IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 15, Issue 1 Ser. I (January 2021), PP 34-41
www.iosrjournals.org

Seasonal Nutritional Variability of Green Mussel (*Pernaviridis*) at Maheshkhali Estuary, Cox's Bazar, Bangladesh.

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Abstract: *The seasonal nutritional variability of cultured green mussel (Pernaviridis)were analyzed from July 2019 to June 2020 at the Maheshkhali coastal area of Cox's Bazar, Bangladesh. The present study revealed that the nutritional status was varied from season to season due to its dynamic characteristics of hydrological parameters. The highest protein (13.72%), Fat (5.44%), Carbohydrate (4.82%), Ash (2.46%), Calcium (227.36mg/100g), Magnesium (778.52mg/100g) and Iron (12.32mg/100g) were found during post monsoon season whether Moisture (74.89%) and Phosphorous (560.00mg/100g) were during monsoon period. On the other hand most of the nutritional values were found lower at monsoon season except moisture and phosphorous which is related to high or low of food abundance with phytoplankton availability. Total protein content did not show significant variations and ranged 13.30% to 13.72% in dry mussel for Pernaviridis. Five minerals were detected and among that calcium were found to be high during pre-monsoon period. The investigation showed that marine bivalve Pernaviridis is a valuable food source for human consumptions as well as for poultry and fish feed. We conclude that culture of green mussel Pernaviridis at Maheshkhali estuary exhibit a natural biological performance and emphasizing their suitability as estuarine aquaculture candidates.*

Keywords: *Green Mussel, Pernaviridis, Nutritional Status, Seasonal Variation, Minerals*

Date of Submission: 07-01-2021 Date of Acceptance: 23-01-2021

I. Background:

Green mussel (*Pernaviridis*) are commercially valuable species and easy to cultivate in coastal area of Cox's Bazar, Bangladesh. The knowledge on nutritional status of any edible organisms is enormously important due to the nutritive value is reflected to the biochemical composition. Green mussels are both ecologically and economically important throughout their ranges and have long constituted an important source of human food [1-5].The green and brown mussels are distributed in tropical, subtropical, warm and cold temperate regions, mostly from the southern hemisphere, but also from northern Africa and the northern coasts of South America [6, 7]. Green mussel contains approximately 20 to 28% calories from fat [8]. The green mussel *Pernaviridis* [9] is used by the fisherman communities themselves for the food and bait. Consumption of green mussel provides an inexpensive source of protein with a high biological value, essential minerals and vitamins. Additionally, the green mussel muscle contains little saturated fat and significant amount of vitamin c and a good source of minerals such as calcium, potassium, zinc, iron, phosphorous and copper. Green mussels are important for marine ecology and human diet as well as for poultry and fish feed, since it is an important source of nutrients. Shellfish should be considered a low-fat, high protein food that can be included in a low fat diet [10].

Biochemical changes in the mussel from different sites and growth conditions may result from fluctuations of environmental parameters such as temperature, salinity and oxygen levels and to the physiological status of the animals, depending on food availability, gametogenic cycle and spawning [11]. Filter-feeding shellfish species such as green mussels are suitable candidates for extensive cultivation, as they do not require supplemental feeding [12-13]. Moreover, they can even improve water quality as essential bio-extractive organisms [14-15]. Green mussels, furthermore, represent high-value products. Compared to other shellfish species, they yield high prices on the market [16-17] and are therefore ideal candidates for cost-intensive offshore aquaculture. Several studies were carried out on seasonal changes of the biochemical composition of green mussels[18-25].

In general, shellfish is a highly nutritious foodstuff, since it contains appreciable quantities of digestible proteins, essential amino acids, bioactive peptides, long-chain polyunsaturated fatty acids, astaxanthin and other carotenoids, vitamin B12 and other vitamins, minerals including copper, zinc, inorganic phosphate, sodium, potassium, selenium, iodine and also other nutrients, which offer a variety of health benefits to consumers [26-27]. Different studies indicated the influence of environmental and nutritional conditions on the composition of bivalves [28]. The experiments on mussel culture were carried out by Central Marine Fisheries Research

Institute, Cochin at various coastal places in India and they were successful [29-30].Perusal of literature showed that much work has been conducted on biochemical composition of various bivalve species [31-32]. Due to lack of detail information about nutritional status of ***Pernaviridis*** from Cox's Bazar coastal area the present study was undertaken.

Materials and Methods: **Sample collection:**

The sample (cultured) were collected during the season of monsoon (July-20219), Post-monsoon (December-2019) and pre-monsoon (May-2020) from the intertidal muddy shore of Maheshkhali estuary, Cox's Bazar which is predominately influenced by riverine water from Matamuhuri and Bakkhali river.

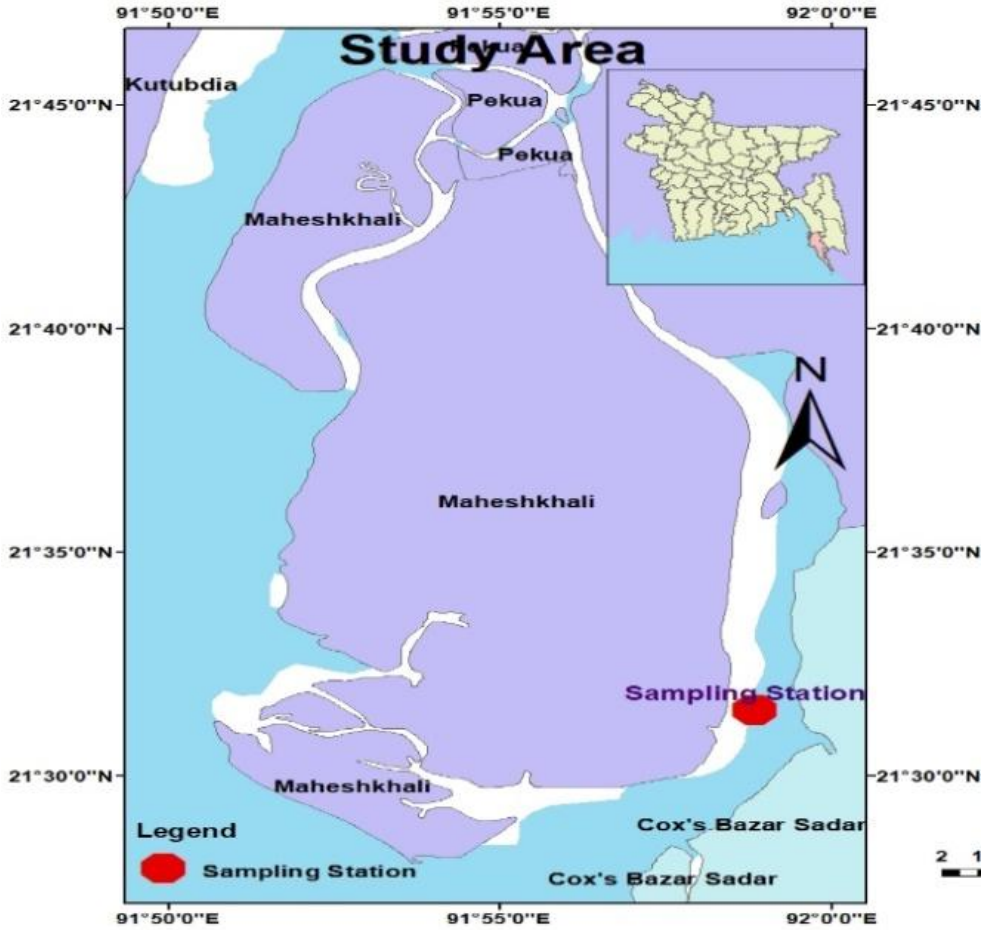

Figure: Study area

Cultured green mussels were stripped from the rope. All samples after cleaning of fouling organism were immediately transported to the laboratory in an ice box. The samples of *P. viridis*were measured for their biometrical parameters-namely, length, width and thickness. The entire amount of pooled edible portion was thereafter ground in a mincer and packed in insulated containers at -20°C before being used for biochemical analysis with respect to protein, fat, carbohydrate, vitamin and mineral composition.

Proximate composition

Moisture was determined by oven drying at 105°c to constant weight (AOAC, 1990) [33]. Dried samples were used for determination of crude fat, crude protein and ash contents. All analysis was done in triplicate. The crude protein was determined by Kjeldhal method (AOAC, 1990) [33]. Crude fat was extracted from the dried tissues using Bligh and Dyer (Bligh and Dyer, 1959) [34] method. The fat content was gravimetrically determined. Ash was determined gravimetrically in a muffle furnace by heating at 550°c constantans weight (AOAC, 1990) [33]. The estimation of minerals was carried out by atomic absorption spectrophotometer (AAS) following the di-acid ($HNO_3/HClO_4$) digestion method with suitable modification [35].

Statistical analysis:
Statistical evaluation was carried out with the statistical program for social sciences 16.0 (SPSS Inc. Chicago, USA, Ver.16.0) and Microsoft Excel 2010.

Seasonal Consideration
Monsoon : June, July, August, September
Post-monsoon : October, November, December, January
Pre-monsoon : February, March, April, May

II. Results:

Seasonal variations in proximate biochemical composition during the period of study in the raft grown green mussel *P. viridis* are shown in table 1.

Table 1: Proximate composition of *Pernaviridis*

parameters	Season			Mean	STD	Mean±STD
	monsoon	post monsoon	pre monsoon			
Ash (%)	2.10	2.25	2.46	2.27	0.18	2.27±0.18
Carbohydrate (%)	4.46	4.75	4.82	4.68	0.19	4.68±0.19
Moisture (%)	74.89	74.15	74.54	74.53	0.37	74.53±0.37
Protein (%)	13.30	13.52	13.72	13.51	0.21	13.51±0.21
Fat (%)	5.25	5.33	5.44	5.34	0.10	5.34±0.10
Iron (mg/100g)	5.81	11.90	12.32	10.01	3.64	10.01±3.64
Calcium (mg/100g)	85.00	205.59	227.36	172.65	76.68	172.65±76.68
Zinc (mg/100g)	2.90	6.23	7.12	5.42	2.22	5.42±2.22
Magnesium (mg/100g)	656.39	702.39	778.52	712.43	61.68	712.43±61.68
Phosphorus (mg/100g)	560.00	317.54	286.44	387.99	149.77	387.99±149.77

Protein: The protein content of *P.viridis* was 13.51±0.21 (Table1). The highest value (13.72%) was found during the pre monsoon season and lower value (13.30%) at monsoon period. An increase in protein from february to may was observed to coincide with maturation of gonad. From june onwards the protein level decreased, indicating that much of the energy contributed by protein was used for maturation and spawning.

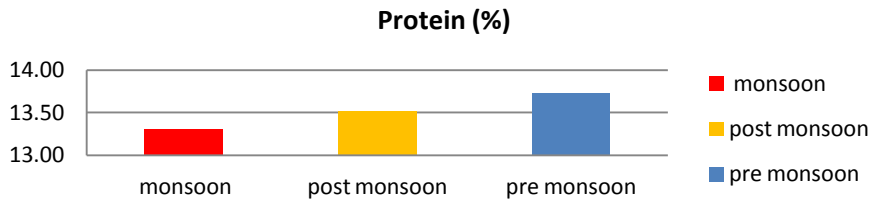

Figure 2: Seasonal protein value of *P.viridis*

Carbohydrate: The carbohydrate content of *P.viridis* was 4.68±0.19 (Table1). The highest value (4.82%) was found during the pre monsoon season and lower value (4.46%) at monsoon period. During pre-monsoon period, just prior to peak spawning period, high carbohydrate content was observed which coincided with higher protein content. However, during spawning period, the carbohydrate content values were low. In general, carbohydrate values observed were higher in immatre mussel which declined in mature mussels.

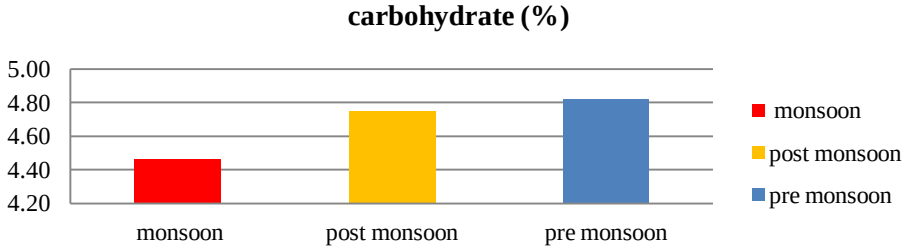

Figure 3: Seasonal carbohydrate value of *P.viridis*

Fat: The fat content of *P.viridis* was 5.34±0.10 (Table1). The highest value (5.44%) was found during the pre monsoon season and lower value (5.25%) at monsoon period. The study showed that during maturation the lipid content was low as compared to early stages of life with an average value of 5.34%. The lipid content was reported to be comparatively high during prespawning period. Soonafter spawning the lipid content declined.

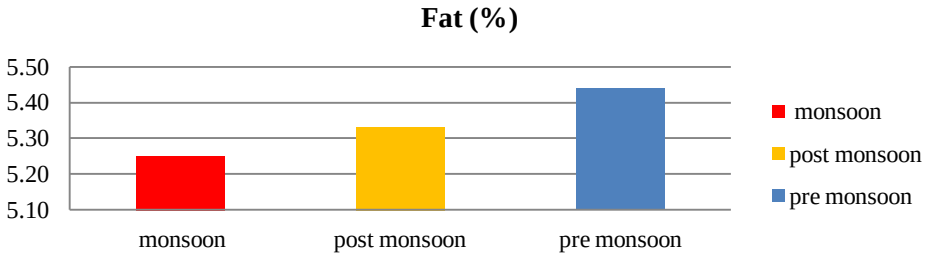

Figure 4: Seasonal fat value of *P.viridis*

Ash: The ash content of *P.viridis* was 2.27±0.18 (Table1). The highest value (2.46%) was found during the pre monsoon season and lower value (2.10%) at monsoon period. During the early stages of growth, the ash content showed higher values which declined sharply registering a values in november. Lower values of the ash content during monsoon period were found to coincide with low values of lipids and proteins, whereas higher values of ash content coincided with higher values of carbohydrates during the early stages of growth.

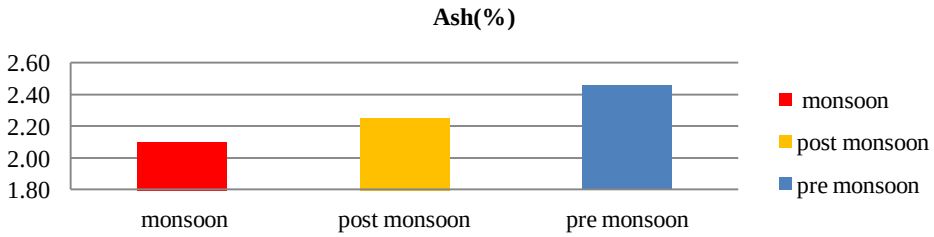

Figure 5: Seasonal ash value of *P.viridis*

Moisture: The moisture content of *P.viridis* was 74.53±0.37 (Table1). The highest value (74.89%) was found during the monsoon season and lower value (74.15%) at post monsoon period.

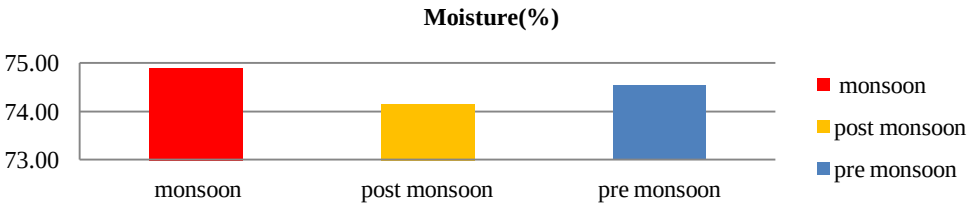

Figure 6: Seasonal moisture value of *P.viridis*

Calcium: The calcium content of *P.viridis* was 172.65±76.68 (Table1). The highest value (227.36mg/100g) was found during the pre monsoon season and lower value (85.00 mg/100g at monsoon period.

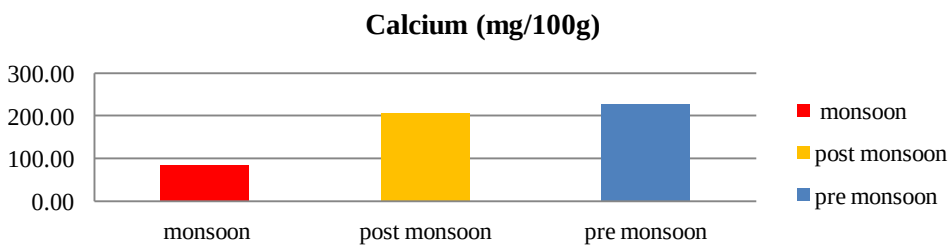

Figure 7: Seasonal calcium value of *P.viridis*

Magnesium: The magnesium content of *P.viridis* was 712.43±61.68 (Table1). The highest value (778.52mg/100g) was found during the pre monsoon season and lower value (656.39 mg/100g at monsoon period.

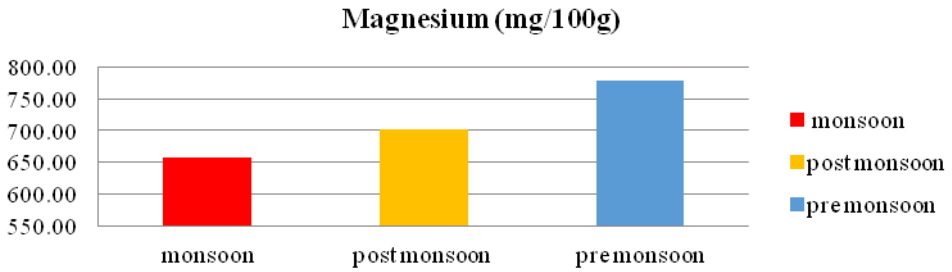

Figure 8: Seasonal magnesium value of *P.viridis*

Iron: The iron content of *P.viridis* was 10.01±3.64 (Table1). The highest value (12.32mg/100g) was found during the pre monsoon season and lower value (5.81mg/100g)at monsoon period.

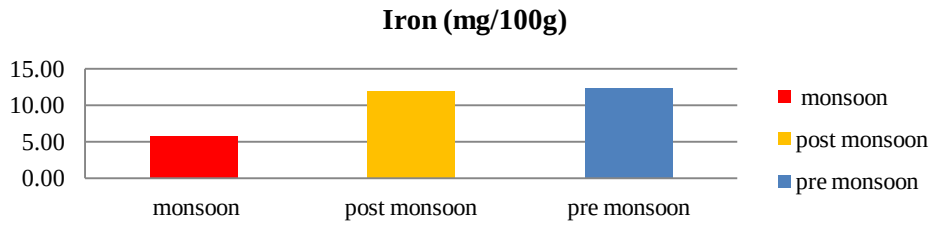

Figure 9: Seasonal Iron value of *P.viridis*

Zinc: The iron content of *P.viridis* was 5.42±2.22 (Table1). The highest value (7.12mg/100g) was found during the pre monsoon season and lower value (2.90 mg/100g)at monsoon period.

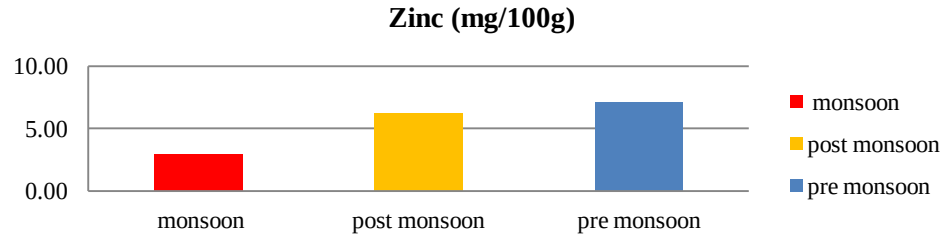

Figure 10: Seasonal Zinc value of *P.viridis*

Phosphorous: The phosphorous content of *P.viridis* was 387.99±149.77 (Table1). The highest value (560.00 mg/100g) was found during the monsoon season and lower value (286.44 mg/100g)at pre monsoon period.

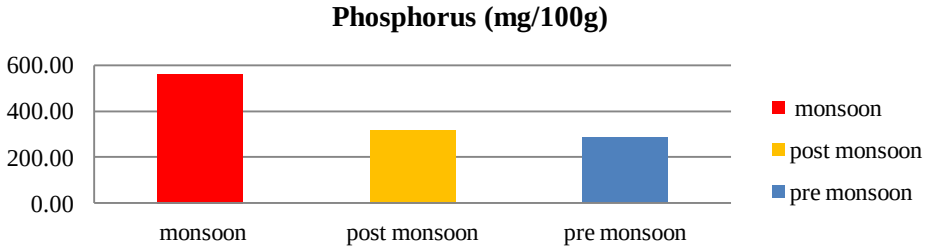

Figure 1: Seasonal phosphorous value of P.viridis

Table 2: Seasonal hydrological parameters of the Maheshkhali Estuary (July 2019-June 2020)

Station: Maheshkhali													
SI	Name of the parameter	July	August	September	October	November	December	January	February	March	April	May	June
1	Water Temperature	28.90	29.50	27.21	29.10	26.60	27.30	26.30	27.90	28.10	33.80	33.10	30.30
2	Water P^H	7.56	7.60	7.76	7.74	7.85	7.64	7.89	7.91	7.95	7.97	8.09	7.84
3	Salinity	7.40	11.62	9.00	5.70	18.60	24.90	25.50	27.90	28.10	29.10	30.10	24.80
4	Conductivity	8.62	19.61	12.53	24.48	26.51	40.98	41.38	42.54	43.38	53.00	49.30	38.44
5	TDS	5.21	10.84	8.77	13.57	16.70	25.48	24.67	26.73	28.42	29.50	27.67	22.67
6	Transparency	1.11	1.22	1.29	2.02	2.13	2.12	2.15	2.16	2.22	2.23	2.20	1.25

III. Discussion:

The present study provided a detailed seasonal nutritional status profile of the green mussel ***Pernaviridis*** collected from the cultured condition of the Maheshkhali estuary, Cox's Bazar. The data provide useful information for food industries and green mussel fishery.The meat content of green mussels was registered to be affected by a variety of environmental and endogenous factors-viz., water temperature, salinity, food availability and gametogenic cycle of animals [36]. Bivalve molluscs were reported to provide an inexpensive source of lipid and protein with high biological value [35]. ***Pernaviridis*** from both seasons were found to be rich in proteins with a low fat content; they may therefore form an essential part of a healthy diet. It is generally accepted that water temperature and differences in salinities are principal environmental factors affecting growth and gonadal development of marine bivalves [37], which is major reason for the differences in lipid and minerals content. Available literature on the biochemical composition of green mussel from tropical waters [38-45]suggest that information on biochemical composition is essential as it reflects directly on the nutritive value, thereby enabling to establish an ideal time of harvest. Further, it reveals that the changes in biochemical constituents depend on the phases of reproductive cycle.In coastal waters of Cox's Bazar, the growth of raft-grown green mussel ***Pernaviridis***L. was very rapid due to the abundance of food material and ideal environmental conditions and the mussels adapt biochemically to wide ranging external conditions and also respond appropriately to rapid and irregular variations in these conditions.

Minerals are nutrients that are conserved by the body and play a significant role in metabolism in the human body. The present investigation shown that Ca and Mg were higher than those reported in the literature for bivalve molluscs [46]. Zn was found to be the second most abundant trace element in *Pernaviridis* and its role in the pathophysiology of disease is stimulating a great deal of interest[47]. The marginal variability in fatty acid composition is due to the fact that the lipid levels and composition of marine bivalves depend on the biochemical and environmental conditions of seed development including the phytoplankton resources available[48].It is understandable that nutritional status are influenced by spatial variation apparently due to differential microalgal diversity and primary flora in the coastal food web and this might be the reason for getting the minor seasonal variations.

IV. Conclusion:

The green mussel ***Pernaviridis*** has been found to be a rich source of protein. It also contains carbohydrates, lipid, Minerals and Vitamins.In conclusion, the present investigation provides insights in different seasonal biochemical composition of ***Pernaviridis*** collected from the cultured farm of the Maheshkhali estuary, Cox's Bazar. No significant differences in different seasonal nutritional status and biochemical parameters under observation were apparent from season to season. The minor differences in biochemical indicators could be attributed to the differential feeding patterns of ***Pernaviridis*** grown under cultured conditions.In summary, no statistically significant inter-seasonal differences in basic chemical parameters and fat quality indices except minerals as descriptive of an edible part of the green mussels were determined. Finally we can conclude that culture of green mussel ***Pernaviridis*** at Maheshkhali estuary exhibit a natural biological performance and emphasizing their suitability as estuarine aquaculture candidates.

Acknowledgements

The authors thank the Director General of the Bangladesh Oceanographic research Institute for his guidance and support. Thanks are due to the BCSIR, Dhaka for facilitating the research activities.

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Md. Tarikul Islam, et. al. "Seasonal Nutritional Variability of Green Mussel (Pernaviridis) at Maheshkhali Estuary, Cox's Bazar, Bangladesh." *IOSR Journal of Environmental Science, Toxicology and Food Technology* (IOSR-JESTFT), 15(1), (2021): pp 34-41.