



SEASONAL VARIATION OF PROXIMATE COMPOSITION OF HILSA SHAD (*TENUALOSA ILISHA* HAMILTON, 1822) IN THREE RIVER CHANNELS OF BARISAL, BANGLADESH

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ABSTRACT:

The River Channels of Barisal are a good source of Hilsa in Bangladesh. The study was conducted to find out the seasonal variation of Hilsa in correspondence with proximate composition. In this study, Hilsa shad (*Tenualosa ilisha* Hamilton, 1822) samples were collected during the three seasons (summer, rainy, and winter) from three different river channels (Kirtankhola, Payra, and Rabnabad) of Barisal Division, Bangladesh, to determine the proximate composition content of Hilsa shad and its variation with seasons. Significant differences in proximate composition content of Hilsa shad were observed among the seasons. Although protein and lipid content differ significantly among the sites, the moisture and ash content of Hilsa

shad were insignificant among the sites. The results revealed that moisture and protein content were highest in summer (moisture $69.03 \pm 1.68\%$, protein $19.50 \pm 0.54\%$) and lowest in winter (moisture $57.95 \pm 2.58\%$, protein $15.92 \pm 1.34\%$). In contrast, lipid and ash content peaked in winter (lipid $20.99 \pm 2.15\%$ and ash $3.05 \pm 0.11\%$) and were lowest in summer (lipid $7.92 \pm 0.49\%$ and ash $1.27 \pm 0.14\%$). The present study shows that different components of proximate composition varied significantly among the seasons. Further study is needed to determine the cause of the differences in amino acid and fatty acid levels, as well as minerals, to resolve the debate about the taste of Hilsa shad in cases of spatiotemporal variation.

KEY WORDS: Seasonal Variation, Proximate Composition, Hilsa Shad (*Tenualosa ilisha*), River Channels of Barisal.

INTRODUCTION:

Three main rivers—the Padma, the Meghna, and the Jamuna—feed Bangladesh's largest and active delta. The Hilsa Shad (*Tenualosa ilisha*, Hamilton, 1822), often known as Hilsa (or Ilish), is the national fish of Bangladesh and makes up one of the largest contributors (around 12.22%) to the nation's overall fish production (DoF, 2020). In 2019-2020, about 550428 metric tons (MT) of hilsa were produced, of which 245862 MT (45%) came from inland waters. These fish were landed in two districts, Barishal and Chandpur, which are located on the west and east banks of the River Meghna, respectively. The remaining 304566 MT (or 55%) of Hilsa was produced from marine waters (DoF, 2020), and it was landed in the districts of Chittagong and Cox's Bazaar. The Hilsa fishery is dominated by *Tenualosa ilisha*, which accounts for more than 99% of the entire Hilsa catch. *Tenualosa ilisha* is one of three river shad species that exit in Bay of Bengal seas (Stobberup, 2011). The Hilsa lives in the Bay of Bengal and migrates to the river to spawn, returning to marine waters along with the young fish (BOBP, 1987; Milton and Chenery, 2003; Hossain et al., 2016). The monsoon, monsoonal floods, and the onset of sexual maturation are thought to affect anadromous fish in the sea to make their upstream breeding migration (BOBP, 1987). The larvae, which range in size from 2.3 to 3.1 mm after hatching, are drifted by tidal currents and wave action as they search for nursery grounds (Rahman, 2006), which are typically in the downstream reaches of rivers, where they gradually develop into juveniles. So far, two significant nursery grounds have been located. The Meghna River's Shatnol (Louhagjang-Mawa-Gazaria,

Munshiganj) under Dhaka Division's upstream end through Chandpur's Nilkamol and Cumilla Division's Hajimara-Char Alexander of Lakshmipur downstream to the largest riverine nursery site (BOBLME, 2010). The coastal nursery grounds stretch from Dublar Char (Khulna) to Kuakata (Patuakhali) (Halder, 2002). The Payra, Kirtonkhola, Bishkhali, Tetulia, Shabazpur channel, Arial kha, Dharmaganj, and Andermanik in Barisal and Bhola districts are the main coastal rivers that Hilsa uses as nursery grounds. The expansive rivers in and around the Sundarbans and other coastal islands serve as Hilsa's nursery grounds as well (Islam and Haque, 2004; Hossain et al., 2016). Proximate composition describes the structure of fish flesh, which is made up of four basic elements in various amounts: water (70–80%), protein (18–20%), fat (5%), and minerals (5% and minor nutrients) (Khurseed and Mosharaff, 1988). Consumers, scientists, and manufacturers should be aware of the fish's body composition to understand its nutritional worth, seasonal fluctuations, and processing requirements (Murray and Burt, 2001). According to age, sex, environment, season, and other factors, the proximate composition changes significantly among species as well as within individuals (Huss, 1988; Srivastava, 1985; Shamim et al., 2011). According to Love (1997), the primary factor determining the proximate composition is the stage of the reproductive cycle, which is linked to the low levels of fat and the subsequent exhaustion. Fish muscles' protein content rises modestly during times of intense feeding, and then it's possible for the fat content to rise noticeably and quickly. On the other hand, fish may experience starving periods due to external factors like a food shortage or natural or physiological causes (such as spawning or migration). In that instance, the amount of fat gradually drops, and the amount of protein may also drop (Huss, 1988). As an omnivore, Hilsa consumes both zooplankton and phytoplankton. Fish body composition, in particular crude protein, crude fat, and moisture content, can be influenced by feed quality and feeding rate (Akram and Swapna, 2014). The upstream river migration considerably lowers the contents of calcium, potassium, sodium, and fat, which affects the near composition of Hilsa shad (Kumar et al., 2019). The Hilsa's average fat values ranged from 7.5 to 26.93% depending on the period of migration, which may be the cause (Majumdar and Basu, 2009). The seasonal variation of Hilsa shad's proximate composition has not yet been reported, despite numerous studies on the species' spatial variation in that regard. The study's goal was to assess the proximate composition of Hilsa shad taken from three river channels in Barisal Division of Bangladesh (Kirtonkhola, Payra, and Rabnabad) and how that composition varied over the course of three seasons (Summer, Rainy, and Winter).

MATERIALS AND METHODS:

Sample Collection:

In the Barisal Division's three rivers, Kirtonkhola, Payra, and Rabnabad, throughout the summer (April), rainy (August), and winter seasons (December), premium quality fresh Hilsa shad (*Tenualosa ilisha* Hamilton, 1822) were taken directly from the local fishermen and close-by landing centers. A total number of 27 fishes (three seasons with 3 samples from each location) were collected from the three Rivers during the three seasons. The fish were freshly carried to those landing stations from the nearby above-mentioned rivers at the time of collection, despite the fact that they were dead. The obtained samples were packed into separate polythene bags, labeled, and maintained at a temperature of $< 4^{\circ}\text{C}$ during transportation and kept there at a temperature of -20°C in lab until further examination in order to prevent microbial contamination.



Figure-1: Sampling Sites of Three River Channels of Barisal

Preparation of sample

The stored samples were filleted, dried in an oven, and then crushed into a paste using a mechanical grinder before biochemical examination.

Proximate analysis

Hilsa's proximate composition (moisture, ash, crude fat, and crude protein) was analyzed using specific adaptations to the techniques outlined in the Association of Official Analytical Chemists' (AOAC, 2005) publication. Using a hot air oven, the sample was dried at 105°C for 8 hours to assess its moisture and dry matter contents. At 600°C, the amount of ash was determined. The Kjeldahl method (described in the Kjeldahl apparatus specification) was used to determine the nitrogen content, and crude protein was calculated by multiplying the nitrogen percentage by 6.25. Diethyl ether, which has a boiling point between 40°C and 60°C, was used as the solvent in a Soxhlet system to extract lipids.

Statistical analysis:

To determine whether there was a significant difference in the proximate compositions depending on the season and the rivers ($p < 0.05$), the data on proximate composition were subjected to an analysis of variance (ANOVA) and mean comparisons were conducted through DMRT (Duncan's New Multiple Range Test) in the Statistical Package for Social Science (SPSS, Version 25). (SPSS Inc., Chicago, USA).

RESULTS:

The proximate composition of Hilsa fish on different seasons from three different river channels of Barisal Division are shown in the Table 1 and interactions of proximate composition with seasons and location of river channels are in the table 2.

Table 1. Proximate composition of Hilsa fish at different seasons in three different rivers Barisal Division

Season	Location	Moisture	Ash	Lipid	Protein
Summer	Kirtonkhola	70.26±1.03	1.37±0.17	7.72±0.21	19.12±0.19
	Payra	67.62±1.67	1.19±0.12	8.12±0.87	20.13±0.35
	Rabnabad	69.21±1.45	1.25±0.10	7.92±0.22	19.25±0.34
Rainy	Kirtonkhola	65.51±2.70	2.15±0.26	12.17±1.47	17.59±0.71
	Payra	63.41±2.45	2.09±0.29	13.51±1.0	18.17±0.28
	Rabnabad	65.37±1.73	2.11±0.17	12.28±0.41	17.72±0.34
Winter	Kirtonkhola	60.05±2.32	2.19±0.75	18.93±1.43	15.70±0.35
	Payra	58.18±2.35	2.12±0.84	20.65±1.05	17.46±0.59
	Rabnabad	55.63±1.00	2.13±0.78	23.39±0.45	14.61±0.75

Table 2. Interactions of proximate composition of Hilsa shad with seasons and locations

Treatments	Proximate composition (%)			
Seasons	Moisture	Ash	Lipid	Protein
Summer	69.03±1.68 ^a	1.27±0.14 ^c	7.92±0.49 ^c	19.50±0.54 ^a
Rainy	64.76±2.26 ^b	2.12±0.21 ^b	12.65±1.1 ^{1^b}	17.83±0.49 ^b
Winter	57.95±2.58 ^c	3.05±0.11 ^a	20.99±2.1 ^{5^a}	15.92±1.34 ^c
Locations				
Kirtonkhola	65.27±4.80 ^a	2.19±0.75 ^a	12.94±4.9 ^{9^b}	17.47±1.54 ^b
Payra	63.07±4.51 ^b	2.12±0.84 ^a	14.09±5.5 ^{1^a}	18.59±1.25 ^a
Rabnabad	63.40±6.19 ^a	2.13±0.78 ^a	14.53±6.9 ^{1^a}	17.20±2.10 ^b
P Value				
Season	0.000	0.000	0.000	0.000
Location	0.058	0.661	0.005	0.000
*Season×Location	0.239	0.898	0.002	0.004

Data represents the mean±SD. Different super script letters in the same column indicates the significant difference ($p < 0.05$)

Moisture:

The moisture content of Hilsa fish ranged between 67.62±1.67 (Payra river) to 70.26±1.03 (Kirtonkhola river) in summer season, 63.41±2.45 (Payra river) to 65.51±2.70 (Kirtonkhola river) in Rainy season, 55.63±1.00 (Rabnabad river) to 60.05±2.32 (Kirtonkhola river) in Winter season (Table 1). There was a significant ($p = 0.000$) difference in the mean values of moisture on seasons (69.03±1.68, 64.76±2.26, and 57.95±2.58 in Summer, Rainy and Winter season respectively), while the means values of moisture in different river channels (65.27±4.80, 63.07±4.51, and 63.40±6.19 in Kirtonkhola, Payra, and Rabnabad river) were not significantly ($p = 0.058$) different from each other. The season and the river channels

did not have significant interactions ($p = 0.239$) in determining the moisture content of Hilsa fish (Table 2).

Ash:

The ash content of Hilsa fish ranged between 1.19 ± 0.12 (Payra river) to 1.37 ± 0.17 (Kirtonkhola river) in summer season, 2.09 ± 0.29 (Payra river) to 2.15 ± 0.26 (Kirtonkhola river) in rainy season, and 2.12 ± 0.84 (Payra river) to 2.19 ± 0.75 (Kirtonkhola river) in winter season (Table 1). A significant ($p = 0.000$) difference in ash content of Hilsa fish was seen among the seasons (1.27 ± 0.14 , 2.12 ± 0.21 , and 3.05 ± 0.11 in summer, rainy, and winter season respectively). On the other hand, ash content of Hilsa fish did not differ significantly ($p = 0.661$) with the location of river channels (2.19 ± 0.75 , 2.12 ± 0.84 , 2.13 ± 0.78 in Kirtonkhola, Payra, and Rabnabad river respectively) and therefore the interaction between the season and the location of river channels in determining the ash content of Hilsa fish did not differ significantly ($p = 0.898$) (Table 2).

Lipid:

The crude lipid content of Hilsa fish ranged between 7.72 ± 0.21 (Kirtonkhola river) to 8.12 ± 0.87 (Payra river) in summer, 12.17 ± 1.47 (Kirtonkhola river) to 13.51 ± 1.0 (Payra river) in rainy and 18.93 ± 1.43 (Kirtonkhola river) to 23.39 ± 0.45 (Rabnabad river) in winter season. The mean values of lipid content of Hilsa in three different seasons (7.92 ± 0.49 , 12.65 ± 1.11 , and 20.99 ± 2.15 in summer, rainy, and winter season respectively) and three different river channels (12.94 ± 4.99 , 14.09 ± 5.51 , 14.53 ± 6.91 in Kirtonkhola, Payra, and Rabnabad river respectively) differ significantly ($p = 0.000$, and $p = 0.005$) and the interaction between the season and the river channels in determining the crude lipid content of Hilsa fish was significant ($p = 0.002$) (Table 2).

Protein:

The crude protein content of the Hilsa fish ranged between 19.12 ± 0.19 (Kirtonkhola river) to 20.13 ± 0.35 (Payra river) in summer, 17.59 ± 0.71 (Kirtonkhola river) to 18.17 ± 0.28 (Payra river) in rainy, and 14.61 ± 0.75 (Rabnabad) to 17.46 ± 0.59 (Payra river) in winter season (Table 1). There were significant ($p = 0.000$ and $p = 0.000$) differences in the mean values of crude protein content among the seasons (19.50 ± 0.54 , 17.83 ± 0.49 , and 15.92 ± 1.34 in summer, rainy, and winter season), locations of river channels (17.47 ± 1.54 , 18.59 ± 1.25 , and 17.20 ± 2.10 in Kirtonkhola, Payra, and Rabnabad river respectively) and the interaction between the seasons and the river channels in determining the crude protein content of Hilsa fish was significant ($p = 0.004$) (Table 2).

Table 3. Correlation matrix of proximate composition of Hilsa shad

	Moisture	Ash	Lipid	Protein
Moisture	1			
Ash	-0.845*	1		
Lipid	-0.947*	0.932*	1	
Protein	0.809*	-0.835*	-0.859*	1

*Correlation is significant at 1% level of significance (2-tailed)

DISCUSSION:

During the harvesting seasons, there are significant variations in the proximate composition of fish species. This could be the result of physiological factors and environmental changes, including as spawning, migration, starvation, or heavy feeding (Boran and Karacam, 2011).

In the experiment, moisture content of Hilsa shad was highest in summer season (67.62 to 70.26%) in all the river channels, followed by rainy season (63.41 to 65.51%), and lowest in winter season (55.63 to 60.05%) of all the river channels. The moisture content of Hilsa shad ranged between 66.94 to 72.04% (Begum et al., 2016). Hilsa shad's moisture content showed an inverse relationship with its ash and lipid contents, which Ahmed and Sheikh (2017) supported. Fish muscle retains a high moisture content during the spawning season while having a low lipid content, according to Pradhan et al. (2015).

The ash content of Hilsa shad was highest in winter season (2.12 to 2.19%) in all the river channels, followed by rainy season (2.09 to 2.15%) and lowest in summer season (1.19 to 1.37%) of all the river channels. According to Begum et al. (2016) The ash content of the Hilsa shad ranged between 3.08 to 4.84%. Even though the ash cycle and the feeding or spawning activities of *C. mrigala* were not directly related, Jafri (1968) noted that a slight rise in ash concentration was seen in the winter. This might be as a result of the fish having less food available to them throughout the winter, which decreased their muscle mass and led to a little rise in ash content. When growth is depended on utilizing food reserves in the eggs, fat, and nitrogen are used up during the spawning and pre-spawning period, ash remains relatively constant (Tzikas et al., 2005).

Lipid content of Hilsa shad was highest in winter season (18.93 to 23.39%) in all the river channels, followed by rainy season (12.17 to 13.51%) and lowest in summer season (7.72 to 8.12%) of all the river channels. The lipid content of the Hilsa shad ranged between 4.97 to

8.21% ((Begum et al., 2016). The correlation matrix indicates the negative correlation between lipid and moisture, lipid and protein content (Table 3) which was supported by Pradhan et al. (2015). Phytoplankton (microalgae) is principal source of $\omega 3$ and $\omega 6$ PUFA as well as the $\omega 3/\omega 6$ and DHA/EPA proportions are high in diatoms (Hasan et. al., 2015). The green algae and diatoms were the major phytoplanktonic food for hilsa fish in the MRE food web as well as major source for PUFAs as higher percentage of green algae and diatoms were found in the hilsa fish gut (Shaha D.C. et. al., 2022). Higher levels of lipids and fatty acids in fish muscle, primarily DHA, are due to the high levels of lipids and DHA in the feed in winter season rather than other seasons.(Shaha D.C. et. al., 2022).

Protein content of Hilsa shad was highest in summer season (19.12 to 19.25%) in all the river channels, followed by rainy season (17.59 to 18.17%) and lowest in winter season (14.61 to 17.46%) of all the river channels. The protein content of the Hilsa shad ranged between 18.95 to 20.56% (Begum et al., 2016). Protein content of Hilsa shad was higher in riverine catches whereas fat and mineral value was higher in marine catches (Debnath et al., 2018). Peak abundance of green algae occurred in nitrogen and phosphorus-rich environment during the wet season (Shaha D.C. et. al., 2022. Hilsa is omnivorous and mainly eats phytoplankton(Mackay et. al., 1969). The diatoms were dominant during the dry season that severely depleted dissolved silica (Shaha D.C. et. al., 2022). Thus, phytoplankton diversity showed the potential link to seasonal changes of hydro-chemical parameters and phytoplankton development that was invariably initiated by the decrease of river discharge in the dry season (Shaha D.C. et. al., 2022).

CONCLUSION:

The study demonstrated the seasonal variation of proximate composition of Hilsa shad of different harvesting sites. Several environmental parameters cause variation in proximate composition content of Hilsa shad regardless of which it's a good source of lipid, protein, and minerals. Moisture and Protein content were highest in summer but lipid and ash content were rich in winter. Further study is needed to find out the cause of difference in amino acids and fatty acid levels and also for minerals to disclose the debate about taste of Hilsa shad in case of spatio temporal variation.

CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest

AUTHORS CONTRIBUTION:

All the authors contribute to the concept of the study, design of the study, sample collection and preparation, laboratory analysis, data analysis, prepare and approve the final manuscripts.

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