African Journal of Biotechnology Vol. 9(50), pp. 8687-8692, 13 December, 2010
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.888

Full Length Research Paper

Proximate composition of fresh water bighead carp, *Aristichthys nobilis*, in relation to body size and condition factor from Islamabad, Pakistan

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Accepted 5 November, 2010

Seventy-six Bighead carp, *Aristichthys nobilis*, of different body sizes were selected for analysis of body composition parameters' variables in relation to body size and condition factor. Each fish was measured, weighed, dried and powdered for the analysis of water, ash, fat and protein contents. It was observed that for *Aristichthys nobilis*, significant inverse correlation existed between water content (%), fat content (%wet weight) (r = 0.906) and protein content (%wet weight) (r = 0.847). Body weight has a positive influence on fat (%wet weight) (r = 0.453) and protein content (%wet weight) (r = 0.497) and a negative influence on water content (%) (r = 0.595). Total length has a positive influence on fat (%wet weight) (r = 0.507) and protein content (%wet weight) (r = 0.539) and a negative influence on water content (%) (r = 0.649). Condition factor has a significant inverse correlation on water content (%) (r = 0.701) and a significant positive correlation between fat (%wet weight) (r = 0.655) and protein content (%wet weight) (r = 0.581). However, equations were derived to describe these relationships. The equations of each constituent were estimated and were found to be highly significant (P < 0.001). The predictive equations can be used to estimate values of body composition with a fair amount of accuracy.

Key words: *Aristichthys nobilis*, body composition, condition factor, predictive equations.

INTRODUCTION

Aristichthys nobilis value (as a food fish) has made it possible for it to be exported from its native country (China) to more than 70 other countries, where it has invariably escaped or been intentionally released to the wild. Today, the bighead carp can be found in the wild in Europe, South America and North America. It has also been introduced into most of the Asian subcontinent (India, Pakistan and most Southeast Asian countries) and lakes in western China to which it is not a native. It should be noted that bighead carps are not always considered as undesireable invasive species when they are introduced outside their native range, and they continue to be stocked in some waterbodies to support commercial fisheries. Stocking bighead carp and/or the closely related silver carp usually increases the total biomass of fish available for harvest, but can decrease the catch of a native and sometimes, a more valuable fish (Kolar et al., 2005).

The live weight of the majority of fish usually consists of water, 70 to 80%; protein, 20 to 30% and lipid, 2 to 12% (Love, 1970). However, the values vary considerably within the species and also with size, sexual condition, feeding, time of year, activity, etc. The distribution of these components among the various organs and tissues of the body may also show considerable difference (Weatherley and Gill, 1987).

The body tissues that contribute to the increased mass for length or plumpness of an individual fish in good condition depend largely on the species and its ecological, physiological and environmental factor (Love, 1970, 1980; Weatherley and Gill, 1987). There is yet to be an availability of information on the influence of morphometric

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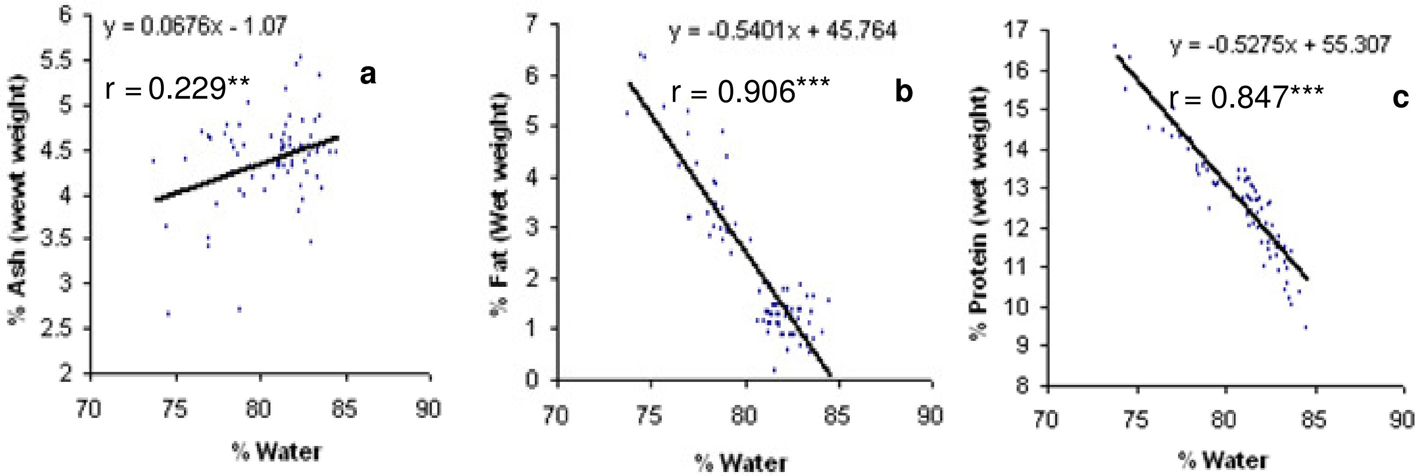

Figure 1. The relationship between (a) ash contents (% wet weight); (b) fat contents (%wet weight); (c) protein contents (%wet weight) and % water in *A. nobilis.* (N = 76).

variables on body composition parameters of *A. nobilis* in Pakistan. The purpose of the present study was to examine changes in the proportion of four major body constituents, that is, protein, water, lipid and ash content in relation to body size and condition factor. Predictive equations are developed to describe these relationships for farmed *A. nobilis.*

MATERIALS AND METHODS

Seventy-six farmed bighead carp, *A. nobilis,* of different body sizes ranging from 08.80 to 47.81 cm total length and 6.86 - 1766.0 g body weight, were obtained from Trout Hatchery, Masote, near Kali Matti, Murree and Madian, Swat using a cast net and were transported live to the Fisheries Laboratory Fish Seed Hatchery, Islamabad in plastic containers. On arrival at the laboratory, fresh fish were washed with tap water several times to remove adhering blood and slime. They were anaesthetized with MS 222, weighed to the nearest 0.01 g on an electric digital balance (OHAUS TS 400S) and their length measured to the nearest 0.1 cm on wooden measuring tray.

For calculating water content of each dead fish, the whole fish was dried in aluminum foil tray to avoid the fat that tends to leak out from the sample to constant weight in an oven at 50 to 60°C to determine water content. Dry carcasses were powdered and sub-samples were taken for ash and fat determination. Ash content was determined in duplicate for each fish using 500 - 1000 mg sub samples in a muffle furnace (Bamford) for 24 h at 450 to 500°C. For single fish, the difference between each sub samples was less than one percent.

The total lipid contents of 1 g dry tissue were determined by extraction in a 1 : 2 mixture of chloroform and methanol (Bligh and Dyer, 1959). For single fish, the difference between replicate samples was less than one percent. Protein contents were estimated by a difference from the mass of other main constituents, that is, ash, fat and water (Caulton and Bursell, 1977; Dawson and Grimm, 1980). Carbohydrates do not form a major component of fish and are usually present in negligible amounts (Elliott, 1976; Salam and Davies, 1994). Condition factor (K) for each fish was calculated using a formula $K = 100 \times W/L^3$ by the method of Weatherley and Gill (1987).

Statistics

Statistical analysis including regression analysis, calculation of correlation coefficients and standard error of the estimates, student's t-test and plotting of data were carried out using the EXCEL program on IBM computer following Zar (1996).

RESULTS

In *A. nobilis*, ash contents (% wet weight) have a positive correlation to percent water. Fat (% wet body weight) and protein contents (% wet body weight) are inversely related to percent water (Figure 1), while protein contents (% dry weight) have a positive correlation with percent water. In *A. nobilis*, body weight has a positive influence on percent fat (wet body weight) and protein contents (wet body weight), and the graph of these relationships are given in Figure 2. When the total values of each parameter of proximate composition (water, ash, fat and protein) are log transformed and plotted against the log of total length, they showed a very strong correlation. Total length has a negative influence on percent water and no influence on percent ash (wet body weight) and a positive influence on percent fat (wet body weight) and protein contents (wet body weight). The graph of these relationships is given in Figure 3.

In *A. nobilis*, K values ranged between 0.728 and 1.756. It was observed that the condition factor has a negative influence on percent water, while it has no influence on percent ash (wet body weight) and a positive influence on percent fat (wet body weight) and protein (wet body weight). The statistical parameters of these

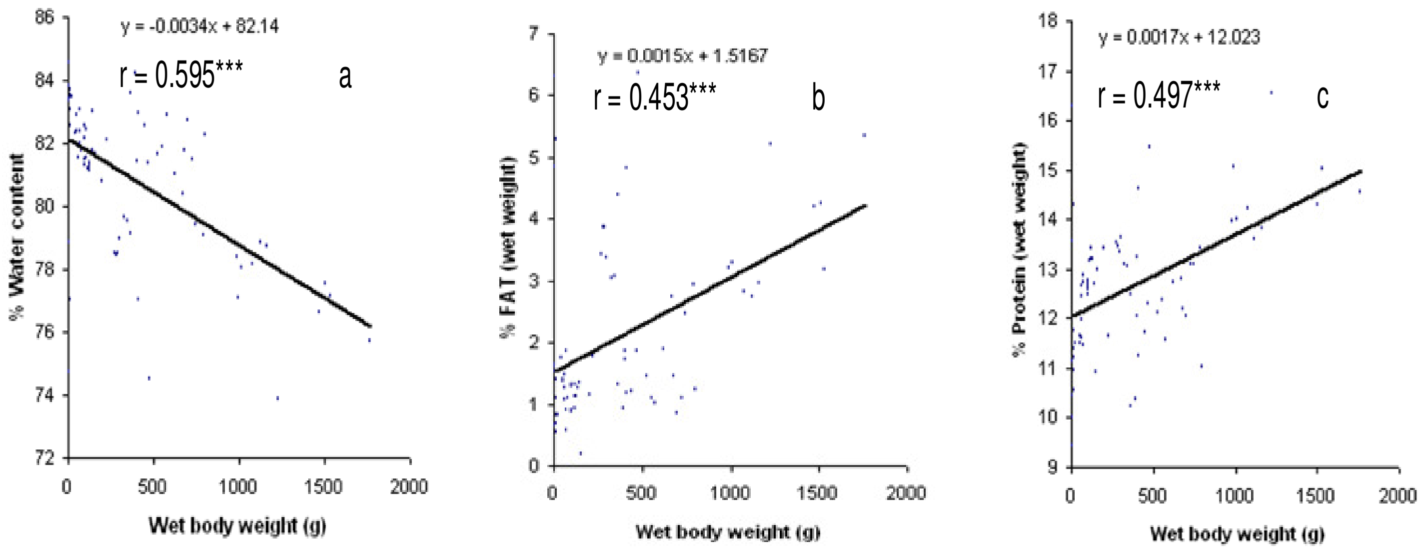

Figure 2. The relationship between (a) water contents; (b) fat contents (% wet weight); (c) protein contents (% wet weight) and wet body weight in *A. nobilis* (N = 76).

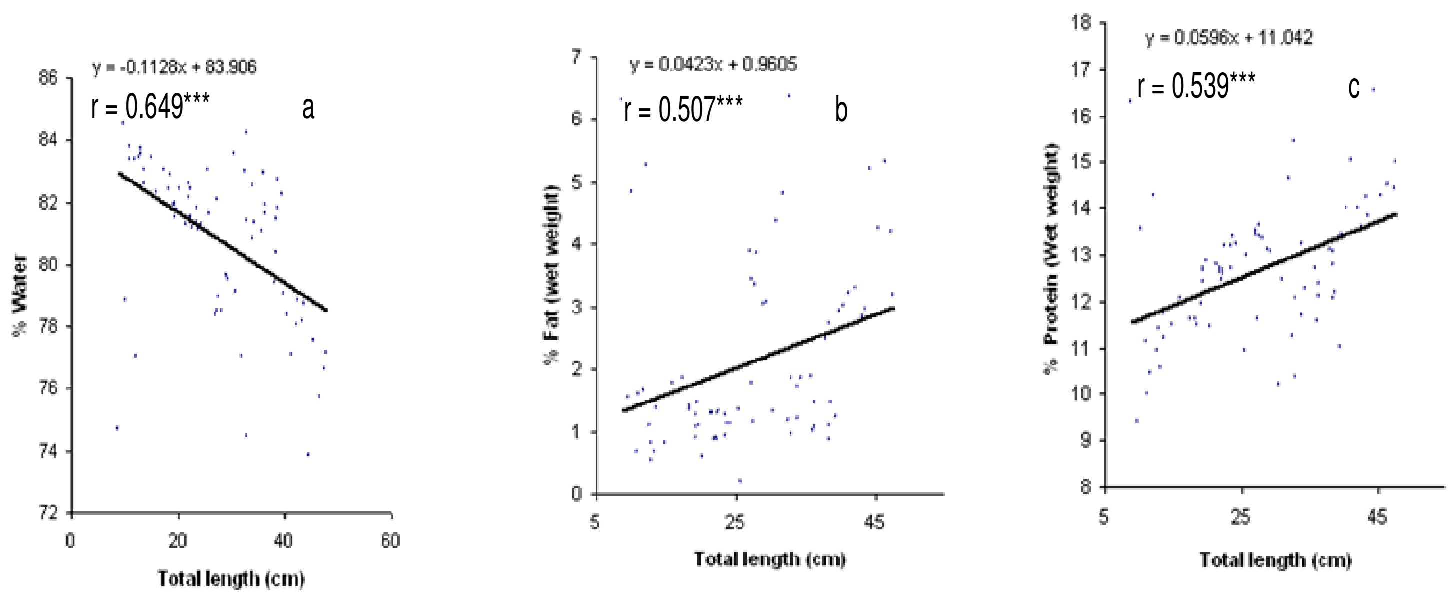

Figure 3. The relationship between (a) water contents; (b) fat contents (%wet weight); (c) protein contents (% wet weight) and total length in *A. nobilis* (N = 76).

relationships are given in Figure 4.

DISCUSSION

Data on water, ash, fat and protein content, expressed in grams (g), have values very similar to those reported by other investigators for other fish species (Table 1). Although several investigators have published an analysis of body composition in fish (Love, 1970, 1980; Weatherley and Gill, 1987; Clawson et al., 1991; Dempson et al., 2004; Jobling, 2001), few have examined the changes in body composition in relation to body size and condition factor (Cue and Wootton, 1988; Elliott, 1976; Staples and Nomura, 1976; Caulton and Bursell, 1977).

Salam and Davies (1994) and Salam et al. (2001) work on *Salmo gairdneri* include that of Staples and Nomura (1976), who reported values of the various components

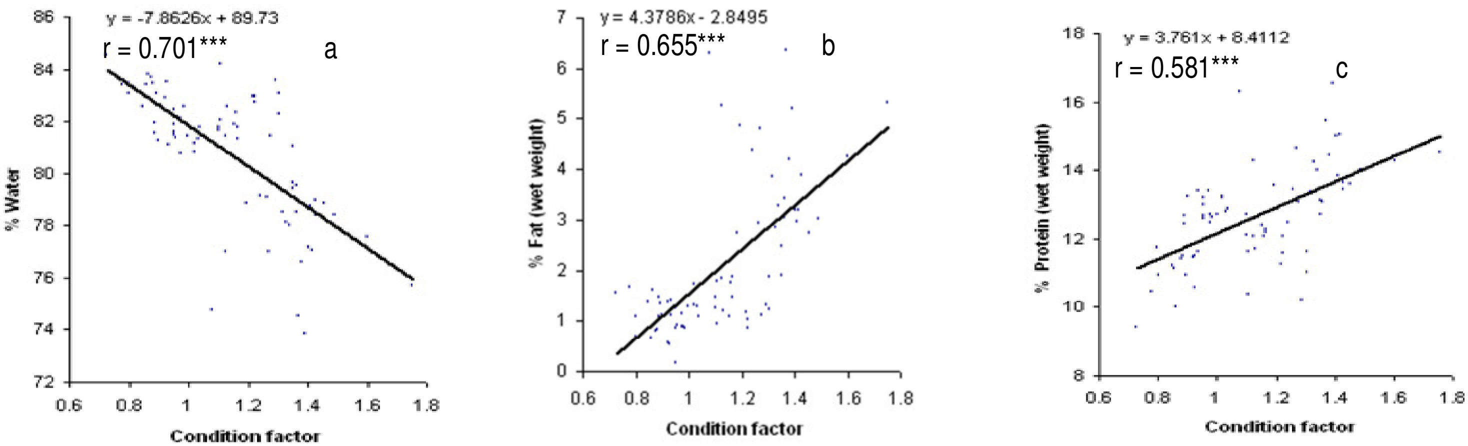

Figure 4. The relationship between (a) water contents; (b) fat contents (% wet weight); (c) protein contents (% wet weight) and condition factor in *A. nobilis* (N = 76).

Table 1. Proximate composition values of various fish species.

Species	Water content (% wet body weight)	Ash content (% wet body weight)	Fat content (% wet body weight)	Protein content (% wet body weight)	Source
Mystus seenghala	77.25-80.37	1.31-1.63	00.12-0.546	15.25-19.31	Khawaja and Jafri (1967)
Wallago attu	76.00-80.66	1.32-1.66	0.216-02.61	14.69-18.44	Khawaja and Jafri (1967)
Dicentrarchus labrax	-	-	01.00-12.00	12.00-19.00	Stirling (1976)
Salmo trutta	66.00-81.50	2.40-2.8	02.00-07.70	14.00-17.50	Elliott (1976)
Salmo gairdneri	-	-	01.50-12.80	12.60-19.10	Staples and Nomura (1976)
Sparus aurata	-	-	10.10-12.60	16.80-18.50	Marais and Kissil (1979)
Scopthalmus maximus L.	-	-		13.90-15.60	Bromley and Smart (1981)
Esox lucius L.	72.77-79.13	3.30-4.70	01.56-03.75	15.42-20.16	Salam (1983)
Tilapia nilotica	67.60-80.65	3.88-6.34	03.00-05.58	09.10-24.78	Salam et al. (1991)
Labeo rohita	71.03-82.19	2.56-5.39	02.00-07.80	13.40-17.90	Salam and Janjua (1992)
Catla Catla (wild)	74.55-86.43	2.31-6.55	03.12-07.12	05.94-16.28	Salam and Mahmood (1993)
Cirrhinus mirgala	-	2.5-4.2	5.3-6.9	13.2-16.3	Kalita et al. (2008)
Aristichthys nobilis	73.86-84.54	2.65-5.52	00.18-06.37	09.43-16.54	Present study

(Table 1). However, no studies on *A. nobilis* have been attempted yet to correlate the variables of body weight, length and condition factor with the whole body composition parameters. Fat and protein percentage increases with the increasing body weight or length, whereas water and ash content decreases when all are expressed on wet weight basis in *A. nobilis.* The study's findings are in general agreement with those reported for other fish species (Grove, 1970; McComish et al., 1974; Denton and Yousef, 1976; Elliott, 1976; Staples and Nomura, 1976; Perera and de Silva, 1978; Marais and Kissil, 1979; Cue and Wootton, 1988; Costopoulos and Fond, 1989; Brown and Murphy, 1991; Salam and Davies, 1994; Salam et al., 2001) and reviewed by Love (1970), Weatherley and Gill (1987) and Clawson et al. (1991).

When an allometric approach, developed initially by Huxley (1932) and proposed and reviewed by Weatherley and Gill (1987) was applied here, it showed that the slope *b* of the log-log regression of the relationship between total body constituents and body weight or length, when compared with b = 1 or b = 3 (an isometric slope) is a good predictor for isometric or allometric increase of these constituents with increasing weight or length (Table 2).

Significant positive correlation exists between the condition factor and percentage fat and protein contents (Figure 4), whereas percentage water and ash contents are negatively related to it. The estimates from the weight and condition factor of *A. nobilis* although broadly satis-

Table 2. Body weight or total length versus body constituents of *A. nobilis.*

Relationship	Statistical parameters of various relationships involving water content				
	r	a	b	S. E. (b)	t value when b = 1
Log body weight (x) Log water content (y)	0.999***	-0.0708	0.9902	0.0021	4.666***
Log body weight (x) Log ash content (y)	0.993***	-1.3939	1.0180	0.0135	1.333 N.S.
Log body weight (x) Log fat content (y)	0.938***	-2.1325	1.1622	0.0495	3.276**
Log body weight (x) Log Protein content (y)	0.996***	-0.9894	1.0377	0.0097	3.886***
Log total length cm (x) Log water content g (y)	0.996***	-2.4639	3.2986	0.0297	10.0538***
Log total length cm (x) Log ash content g(y)	0.994***	-3.8734	3.4049	0.0407	9.9484***
Log total length cm (x) Log fat content g(y)	0.914***	-4.8153	3.7817	0.1983	3.9420***
Log total length cm (x) Log protein content g (y)	0.990***	-3.4776	3.4426	0.0570	7.7649***

r = Correlation coefficient; a = intercept; b = slope; S.E = standard error; ***P < 0.00; **P < 0.01; N.S. > 0.05.

factory, should be used with caution until more or less of their validity has been carried out. It has been found that the body composition in various fish species could be estimated from size and condition factor of the fish (McComish et al., 1974; Elliott, 1976; Caulton and Bursell, 1977; Costopoulos and Fond, 1989; Weatherley and Gill, 1987), but Hart et al. (1940) was unable to make satisfactory estimates of the oil content of Pacific herring from the condition factor. The use of the condition factor raises problems on the interpretation of this index because the weight of a fish is not always proportional to the cube of its length (Le Cien, 1951; Weatherley and Gill, 1987).

It is therefore concluded that if the body composition of *A. nobilis* is impracticably estimated directly, then water content will provide satisfactory estimates of fat and protein contents (Figure 1). If it is impossible to determine water content, the body composition can be estimated directly from the weight (Figure 2) or length (Figure 3) of the fish using predictive regression models developed in this work with a reasonable amount of accuracy.

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