aristichthys nobilis.* The relationship between body composition (% water, fat, protein and ash content in wet body weight) and condition factor (K) was also found to be insignificant in this study, suggesting no effect of K on percentage water, fat, protein, ash and organic content. It may be due to this that the use of the condition factor raises problems about the interpretation of this index because the weight of a fish is not always proportional to the cube of its length (Le Cren, 1951; Weatherley and Gill, 1987).

Multiple regression analysis creates a strong argument that there is a strong influence of wet weight, total length and condition factor on percent water, fat, protein, ash content and organic contents.

Conclusion

In conclusion, this study provides the basic information about body composition on small wild catfish, *Mystus bleekeri*. Percentage body constituents were found to be similar to the commercially important fish species of Pakistan. Furthermore, the results obtained in this study confirm the fact that proximate composition of fishes vary with species, body size and condition factor.

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