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Seasonal Variations in the Proximate Composition of the Wild-Captured and Cultured Pangas

Md. Refat Jahan Rakib [1*], Habib Ul Hassan[2, 3*], M. U. M. Abu Zakaria[1], Naseem Rafiq[4], Yasmeen Gul[5], Ataallah Abdel-Tawab A Metwalli[6], Safia Mushtaq[2], M. Belal Hossain[1], Md Anisuzzaman[1], Saba Rizwan[7], M.F.A. Abdel-Aziz[8]

1-Department of Fisheries and Marine Science, Faculty of Science, Noakhali Science and Technology University, Noakhali, Bangladesh
2-Fisheries Development Board, Ministry of National Food Security and Research, Pakistan
3-Department of Zoology, University of Karachi, 75270 Karachi, Pakistan
4-Department of Zoology, Abdul Wali Khan University Mardan 23200, Pakistan
5-Department of Zoology, Government College Women University, Faisalabad, Pakistan
6-National institute of oceanography and Fisheries, Fayoum Aquatic Research Station, Egypt
7-Jinnah University for Women, Nazimabad Karachi-74600, Pakistan
8-Fish Rearing Lab., National Institute of Oceanography and Fisheries, Egypt
[*]Corresponding Author: rifatjahanrakib@gmail.com; habib5447@gmail.com

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ABSTRACT

The current study was conducted to compare the nutritional values of the wild-captured *Pangasianodon hypophthalmus* and those of the farm-cultured *Pangasius pangasius*, pangas. Fish samples were collected from the Meghna River Estuary (from the river and a fish farm) from October 2018 till January 2020 with respect to three seasons. Moisture, protein, lipid, carbohydrate, ash, and fiber contents were estimated. according to AOAC 2000 methodsData obtained were analyzed using one- and two-way ANOVA. The means of values were compared using Duncan's test at ($p < 0.05$). Proximate composition was affected by season and fish environment. Protein content was significantly higher in winter for both wild and farmed fish. Ash, fiber, and carbohydrate contents were higher in winter than in other seasons in both wild and farmed fish. Protein and carbohydrate contents were higher in wild pangas than in farmed fish in all seasons. The ash content of pangas was higher in the wild fish in autumn and winter, while in the farmed fish, the ash content was higher in summer. It was concluded that wild pangas contain higher levels of nutrients than farmed pangas. This variation is due to feeding regime, feed type, environmental factors and water depth. However, both wild and farmed pangas are rich in essential nutrients, so both may play a significant role in contributing to the nutritional demands of the population in Bangladesh.

INTRODUCTION

Fish represent an excellent source of animal protein and are generally more available and affordable than other animal protein sources **(Mohanty *et al*., 2019; Ahmad *et al.*, 2020; Hassan *et al.*, 2021ab);** they are consumed by one billion people worldwide **(Khalid *et al.,* 2020; Ahmad *et al.,* 2020; Hussain *et al.,* 2021)**. Fish muscle protein is of a high quality; it contains all essential amino acids, including methionine and lysine, but it is low in tryptophan compared to mammalian protein **(Nowsad, 2007)**. In addition, it contains minerals and micronutrients, such as iron, zinc, n-3 long-chain polyunsaturated fatty acids and vitamins often found in highly bioavailable forms **(Golden, 2016)**. These factors make fish a desirable food for infants, adults and the elders **(Abdullahi *et al*., 2001)**. In addition, fish meal is considered an important source of animal protein in fish feed. Pangas (*Pangasianodon hypophthalmus* and *Pangasius pangasius*) is one of the most familiar species in Bangladesh, being important in aquaculture for its fast growth, easy culture, high disease resistance, and tolerance of a wide range of environmental parameters compared to other species **(Begum *et al*., 2012)**. The high demand on wild pangas is due to its physical appearance, color and affordability. Proximate composition (percentages of moisture, protein, lipid, ash, fiber, and carbohydrate in the body) varies from species to species and even within the same species from one individual to another **(Aberoumad & Pourshafi, 2010; Ahmed, 2011)**. Size, age, season, sex, and the geographical location are the main causes for this variation **(Stansby, 1962; Hassan *et al.,* 2020a)**. The nutritional arrangements within the same species may vary with environmental and feeding conditions, water depth and water quality **(Javaid *et al*., 1992; Drazen, 2007; Ahmed, 2011)**. The estimation of the proximate composition of fish provides information regarding its nutritive value and informs better processing and preservation methods **(Mridha, 2005)**. Moreover, it is a good indicator of physiological state and health, forming an essential knowledge for managing methods of fish processing **(Silva & Chamul, 2000; FAO, 2004; Saliu *et al*., 2007)**. The present study was conducted to investigate and compare the nutritional composition of wild and farmed pangas harvested in three different seasons.

MATERIALS AND METHODS

Collection and preparation of fish samples

The farm-cultured (closed pond) fish, *Pangasianodon hypophthalmus*, were collected from Globe Agro Fisheries Ltd., Noakhali (S1); whereas, the wild-captured fish, *Pangasius pangasius*, were collected from Chairman Ghat near the Meghna River Estuary (S2) during the period from October 2018 to January 2020 in three seasons (summer, autumn and winter) (Fig. 1). In each season, fish samples were collected, immediately transferred to an insulated cool box filled with ice, and then transferred to the laboratory at the Fisheries and Marine Science Department at Noakhali Science and Technology University, Bangladesh. Fish samples were cut into small pieces and ground in an electric blender to make a homogenous pulp for analytical evaluation. Then, the samples were labeled and stored at −20°C until laboratory analysis. The samples were then transported to the Nutrition Laboratory at the Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, for nutritional analysis.

Determination of proximate composition

The proximate composition of fish samples was determined in triplicate according to the methods of AOAC International **(AOAC, 2000)**. Moisture content was assessed by drying the samples in an oven at 105°C for 24 h; crude protein content (N × 6.25) was determined by the Kjeldahl method using a BehrosetInKje M digestion apparatus and a Behr S I steam distillation apparatus (both from labor-Technik GmbH, Dusseldorf, Germany). Furthermore, lipid content was estimated by ether extraction in a Soxhlet system SOCS; ash content was evaluated by incineration in a muffle furnace at 600°C for 6h, and crude fiber content was assessed by using a filter crucible and hot extractor unit with 150 mL of 0.128 H_2SO_4 at 230°C. Carbohydrate content was determined as the total carbohydrate by difference using the following calculation: 100 − (moisture + protein + fiber + lipid + ash).

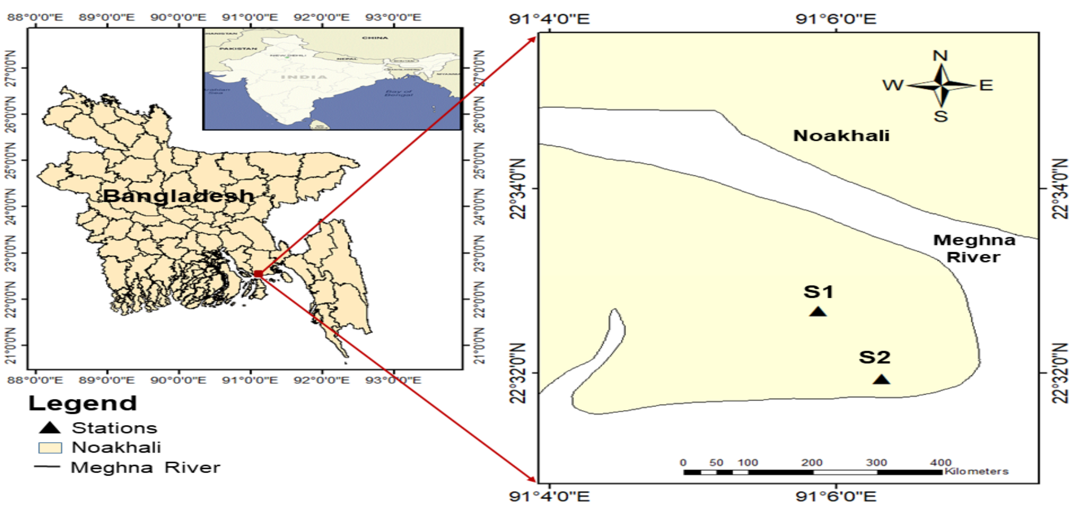

Fig 1. Geographical presentation of study areas

Data analysis

One- and two-way ANOVA were used for statistical analysis of the data obtained, and means were compared using Duncan's test at $p < 0.05$. Analysis was accomplished using Statistical Package for Social Sciences (SPSS/PC, version 20.0; SPSS Inc., Chicago) to understand significant differences ($p < 0.05$) among variables.

RESULTS AND DISCUSSION

The chemical composition of wild pangas during the different seasons is shown in Table (1). Significant differences were recorded among the seasons in terms of moisture, protein, lipid, ash, fiber and carbohydrate contents. Moisture content recorded its highest in autumn, followed by summer, while it was at its lowest in winter. Lipid content was at its significant highest in summer, followed by autumn and winter. Lipid content is affected by environmental and physiological factors, such as gonad maturation, spawning period and starvation **(Bumb, 1992)**. Ash content was at its highest in winter and its lowest in summer; protein content followed a similar trend. Similarly, the ash content was found higher in winter in the studies of **Petenuci *et al*. (2008)** and **Azim *et al*. (2012)**. Both fiber and carbohydrate contents showed their highest in winter, followed by summer and then autumn. Results in the study of **Deka *et al*. (2012)** noted that chemical compositions of species differ by season.

Table 1. Seasonal variations in proximate composition of wild-captured pangas (*Pangasianodon hypophthalmus)* (%) on basis of wet weight

Season	Moisture	Lipid	Protein	Ash	Fiber	Carbohydrate
Summer	77.55±0.60[a]	9.35±0.63[a]	15.85±0.50[b]	3.95±0.21[c]	1.19±0.29[b]	1.42±0.10[b]
Autumn	79.02±0.98[a]	7.78±0.53[b]	17.09±0.31[b]	5.30±0.42[b]	1.05±0.08[b]	0.76±0.09[c]
Winter	73.63±0.96[b]	6.35±0.45[c]	19.22±1.16[a]	6.73±0.45[a]	2.78±0.26[a]	1.69±0.15[a]

Different superscripts in the same column differ significantly ($p<0.05$)

In farmed pangas, chemical composition differed significantly by season (Table 2). The highest protein content was achieved in winter, followed by autumn, but levels were significantly the lowest in summer. Ash content was significantly at its highest in winter. Both lipid and carbohydrate contents were significantly higher in winter and summer compared to autumn. Fiber content was the highest in winter, lower in autumn, and reached its lowest in summer, with a trend observed in the study of **Azim *et al*. (2012)**, who found that crude fiber and carbohydrate recorded their highest in winter. Contrarily, moisture content was at its lowest in winter. All parameters, except moisture, were higher in winter; results that mirror those of **Saeed (2013)** and **Younis *et al*. (2015)**, who noted that the protein and lipid contents in the tilapia (*Oreochromis niloticus*, *O. aureus*, and *Tilapia zillii*) increased in winter and spring compared to summer, and *vice versa* for moisture content.

Table 2. Seasonal variations in proximate composition of farm-cultured pangas (*Pangasius pangasius)* (%) on basis of wet weight

Season	Moisture	Lipid	Protein	Ash	Fiber	Carbohydrate
Summer	76.77±0.15[a]	5.24±0.42[a]	13.29±0.76[b]	4.94±0.11[b]	0.92±0.13[c]	1.02±0.08[a]
Autumn	76.72±0.47[a]	4.02±0.03[b]	16.25±0.78[a]	4.72±0.10[b]	1.60±0.16[b]	0.52±0.09[b]
Winter	69.91±0.20[b]	5.09±1.53[a]	16.69±1.53[a]	5.39±0.35[a]	2.26±0.28[a]	1.19±0.21[a]

Different superscripts in the same column differ significantly ($p<0.05$)

The proximate compositions of wild and farmed pangas in different seasons are shown in Table (3). There were no significant differences in seasonal moisture content in wild pangas, though in the farmed pangas, the moisture content was significantly lower in autumn and winter than in summer. Lipid content showed no significant seasonal change in wild pangas, though in the farmed pangas, lipid content was significantly lower in summer and autumn than in winter. There were non-significant differences in protein content in the wild pangas in all seasons, and in the farmed pangas, non- significant differences were noted in winter and autumn. The lowest protein levels were found in farmed pangas in summer. Fiber content in both the wild and farmed pangas did not significantly differ across seasons. Carbohydrate and ash contents showed no significant differences in wild pangas or in farmed pangas in winter and autumn, although in the latter, they showed significant decreases in summer. There were non-significant differences between the seasons for all content parameters for wild pangas. This result partially agrees with those of **Ali *et al*. (2013)** who found that, the protein content of fish did not show seasonal variability. Furthermore, the wild pangas showed higher levels for almost all parameters compared to farmed pangas in all seasons. This finding coincides with the result of **Monalisa *et al*. (2013** who reported that, the wild pangas was superior in terms of proximate composition, minerals, and amino acid profile compared to farmed pangas. Similarly, **Özogul *et al*. (2009)** reported that fish harvested from the open sea had higher lipid content than other fish. Wild pangas showed higher levels of fiber compared to farmed fish because they consume more food of plant origin in their natural habitat **(Mondal *et al*., 2019)**. Diverse environmental and feeding conditions, water depth, and water quality were the given reasons for the variation detected within species **(Drazen, 2007; Ahmed, 2015; Hassan *et al.*, 2020b)**. In the wild areas, fish mainly consume phytoplankton, zooplankton, crustaceans, insects and vascular plants, and their habitat is not confined as that of the farmed fish; these factors explain the higher nutritional values in wild pangas. In this context, **Oliveira *et al*. (2003)** and **Syed *et al.* (2021)** reported that, in different environmental conditions, the chemical composition of the same fish species changes due tothe differences in water quality, feeding source, state of maturity, the period during which the fish was harvested and sex. Moreover, **Ibrahim *et al*. (2008)**

postulated that, fish quality is affected by the environmental conditions, including feed availability, water temperature and hydrological levels. This was reflected in the present study, where the wild pangas showed superior levels in all nutritional parameters (protein, lipid, carbohydrate, ash, fiber and moisture) compared to those that were farmed.

Table 3. Variations in proximate composition between wild captured and farm-cultured pangas (%) on basis of wet weight

Proximate composition	Summer		Autumn		Winter	
	Wild	Cultured	Wild	Cultured	Wild	Cultured
Moisture	77.55±0.60[a]	76.77±0.15[a]	79.02±0.98[a]	76.72±0.47[b]	73.63±0.96[a]	69.91±0.20[b]
Lipid	09.35±0.63[a]	05.24±0.42[b]	07.78±0.53[a]	04.02±0.03[b]	06.35±0.45[a]	05.09±1.53[a]
Protein	15.85±0.50[a]	13.29±0.76[b]	17.09±0.31[a]	16.25±0.78[a]	19.22±1.16[a]	16.69±1.53[a]
Ash	03.95±0.21[a]	04.94±0.11[b]	05.30±0.42[a]	04.72±0.10[a]	06.73±0.45[a]	05.39±0.35[b]
Fiber	01.19±0.29[a]	0.92±0.13[a]	01.05±0.08[a]	01.60±0.16[b]	02.78±0.26[a]	02.26±0.28[a]
Carbohydrate	01.42±0.10[a]	01.02±0.08[b]	0.76±0.09[a]	0.52±0.09[a]	01.69±0.15[a]	1.19±0.21[b]

Different superscripts in the same row for same season differ significantly (*p<0.05*)

Differences in proximate composition can be due to differences in species, size, sex, age, geographical location and water quality, among other parameters (Table 4).

Table 4. Comparison in the proximate composition of wild captured and farm-cultured pangas

Location	Species name	Collection	Moisture	Lipid	Protein	Ash	Reference
Songhuajiang River, China	*Pseudobagrus ussuriensis*	Wild	72.91±0.28^{a}	6.78±0.02^{b}	18.97±0.15	1.25±0.10	**Wang *et al.* (2014)**
		cultured	70.82±0.20^{a}	6.78±0.02^{b}	19.46±1.19	1.28±0.10	
Gomti river of Tripura, India	*Ompok bimaculatus*	Wild	75.58	6.36	16.77	1.06	**Pal *et al.* (2017)**
		cultured	74.99	7.06	16.38	1.07	
Munzur River, Tunceli Turkey	*Salmo trutta sp* (W)	Wild	74.8^{a} ±1.1	2.7^{a} ±0.3	18.1^{a} ±2.0	1.6^{a} ±0.4	**Yeşilayer *et al.* (2013)**
	Oncorhynchus mykiss (F)	cultured	75.6^{a} ±1.2	4.3^{a} ±1.5	17.9^{a}±1.01	2.1^{a} ±0.4	
Pakistan	*Cirrhinus mrigala*	Wild	74.9±0.01^{a}	2.0±0.01^{f}	21.0±0.02^{f}	1.8±0.03^{c}	**Ahmed *et al.* (2015)**
		cultured	69.7±0.13^{d}	2.2±0.02^{e}	24.6±0.07^{c}	2.0±0.04^{b}	
Chairman ghat, Subornochor, Noakhali, Bangladesh	*Macrobrachium rosenbergii*	wild	72.35±2.54^{a}	5.53±0.43^{b}	20.32±0.87^{c}	0.87±0.06^{a}	**Islam *et al.* (2017)**
		cultured	63.29±4.97^{c}	7.02±0.21^{a}	28.24±176^{a}	0.75±0.11^{c}	
Kanasokhala, Sherpur, Bangladesh	*Anabas testudineus*	wild	67.20±2.78	7.84±1.01	15.60±0.70	6.81±1.34	**Mondal *et al.* (2019)**
		cultured	69.7±0.13^{d}	2.2±0.02^{e}	24.6±0.07^{c}	2.0±0.04^{b}	
Noakhali region Noakhali, Bangladesh	*Pangasianodon hypophthalmus*	Wild-S	77.55±0.60^{a}	9.35±0.63^{a}	15.85±0.50^{b}	3.95±0.21^{c}	**Present study**
		Wild-A	79.02±0.98^{a}	7.78±0.53^{b}	17.09±0.31^{b}	5.30±0.42^{b}	
		Wild-W	73.63±0.96^{b}	6.35±0.45^{c}	19.22±1.16^{a}	6.73±0.45^{a}	
Noakhali region Noakhali, Bangladesh	*Pangasius pangasius*	Cultured-S	76.77±0.15^{a}	5.24±0.42^{a}	13.29±0.76^{b}	4.94±0.11^{b}	**Present study**
		Cultured-A	76.72±0.47^{a}	4.02±0.03^{b}	16.25±0.78^{a}	4.72±0.10^{b}	
		Cultured-W	69.91±0.20^{b}	5.09±1.53^{a}	16.69±1.53^{a}	5.39±0.35^{a}	

S-Summer, A- Autumn, W- Winter

CONCLUSION

Both wild and farmed pangas are rich in protein, lipid and ash content, and both show a degree of seasonal variation in proximate composition. Consequently, pangas can play an important role in meeting the nutrient demands of the population in Bangladesh. Variations in proximate composition may be influenced by feed type, feeding regime, living conditions and environmental factors. Further research is recommended to clarify the variations in the mineral, amino acid, and fatty acid profiles of wild and farmed pangas.

AUTHOR CONTRIBUTIONS

MRJR, HUH and MAZ designed the study and executed the experimental work. MBH and MA performed chemical analysis. AATM and NR helped in data analysis. SM and YG helped in literature search. HUH and MFA conceived the concept of the review. MRJR and HUH wrote the article. Many thanks and sincere gratefulness to them all.

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