Research Article

Relative Body Size Relationship to Proximate Composition of Farmed *Hypophthalmichthys nobilis* from Bahawalnagar, Pakistan

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Abstract | The objective of the study was to evaluate the proximate composition of Bighead carp, *Hypophthalmichthys nobilis,* from the farming system of Bahawalnagar, Pakistan, in relation to body size and condition factor. For this purpose, twenty-eight samples of *H. nobilis*, of different body size were procured from a private fish farm, for analysis of body composition parameters' variables in relation to body size and condition factor. Mean body weight and total length was measured and condition factor of farmed collected fish was calculated as 556.45±28.24 g, 34.78±0.60 cm and 1.30±0.02, respectively. On wet weight basis, mean percentage for water, protein, fat and ash was found 74.70±0.76%, 16.92±0.66%, 4.60±0.16% and 3.78±0.12%, respectively, in *H. nobilis*. Highly significant (P<0.001) positive correlation was observed between fish size (weight and total length) and various body constituents of the fish. Positive allometry for all the studied constituents was found except for log total water content which represented negative allometric pattern with an increase in body size of farmed *H. nobilis*. Condition factor showed no significant correlation (P>0.05) with all the body constituents (%) in the bighead carp. % fat (wet weight) showed no significant correlation (P>0.05) with %water content while %protein, %ash and %organic content (wet weight) showed highly significant (P<0.001) negative correlation with %water content of farmed collected fish (*H. nobilis*). The study confirms that the predictive equations can be used to estimate values of body composition with a fair amount of accuracy. This study would be helpful for fisheries industry and consumers as the awareness about fish proximate composition is crucial for its maximal consumption.

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Introduction

Bighead carp (*Hypophthalmichthys nobilis*) is considered as a superb source of protein, because of its excellent nutritional value and high protein contents. It contains a lot of fatty acids and amino acids as well as vitamins like pyridoxine (B6), riboflavin (B2), D3 and cyanocobalamin (B12) (Chukwu,

2009). Due to bighead carp's great size, high fertility and lengthy maturation period, smaller hatcheries frequently employ fewer brood stocks for artificial propagation in order to reduce expenses (Kolar *et al*., 2007). These reasons make highly popular and economically valuable among the both, consumers and farmers (Shi *et al*., 2022).

The unexpected rise in global population is driving up demand for products derived from fishing (Laxe *et al*., 2018). The majority of essential dietary components, like essential fatty acids and nutrients including proteins, and micronutrients that can combat world hunger, are found in fish that inhabit freshwater environments in inland locations (Nyboer *et al*., 2019). Fish protein also aids in better digestion because it contains key amino acids including tryptophan, cystine, lysine, methionine and threonine. Nevertheless, it has developed into one of the industries that produce the most protein for all customers (Ytrestoyl *et al*., 2015).

Although this demand is substantially higher in emerging countries, fish is recognised as a powerful meal in the human diet that offers more than 20% of the protein needed in developing countries (Belhabib *et al*., 2015). The remaining 60% of fish parts, such as the head, skin, fins, frames, viscera, roes and trims are viewed as waste yet contain a significant quantity of protein in addition to the 40% of fish protein products used by humans (Zamora-Sillero *et al*., 2018).

Daily fish eating has been linked to a lower risk of heart disease (Chrysohoou *et al*., 2007). By consuming fish poly unsaturated fatty acids, many diseases, including cancer, arterial hypertension and inflammatory diseases, can be avoided or treated (Turkmen *et al*., 2005). The macro and micronutrients in fish make it superior to other protein sources (Lilly *et al*., 2017). Fish is usually referred to as "rich food for impoverished people" because it supplies important nutrients, particularly proteins with high biological values and lipids (Sujatha *et al*., 2013). The amount of protein and fat in fish determines much of its nutritional value (Lilly *et al*., 2017).

Analysis of fish's fat, water, ash and protein contents is known as "proximate body composition" (Aberoumad and Pourshafi, 2010). Fish muscles and bones are a great source of amino acids, protein and fatty acids, among other necessary nutrients (Zula and Desta, 2021). Food's proximate composition can be described by the type of nutrients it contains. Water percentage is an excellent predictor of the relative protein and lipid levels because they rise as the water percentage falls (Dempson *et al*., 2004). The moisture content, caloric content, dry matter, lipids, protein, vitamins and mineral of fish all affect how nutritious the meat is (Steffens, 2006). Consumer acceptance and human consumption both are influenced by body composition and flesh quality (Kause *et al*., 2002).

Fish composition depends on a number of variables, including the time of year, the fish's habitat, its sex, availability of food (Oliveira *et al*., 2003), water temperature (Bowyer *et al*., 2013), life cycle (Shearer *et al*., 1994), migration (Jonsson *et al*., 1997), starvation (Liao *et al*., 2022), seasonal variability (Ali *et al*., 2013) and age (Alemu *et al*., 2013). Studies have shown that one of the most significant elements affecting the reproduction of the four main Chinese carp species is hydrological variations (Li *et al*., 2021). Body weight of a fish significantly affects the various body constituents (Khalid and Naeem, 2018; Ishtiaq and Naeem, 2019). Fat and protein increase while ash and water decrease with the increasing total length (Barakat *et al*., 2022). Condition factor has no significant effect on proximate composition (Naeem and Ishtiaq, 2011).

The aim of present study was to study the relative body size relationship to proximate composition of Bighead carp (*Hypophthalmichthys nobilis*) from the farming system of Bahawalnagar, Pakistan.

Materials and Methods

A total of 28 specimens of bighead carp (*Hypophthalmichthys nobilis*) with variable body size were caught from Ali Salman Fish Farm, located at Minchinabad Road, Adda Loharka, 17 km, Bahawalnagar (latitude 30.055° and longitude 73.382°), Pakistan, with the help of drag net, in October, 2022. The city of Bahawalnagar experiences cold winters and scorching, dry summers. The winter season only lasts until the middle of February, beginning in December. The river Sutlej flows on Bahawalnagar's northern side and its eastern and southern borders touch Indian Territory (Aziz and Ghaffar, 2017).

Collected samples were thoroughly cleaned with blotting paper and transported to laboratory of the

Islamia University of Bahawalpur (Bahawalnagar Campus), Pakistan for further analyses. Total length (TL) and body weight (W) of each fish sample was taken and rounded up to the nearest 0.1cm and 0.01g, using a measuring wooden tray and weighted on a digital electric balance, respectively.

After taking size of each fish sample, the specimens were wrapped in aluminum foil and dried in an electric oven (POL-EKO, SLW-400) on 70-80°C at the Horticulture Department, University of Agriculture Faisalabad, Sub Campus Burewala, Pakistan, till the constant weight to examine water content. In accordance with the techniques of both, Bligh and Dyer (1959) and Salam and Davies (1994), content of fat was extracted using a 1:2 v/v ratio of chloroform and methanol. One gram sub-sample of homogenized powder of dried sample of *H. nobilis* was taken in pre-weighted China crucible and burned to make ash inside a muffle furnace (RJM-1.8-10A) at 550°C till the powdered sub-sample turns into colorless ash content of a sample, and the crucible including ash were re-weighted to determine the ash content. The dry weight of other components, such as fat, ash and water mass, was used to compute the gross accessible quantity of protein (Dawson and Grimm, 1980).

Statistical analyses

Condition factor (K) was determined by using the formula, K=100 W/ TL^3, following the techniques of Weatherly and Gill (1987) and Wootton (1990). The effect of condition factor and fish body size on different body contents was examined using regression equation ($Y = a + b X$), where a is constant, b is slope, Y represents one of the body contents, and X represents either body weight, total length or condition factor.

Results and Discussion

Fish samples of *H. nobilis* were ranged as 360.27-850.35g, 29.90-40.40cm and 1.16-1.53 in body weight, total length and condition factor, respectively. Range and mean percentages of different constituents in whole body of farmed *H. nobilis* collected from Bahawalnagar (Pakistan) are also given in Table 1.

Figure 1 shows relationship between body weight (g) and % different body constituents of farmed fish (*H. nobilis*). Water found highly significant negatively correlated while fat in wet weight showed significant positive correlation (P<0.01) with body weight of *H. nobilis*. Protein% and ash%, in wet weight showed highly significant positive correlation (P<0.001) with body weight of the studied fish.

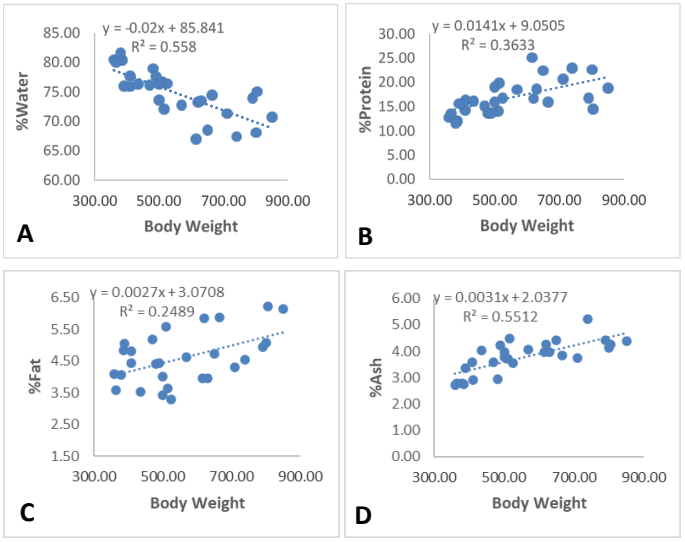

Figure 1: *The relationship of wet body weight with %water (A), %protein (B), %fat (C) and %ash contents (D) of H. nobilis.*

Table 1: *Descriptives of various parameters of proximate composition in the whole body of farmed Hypophthalmichthys nobilis.*

Body constituents	Range	Mean±SE
Water content (%)	67.00-81.55	74.70±0.76
Protein contents (% wet weight)	11.61-25.09	16.92±0.66
Protein contents (% dry weight)	57.97-76.01	66.50±0.83
Fat content (% wet weight)	3.30-6.24	4.60±0.16
Fat content (% dry weight)	11.99-25.01	18.52±0.73
Ash content (% wet weight)	2.73-5.21	3.78±0.12
Ash content (% dry weight)	11.99-18.87	14.98±0.29
Organic contents (% wet weight)	15.68-29.05	21.52±0.67
Organic contents (% dry weight)	81.13-88.01	85.02±0.29

SE, Standard Error.

Relationship between total length and % different body constituents of *H. nobilis* are given in Figure 2. Water% remained highly significant (P<0.001) negatively correlated while protein % and ash% in wet weight found highly significant (P<0.001) positively correlated with total length of *H. nobilis*. %Fat showed significant (P<0.01) positive correlation with total length of farmed *H. nobilis*.

Log transformed data of total water, protein, fat, ash and organic contents remained highly significant positively correlated with log body weight of farmed fish (*H. nobilis*) collected from Bahawalnagar (Pakistan). Body weight showed positive allometry (b=

>1) for all the studied constituents except for log total water content which represented negative allometry (b= <1) with an increase in body weight (Table 2). Log-log relationship of water, protein, fat, ash and organic contents, was highly significant positively correlated with log total length of farmed fish *H. nobilis*. Log total length showed negative allometry (b= <3) with log water while positive allometry (b= >3) with all remaining body constituents in the studied samples of fish (Table 3).

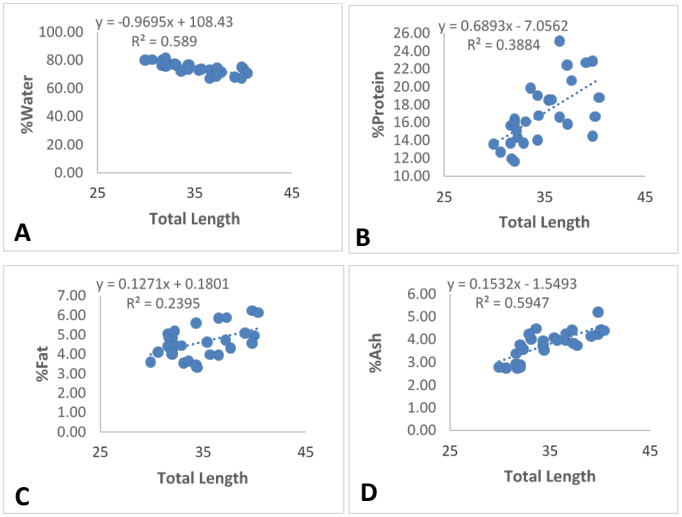

Figure 2: *The relationship of total length with %water (A), %protein (B), %fat (C) and %ash contents (D) of H. nobilis.*

Table 2: *Statistical variables of log body weight (W, g) versus log of different body constituents in H. nobilis.*

Relationship	r	a	b	SE(b)	t value when b=1
W vs Water	0.988***	0.302	0.843	0.026	-37.43
W vs Protein	0.934***	-2.144	1.500	0.115	-7.20
W vs Fat	0.909***	-2.168	1.302	0.120	-7.06
W vs Ash	0.965***	-2.824	1.511	0.082	-10.67
W vs Organic contents	0.964***	-1.934	1.462	0.080	-11.04

*r = Correlation Coefficient; a = Intercept; b = Slope; S.E= Standard Error; ***= P< 0.001*

Relationship between condition factor (K) and % different body constituents of farmed fish (*H. nobilis*) are provided in Table 4. Water %, protein %, fat %, ash % and organic % contents showed no significant correlation (P>0.05) with condition factor of farmed fish (*H. nobilis*) collected from Bahawalnagar, Pakistan.

Results of Table 5 described % fat (wet weight) showed no significant correlation (P>0.05) with % water content of farmed fish *H. nobilis*. On the other hand, % protein, % ash and % organic content (wet weight) showed highly significant (P<0.001) negative correlation with %water content of farmed fish (*H. nobilis*) collected from Bahawalnagar, Pakistan.

Table 3: *Statistical parameters of log total length (TL, cm) versus log different body constituents (g) of farmed H. nobilis.*

Relationship	r	a	b	SE(b)	t value when b=3
TL vs Water	0.951***	-1.071	2.387	0.156	-16.90
TL vs Protein	0.909***	-4.668	4.299	0.393	-3.34
TL vs Fat	0.892***	-4.407	3.763	0.380	-4.13
TL vs Ash	0.943***	-5.389	4.345	0.306	-5.45
TL vs Organic contents	0.942***	-4.411	4.201	0.300	-5.81

****= P< 0.001*

Table 4: *The relationship between condition factor (K) and % different body constituents of H. nobilis.*

Relationship	r	a	b	SE(b)	t value when b=0
K vs %Water	0.077 ns	70.231	3.451	8.892	0.388
K vs %Protein	-0.051 ns	19.499	-1.991	8.907	-0.223
K vs %Fat	-0.097 ns	5.751	-0.889	8.876	-0.100
K vs %Ash	-0.082 ns	4.520	-0.572	8.889	-0.064
K vs %Organic contents	-0.073 ns	25.250	-2.879	8.895	-0.324

ns= P>0.05

Table 5: *Relationship between percent water and percent different body constituents of H. nobilis.*

Relationship	r	a	b	SE(b)	t value when b=0
%Water vs % Protein	-0.962***	79.858	-0.843	0.048	-17.707
% Water vs %Fat	0.167 ns	7.163	-0.034	0.041	-0.847
% Water vs %Ash	0.783***	12.979	-0.123	0.020	-6.307
% Water vs % Organic content	-0.994***	87.021	-0.877	0.020	-44.900

****= P< 0.001; ns= P>0.05*

Hypophthalmichthys nobilis is one of the most important carps that is cultured and consumed in the studied area (Bahwalnagar, Pakistan), hence it was a dire need to explore its nutritional value from the studied area. Most fish have a protein content of 15 to 30% by weight, a fat content of 0 to 25% and a moisture content of 50 to 80% by weight (Chakma *et al.*, 2020).

Table 6: *Mean percentage values of proximate composition in wet body weight of different fish species.*

Fish species	Water	Protein	Fat	Ash	Refrences
Hypophthalmichths nobilis	77.31±0.93	15.78±0.25	1.68 ± 0.07	1.34± 0.03	Alahmad *et al.* (2022)
Snakehead murrel	76.90±0.99	19.71±0.28	2.65 ±0.83	1.44 ±0.12	Chasanah *et al.* (2021)
Tor putitora	70.2± 0.59	22.2 ± 0.10	1.4 ± 0.01	1.2 ± 0.17	Ahmed *et al.* (2020)
Hypophthalmichths molitrix	77.1 ± 0.53	18.5 ± 0.16	1.4 ± 0.09	1.3 ± 0.17	
Cyprinus carpio	70.6± 0.36	19.3 ± 0.36	3.3 ± 0.08	1.0 ± 0.03	
Catla catla	-	15.11±1.4	5.2±1.3	3.1±1.1	Ahmad *et al.* (2019)
Aoricthyes aor	75.40±0.56	15.76±0.73	4.47±0.64	4.36±0.74	Hussain *et al.* (2016)
Hypophthalmichths nobilis (Juvenile)	78.87±0.67	15.89±0.68	1.69 ± 0.06	1.24 ± 0.08	SHI *et al.* (2013)
Cirrhinus mrigala	72.4±0.247	15.2± 0.31	5.31± 0.04	4.29± 0.04	Yadav *et al.* (2010)
Labeo rohita	82.14±0.11	14.36±0.10	1.21 ± 0.03	1.13 ±0.18	Keshavanath and Renuka (1998)
Hypophthalmichths nobilis	74.70±0.76	16.92±0.66	4.60±0.16	3.78±0.12	Present Study

The results obtained on proximate composition in present work are given in Table 1. These values are roughly equivalent to those reported by the other researchers who studied proximate composition in various fish species (Table 6).

Highly significant (P<0.001) positive correlations of fish size (body weight and total length) represented a definite effect of the size on proximate composition. Relationship of fish size with various body constituents (in log transformed data) revealed significant positive correlations, and confirm the findings of previously reported studies by Bano *et al.* (2019) in *Labeo calbasu,* Iqbal *et al.* (2019) in hybrid fish (*Labeo rohita* ♀ and *Catla catla* ♂), Ishtiaq and Naeem (2019) in *Catla catla,* Lal and Naeem (2021) in *Terapon jarbua* and Azam and Naeem (2022) in *Scomberoides commersonnianus.* Positive allometry in protein, fat and ash indicated significant proportional increase in these body constituents of with increase in size of *H. nobilis*. The results of allometric approach proposes that protein, fat and ash contents increased at higher rate compared to its rate of consumption as the bighead carp grows in size.

In the current study, water content in *H. nobilis* falls when all percentages are represented on a wet weight basis, whereas protein and fat percentages enhance with escalating body weight. These results were mostly consistent with those of reported by Naeem and Salam (2010) in bighead carp. The present study showed ash and organic contents percentages increases with the increasing body weight in wet. Present results remained similar to the findings of Naeem *et al.* (2011) in *Notopterus notopterus* in case of organic contents but deviate in case of ash content.

In present study protein, fat, ash and organic contents percentages increases with the increasing total length. Total length inversely correlated with percent water content in wet weight of *H. nobilis.* Findings of current study in case of percent (water, protein and fat) found in common concurrence with findings of Naeem and Salam (2010) in bighead carp but in case of percent ash and percent organic contents deviate with findings of Naeem *et al.* (2011) for *N. notopterus.* Regarding the relationship of total length (cm) in wet weight with the chemical components of muscle, percent (water, protein and fat) content of present study found similar with findings of Barakat *et al.* (2022) but deviate in case of percent ash content.

Studied body constituents remained constant when related to condition factor in *H. nobilis.* Many authors (Naeem and Ishtiaq, 2011; Bano *et al.*, 2019; Lal and Naeem, 2021) have also reported insignificant relationship between these parameters, whereas some other studies by Salam and Davies (1994) in *Esox lucius* (northern pike) and Azam and Naeem (2022) in *S. commersonnianus* (Talang Queenfish) documented significant correlation between condition factor and body constituents of fish. The variations may be due to fact that body weight of a fish is not always proportional to the cube of its total length (Weatherley and Gill, 1987; Salam and Davies, 1994).

In the present study protein, fat, ash and organic contents percentages decreased with increase in percent water content. Present results found similar to the findings of Khalid and Naeem (2018), except

for fat content. This difference may be due to different environment, type of feed, size, age, seasons or habitat of the different fish species.

Conclusions and Recommendations

The current study's findings show that body constituents (fat, water, ash, protein and organic contents) fluctuate with the changes in body weight and total length. According to this study, the values of the proximate body composition may be estimated simply by knowing the fish size without scarifying it.

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Novelty Statement

Findings of the present study provide nutritional insight of an exotic and commercially important culturable carp, *Hypophthalmichthys nobilis*, from the farming system of Bahawalnagar, Pakistan.

Author's Contribution

Abir Ishtiaq and Abdul Ghaffar being research supervisor and co-supervisor, respectively, provided the guidelines to complete research experiment and reviewed the manuscript. Maria Younas has collected the data, conducted the experiment, performed data analysis and wrote the first draft of the manuscript. Tasveer Ishtiaq and Zara Naeem helped in the experiment and statistical analysis. Muhammad Naeem provided the lab facilities and helped in reviewing the manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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