African Journal of Biotechnology Vol. 10(19), pp. 3867-3871, 9 May, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.1507

Full Length Research Paper

Proximate analysis of female population of wild feather back fish (*Notopterus notopterus*) in relation to body size and condition factor

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Accepted 5 January, 2011

The present study was conducted to investigate the proximate body composition of fresh water wild female *Notopterus notopterus* relative to its body size and condition factors. For this purpose, 54 specimens ranging from 18.50 to 27.90 cm in length and 53.07 to 179.06 g in weight were sampled from the Indus River Pakistan, during year 2007. Fish were blotted dry and their sex distinguished. Each specimen was dried and powdered to determine dry mass, water mass, ash content, protein content and organic content. There was good correlation between percentage water content and other constituents (percentage ash, protein and percentage organic contents) of yield processing. Total length remains constant ($p > 0.05$) with nutrient constituents. Equations were developed to describe relationship among body constituents, body mass and length. The equations of each constituent were estimated and found highly significant ($p < 0.001$). Regression was applied as a statistical tool to assess the difference among the body composition parameters.

Key words: Body composition, *Notopterus notopterus,* condition factor, wild fish.

INTRODUCTION

Proximate body composition is the analysis of water, fat, protein and ash contents of the fish (Love, 1980). Proximate composition is a good indicator of physiology which is needed for routine analysis of fisheries (Cui and Wootton, 1988). Lipid is regarded as one of the most important food reserves and has led to the use of fat indices as a measure of relationship between percentage of water and fat (Salam and Davies, 1994; Sinclair and Duncan, 1972). A number of investigators have attempted to relate changes in body composition to seasonal variables (Dawson and Grimm, 1980; Diana and Mackay, 1979; Jangaard et al*.,* 1967; Jarboe and Grant, 1996). The feeding frequency has an influence on body composition (Brett et al*.,* 1969; Cui and Wootton, 1988). Body size or age has also been shown to have a definite effect on body composition (Ali et al. 2005, 2006 a, b). Several studies have shown significant changes in whole body composition or in the composition of specific organs or muscle tissues due to age, feeding frequency, migration, ration, season, sex, starvation and temperature (Ali et al. 2005, 2006 a, b; Brett et al., 1969; Chang and Idler, 1960; Millikin, 1982; Weatherley and Gill, 1983).

The measurement of physiological condition, determined by comparison with a standard weight length relationship, may provide reliable estimates for determining body composition of live fish. Typically, body composition of fish is assessed by chemical proximate analysis, which is expensive and time consuming and requires the death of the fish. If body composition can be estimated reliably from a mathematical condition index such as relative weight, this would allow fish to be released unharmed after weight-length measurements. Furthermore, this

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Table 1. Mean values and ranges of various constituents of wild female *N. notopterus* (n = 54 in each case).

Body constituent (%)	Mean ± S.D	Range
Water contents	75.18 ± 2.44	71.13 - 89.61
Ash contents (wet weight)	5.41 ± 0.63	3.46 - 7.76
Ash contents (dry weight)	21.63 ± 2.85	12.00 - 30.02
Fat contents (wet weight)	3.66 ± 1.20	1.8 - 8.61
Fat contents (dry weight)	14.57 ± 4.68	6.98 - 33.83
Protein contents (wet weight)	16.05 ± 1.75	11.25 - 20.50
Protein contents (dry weight)	63.80 ± 5.69	44.19 - 72.03
Organic contents (wet weight)	19.72 ± 1.63	15.35 - 25.41
Organic contents (dry weight)	78.37 ± 2.88	68.98 - 88.00

S. D., Standard deviation.

method can be applicable to aquaculture. The fat and protein levels can be monitored indirectly at various stages of growth. The purpose of the present study is to provide information about comparison of body composition, growth performance and condition factor of fish species *Notopterus notopterus* from water bodies, of the Indus River, Pakistan.

MATERIALS AND METHODS

A total of 54 specimens of *N. notopterus* were collected from water bodies of the Indus River during 2007 for laboratory studies and were transported in fiber glass tank to laboratory; sex was distinguished by the shape of the genital papilla, which is cone-shaped in male and a V-shaped filamentous like protrusion in females (Haniffa et al., 2004).

After sex identification, length and weight of each fish were measured after blotted dry. Specimens were weighed on an electronic digital balance (MP-3000) to the nearest 0.1g total body length was measured to the nearest of 0.01 cm using a wooden measuring tray. Water content was measured by weighing differences before and after oven drying at 65 to 80℃ in an electric oven (Memmert). Each dry specimen was powdered and homogenized for further analysis. Ash content of fish was determined by dry ashing method using Muffle furnace (Sybron Thermolyne 1300) for 10 h at 600℃.

Dry extraction method was used to determine fat content following the Blight and Dyer method (1959). Carbohydrates are found in a negligible amount in a fish (Caulton and Bursell, 1977; Salam and Davies, 1994). Hence, no attempt was made in the present study to calculate the carbohydrate contents. To calculate the condition factor, the method of Weatherley and Gills (1983) was followed by using the formula, W/L^3 x100. Data were analyzed statistically using analysis of variance, co-efficient (r), intercept (a), regression coefficient (b), standard error of b (S.E.) and probabilities (p).

RESULTS

Mean values and ranges of various body constituents of *N. notopterus* are provided in Table 1. The variation observed in the data and their interrelationship was analyzed. The relationship between percent water and organic content (wet mass) showed negative cor-relation. Percent ash (dry mass) and organic content (dry mass), percent protein (wet mass) were less significant ($p < 0.05$) to percent water. While percent water and percent ash (wet mass), percent fat (wet and dry mass) and percent protein (dry mass) were not significant ($p < 0.05$) (Table 2) and can be well described by simple linear equation:

$$Y = a - bx \text{ ....} \quad (1)$$

Where, a and b are constants, Y is dependent variable (percentage of fat, protein, ash and organic contents) and x is percentage of water content which is independent. The equation describing the relationship can be used to predict the body composition from water content. The condition factor used in this species is “K”. The relationship between condition factors with percentage of ash (wet mass) was highly significant ($p < 0.001$), water and organic content (wet mass) were significant ($p < 0.01$), percentage of fat (wet mass) was least significant. However, the relationship between condition factor and protein was non-significant (Table 3).

As fluctuations in body constituents were found to be related to body mass or length, regression analysis was applied to assess the size of dependence of percentage of water, ash, fat and protein content (percentage wet and dry body mass) in wild female *N. notopterus*. The relationship between body mass with percentage of water, percentage of ash (wet mass), fat (wet mass), organic content (wet and dry mass) was less significant ($p < 0.05$). The relationship between body mass and percentage of protein (wet and dry mass) were non-significant (Table 4). Total length has no influence on body constituents as mentioned in Table 5. When the total values of each body constituents (water, ash, fat, protein and organic contents) were transformed into log and plotted against log wet body mass and log total length

Table 2. Statistical parameters of percent water content versus percent body constituents of wild female *N. notopterus* (n = 54).

Relationship	r	a	b	S. E. (b)	t value when b = 0
% Water (x); % ash wet weight (y)	0.1982 ns	1.5655	0.0512	0.0351	1.4587
% Water (x); % ash dry weight (y)	0.3227*	-7.0353	0.3813	0.1551	2.4584
% Water (x); % fat wet weight (y)	0.2521 ns	13.0254	-0.1245	0.0663	-0.0582
% Water (x); % fat dry weight (y)	0.1748ns	39.8259	-0.3351	0.2624	-1.2801
% Water (x); % protein wet weight (y)	0.2031*	27.0084	-0.1457	0.0974	-1.4959
% Water (x); % protein dry weight(y)	0.0222 ns	67.2912	-0.0465	0.2901	-0.1603
% Water (x); % O.C wet weight (y)	0.4044**	40.0353	-0.2702	0.0848	-3.1863
% Water (x); % O.C dry weight (y)	0.3227*	107.0313	-0.3812	0.1550	-2.4594

ns, P <0.05; *, P < 0.05; **, P < 0.01; ***, P < 0.001.

Table 3. Condition factor versus percent body constituent (g) of wild female *N. notopterus* (n = 54).

Relationship	r	a	b	S. E. (b)	t value when b = 0
Condition factor (x); % water (y)	0.4137**	85.6308	-13.6807	4.1744	3.2773
Condition factor (x); % ash wet weight (y)	0.5063***	8.7165	-4.3237	1.0210	-4.235
Condition factor (x); % fat wet weight (y)	0.3432*	-0.6174	5.6059	2.1273	2.6352
Condition factor (x); % protein wet weight (y)	0.1218 ns	13.8465	2.8901	3.2648	0.8852
Condition factor (x); % O.C wet weight (y)	0.3845**	13.2289	8.4962	2.8286	3.0036

ns , P < 0.05; *,P < 0.05; **, P < 0.01; ***, P < 0.001

Table 4. Body weight versus percent body constituents (g) of wild female *N. notopterus* (n = 54).

Relationship	r	a	b	S. E. (b)	t value when b = 0
Body weight, g (x); % water contents(y)	0.3013*	77.7831	-0.0260	0.0114	-2.2070
Body weight, g (x); % ash wet weight (y)	0.2987*	6.0803	-0.0067	0.0029	-2.3103
Body weight, g (x); % fat wet weight (y)	0.3219*	24.9115	-0.0328	0.0134	-2.4478
Body weight, g (x); % protein wet weight (y)	0.2267 ns	2.6972	0.0096	0.0058	1.6552
Body weight, g (x); % protein dry weight (y)	0.0055 ns	63.6956	0.0010	0.0251	0.0398
Body weight, g (x); % O.C. wet weight (y)	0.2852*	18.0722	0.0165	0.0077	2.1429
Body weight, g (x); % O.C. dry weight (y)	0.3221*	75.0867	0.0328	0.0133	2.4662

ns P <0.05; * P < 0.05; **, P < 0.01; ***, P < 0.001.

a linear relationship was obtained having the form:

$$\log Y = a + b \log x \text{ .... } \quad (2)$$

This relationship showed a high degree of correlation (p < 0.001) in wild female *N. notopterus* as in shown in Tables 6 and 7. The value of exponent “b” on log-log scale for mass/mass indicated isometric condition. The log-log relationship of the total water, ash, fat, protein and organic contents, with wet body mass showed highly significant correlation (p > 0.001) when b = 1 (Table 6). As all these correlations had “b” on log-log scale for mass/length, when increase in mass of the constituents was isometric, the value should be b = 3. The log-log relationship of total values (Table 7) of body constituents with total length was observed highly significant correlation (p > 0.001) in comparison of slope with b = 3 indicated that all these constituents were showing positive allometry with increasing total length.

DISCUSSION

Various parameters of composition (water, ash, fat, protein and organic content) analyzed in 54 species of *N. notopterus* and expressed as over all means, have values very similar to those reported for whole body composition of various species, whether farmed or wild.

Table 5. Total length versus percent body constituents (g) of wild female *N. notopterus* (n = 54).

Relationship	r	a	b	S. E. (b)	t value when b = 0
Total length, cm (x); % water (y)	0.2030 ns	81.4405	-0.2677	0.1790	-1.4955
Total length, cm (x); % ash wet weight (y)	0.1081 ns	6.2748	-0.0368	0.0469	-0.7841
Total length, cm (x); % ash dry weight (y)	0.1231 ns	26.1123	-0.1918	0.2143	-0.8950
Total length, cm (x); % fat wet weight (y)	0.0485 ns	2.9250	0.0316	0.0902	0.3503
Total length, cm (x); % fat dry weight (y)	0.0247 ns	13.1086	0.0625	0.3512	0.1779
Total length, cm (x); % protein wet weight (y)	0.0961 ns	13.9284	0.0909	0.1305	0.6966
Total length, cm (x); % protein dry weight (y)	0.0477 ns	60.7179	0.1317	0.3822	0.3446
Total length, cm (x); % O.C wet weight (y)	0.1390 ns	16.8531	0.1225	0.1209	1.013
Total length, cm (x); % O.C dry weight (y)	0.1233 ns	73.819	0.1921	0.2143	0.8964

ns , P < 0.05; *, P < 0.05; **, P < 0.01; ***, P < 0.001.

Table 6. Log body weight versus log body constituents of wild female *N. notopterus* (n = 54).

Relationship	r	a	b	S. E. (b)	t value when b = 1
Log body weight, g (x); log water contents, g (y)	0.9941***	-0.0528	0.9641	0.0145	-2.4759
Log body weight, g (x); log ash contents, g (y)	0.9127***	-1.0148	0.8717	0.0541	-2.3715
Log body weight, g (x); log fat contents, g (y)	0.7471***	-1.8749	1.2109	0.1494	1.4116
Log body weight, g (x); log protein contents, g (y)	0.9337***	-0.9105	1.0572	0.0562	1.0177
Log body weight, g (x); log O.C, g (y)	0.9656***	-0.8434	1.0689	0.0399	1.7268

ns P < 0.05; *,P < 0.05; **,P < 0.01; ***, P < 0.001.

Table 7. Log total length versus log body constituents of wild female *N. notopterus* (n = 54).

Relationship	r	a	b	S. E. (b)	t value when b = 3
Log total length, cm (x); log water contents, g (y)	0.9444***	-2.5058	3.1923	0.1541	1.2479
Log total length, cm (x); log ash contents, g (y)	0.9199***	-3.4729	3.0620	0.0069	8.9855
Log total length, cm (x); log fat contents, g (y)	0.6138***	-4.2145	3.4674	0.6185	0.7556
Log total length, cm (x); log protein content, g (y)	0.8693***	-3.5045	3.4304	0.2705	1.5911
Log total length, cm (x); log O.C, g (y)	0.8779***	-3.3552	3.3874	0.2562	1.5120

ns P < 0.05; *, P < 0.05; **, P < 0.01; ***, P < 0.001.

The negative corre-lations between water content and other body consti-tuents (percentage fat wet and dry body weight, percen-tage of protein wet weight, ash free matter wet and dry body weight) observed in this study were in general agreement with those reported by other investigators (Costopoulos and Fonds, 1989; Craig et al., 1989; Jobbling, 1980; Love, 1980; Staples and Nomura, 1976).

The changes in the nutritional habits of fish during growth actually result in the changes in the muscle fat and water ratio of the non-fatty fish (Love, 1970), as well as other body constituents with water content. This study indicates that the fish used were non fatty and had low nutritional conditions, which led to the loss of muscle proteins and increase in water contents. Many investi-gators have developed equations relating water content with fat and protein content and concluded that, body composition can be predicted from water content using the regression equation (Brett et al., 1969; Brown and Murphy, 1991; Jobbling, 1980; Tabachek, 1986).

The results of present study showed that a significant (p < 0.01) negative correlation exists between water con-tent and condition factor and a significant (p < 0.01) positive correlation exists between fat content and con-dition factor which was non significant in case of protein. This might due to be that *N. notopterus* was adding some new tissues which were largely protein and fatty and became heavier, due to the relative increase in fat and protein. A fish with higher condition factor will have more fat and protein while, that with low condition factor will have less water and skeleton (Javed et al., 1992).

Variations in condition factor might be due to fact that fish samples were collected from natural reservoir and were not given sufficient feed. It might mobilize reserves and increase water content and exhibit higher condition. It had been reported that, where seasonal variations in ecological conditions were more pronounced, changes in condition factor were often related with feeding and seasonal cycle (Le Cren, 1951). The natural variation in body shape also affects the condition factors, brood fish having higher condition factor than slender individuals (Costopoulos and Fonds, 1989).

Regression analysis showed that, wet body weight had significant ($p < 0.05$) inverse relationship with percent water, less significant ($p < 0.05$) with percent fat (wet body weight) and percent organic content wet body weight while non-significant with percent protein. It was observed in the present study that protein contents were not increasing significantly because the fish was collected from natural reservoir. This might be due to fluctuations in environmental conditions. As mentioned earlier the food supply was not proper and also artificial food was not provided. A large number of other researchers have also reported the variation in body composition in relation to body size (Ali et al; 2005; Love, 1980; Salam et al; 2001; Weatherley and Gill, 1987).

Allometric approach applied here which is good predictive of body constituents rather than percentages. In this study, regression model was used to determine body constituents at specific fish size.

Conclusion

It is concluded that, if it is not possible to determine body composition of *N. notopterus,* then water content will provide satisfactory estimates of all other body constituents within size range studied. But even if it is not possible to determine the water content then the body constituent can be estimated from total length, wet body weight and condition factor of this species within the size range studied without sacrificing the fish.

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