Chapter 5

Chemical Oceanography Division

Adaptive responses to ocean warming and acidification of different marine invertebrates inhabit in the South east coastal area of Cox's Bazar, Bangladesh

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Abstract

Ocean acidification, a complex phenomenon that lowers seawater pH, is the net outcome of several contributions. A study pertaining to the seasonal variation in physico-chemical properties and its impacts on marine invertebrates inhabit at the south east coastal waters of Cox's Bazar, Bangladesh for a period of January 2018 to June 2018. It shown that the coastal water was significantly influenced by the freshwater discharged from Naf River and other sources from upstream to the coastal area. Total five sampling stations namely saint Martin Island (S1), Naf River (S2), Teknaf (S3), Inani (S4) and Rezukhal estuary (S5) were considered for taking the desirable parameters reading. The physic-chemical parameters like Dissolved oxygen, Salinity, Temperature, Conductivity, Total dissolved solids, Transparency were determined by using Hanna HI98194, Refract meter, YSI Pro30 multimeter, Hach HQ11d, Winklers Titration method, Secchi disk respectively. There were implementing two types of experiment 1) Insitu experiment and 2) Exsitu experiment to assess the adaptive responses of different marine invertebrates inhabit on ocean acidification and their potential detrimental effects to marine environment as well as ecosystem processes and services. The foreseen danger to marine invertebrates by acidification is in fact expected to be amplified by several concurrent and interacting phenomena. In addition, a robust ocean acidification monitoring program over time will provide necessary information to scientists and resource managers on the status and trends in ocean parameters related to OA, and thus aid decisions in light of ocean change.

Keywords: Ocean Acidification, Invertebrates, Adaptability, Parameter, Ecosystem

A study on seasonal variation in physico-chemical properties and its impacts on coral associated biodiversity at the south eastern coastal waters of Cox's Bazar, Bangladesh

Abstract

The present investigation carried out to assess the seasonal variation in physico-chemical properties and its impacts on coral associated biodiversity at the coastal waters of Saint Martin Island, Bangladesh for a period of July 2018 to June 2019. It shown that the coastal water was significantly influenced by the freshwater discharged from Naf River and through heavy precipitation during the monsoon period. Total nine sampling stations namely Saint Martin Island (S1), Shahporir Dwip (S2), Teknaf (S3), Inani (S4), Rezukhal (S5), Himsori (S6), Bakkhali (S7), Moheshkhali (S8) & Sonadia (S9) were considered for taking the desirable parameters reading. The parameters like Dissolved oxygen, Salinity, Temperature, Conductivity, Total dissolved solids, Transparency were determined by using Hanna HI98194, Refract meter, YSI Pro30 multimeter, Hach HQ11d, Winklers Titration method, Secchi disk respectively. Salinity and water pH showed very strong changes between 14 psu to 34 psu and 7.78 to 8.28 due to heavy precipitation and freshwater discharges into the stations from the Naf River. Water pH, Total dissolved solids and Electrical conductivity displayed strong correlation with salinity changes. The physico-chemical parameters such as temperature, Salinity, pH, TDS, Water Transparency and EC were increased during Pre-Monsoon season and decreased during monsoon season. In contrast, only temperature was decreased during winter & monsoon season. The physico-chemical properties have exposed reasonable seasonal and spatial variations. Saint Martin is the only coral Island of Bangladesh and generally we referred it as a biological paradise. Due to the change of physico-chemical properties seasonally, its strongly influenced on the coral associated biodiversity. This study revealed that coral bleaching has been occurred frequently during the monsoon and post monsoon period. About 15% boulder coral were partly bleached. But it is a hope that most of the bleached coral were regenerate easily with the change of physico-chemical properties during the winter and pre-monsoon season. Physico-chemical properties have strong influence on Saint Martin seaweed vegetation. During the study period the author shown that from May to December about 95% seaweed was totally absence and January to April were heavily vegetated. On the other hand due to ocean acidification and surface water warming some of the invertebrate species were migrated from the coastal area to another place and some inhabitants face great problem.

Keywords: Physico-chemical parameters, Coastal waters, Seasonal variation, spatial variation, Cox's Bazar

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At a Glance

Chemical oceanography encompasses the study of the chemical components of the oceans, their reactions, and their pathways of transformation. We study both organic and inorganic compounds, particulate and dissolved material, and the ocean sediments. The pathways that compounds follow affect the global cycling of elements such as carbon and nitrogen, and are often intimately related to biological activity. We undertake our research in environments such as mangroves and saline lakes, salt marshes, and deep ocean sediments. We combine field observations, laboratory experiments, and computer models to understand factors affecting chemical compositions and how they vary in time and space.

Chemical oceanography is the study of ocean chemistry and the behavior of the chemical elements within the Earth's oceans. It is a broad and complex study of the metamorphosis that the chemicals within oceans, living marine organisms, and the ocean floor undergo. The ocean contains a multitude of chemicals; some are natural, and others are man-made. These chemicals enter the sea in a number of ways. The ocean is unique in that it contains-in greater or lesser quantities-nearly every element in the periodic table. Rivers and streams bring freshwater into the ocean along the coast line. Freshwater brings the chemicals which have been dissolved into it from natural weathering and human activities. Examples of this would be the weathering of rocks or soils, industrial sources like agriculture, power plants, or manufacturing facilities, and pollution from nearby towns and cities. Chemicals can also enter the oceans through the atmosphere by dissolving or dissipating. Substances like aerosols and pesticides can enter this way. Other ways chemicals can enter the ocean are through ocean exploration, the shipping industry, and the harvesting of oil. Many chemicals introduced to the ocean can be harmful to the ecosystems within it.

Coral Biodiversity: A Mysterious Life beneath the Blue Water Body of Saint Martin Island, Bangladesh

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Abstract

The study carried out to assess the present status of coral biodiversity and water quality of Saint Martin Island for a period of February, 2018 to January, 2021, the only coral bearing island of Bangladesh in the Bay of Bengal which are generally referred as a biological paradise. The coral protect coastlines from storms and erosion, provide jobs for local communities, and offer opportunities for recreation and serve as a fish spawning, breeding and nursery ground and also a source of food and new medicines. Corals sampling were conducted at different locations around the Island by using the Video Transects method through snorkeling, scuba diving with proper underwater video camera. The video footage was analyzed back in the laboratory. This method provides a permanent visual record of the reef community, and reduces time required in the field and helps to monitor-percentage covers of organism groups, proportion of cover bleached and severity of bleaching, recovery rates, and nature of shifts in species composition, percentage of live coral, dominant coral, amount of coral bleached, presence/absence of bleaching at one or multiple sites, type, abundance and density of individual organisms. A total 74 species of 35 genera under 15 families of hard corals and 12 species of 7 genera and 6 families of soft corals image were collected & identified from the Saint Martin's Island. Among the hard corals Porites, Favites, Goniopora, Cyphastrea & Gonlastrea were the most abundant and among the soft corals Gorgonian sea fans, Small sea fans, Sea whips were mostly dominant. Seasonal change of physico-chemical parameters (salinity, P^H, turbidity, TSS, transparency, temperature) has strong influenced on the coral associated biodiversity. This study revealed that coral bleaching has been occurred frequently during monsoon period. About 15% boulder coral were partly bleached. But it is hope that most of the bleached coral were regenerate easily with the change of physico-chemical properties during the winter and pre-monsoon season every year. On the other hand, due to ocean acidification and global warming some of the temperature and P^H sensitive species were migrated from the coastal area to another place and some inhabitant face great problem.

Key Words: Coral, Seaweed, Physico-chemical Parameters, Snorkeling, Scuba diving.

Coral of Saint Martin's Island

Seaweed of Saint Martin's Island

Seasonal Nutritional Variability of Green Mussel (Perna viridis) at Maheshkhali Estuary, Cox's Bazar, Bangladesh

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Abstract

The seasonal nutritional variability of cultured green mussel Perna viridis 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 Perna viridis. Five minerals were detected and among that calcium were found to be high during pre-monsoon period. The investigation showed that marine bivalve Perna viridis is a valuable food source for human consumptions as well as for poultry and fish feed. We conclude that culture of green mussel Perna viridis at Maheshkhali estuary exhibit a natural biological performance and emphasizing their suitability as estuarine aquaculture candidates.

Key words: Green Mussel, Perna viridis, Nutritional Status, Seasonal Variation, Minerals

Introduction

Green mussel (Perna viridis) 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 Perna viridis [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 Perna viridis from Cox's Bazar coastal area the present study was undertaken.

Materials and Method

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.

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

Figure: Study area

(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

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 Perna viridis

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.

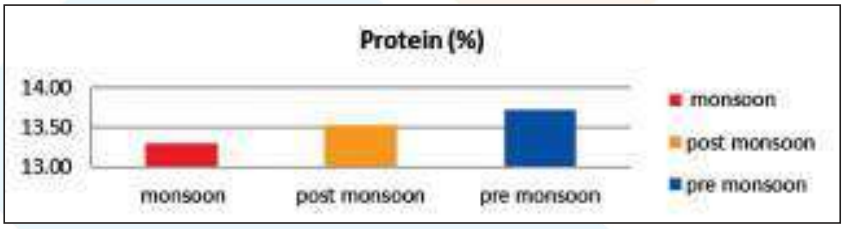

Figure 2: Seasonal protein value of P.viridis

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.

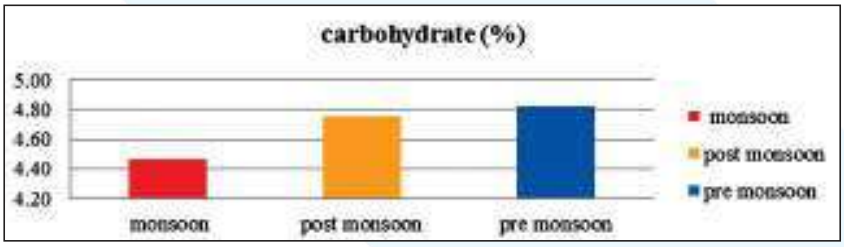

Figure 3: Seasonal carbohydrate value of P.viridis

Fat: The fat content of P.viridis was 5.34±0.10 (Table 1). 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.

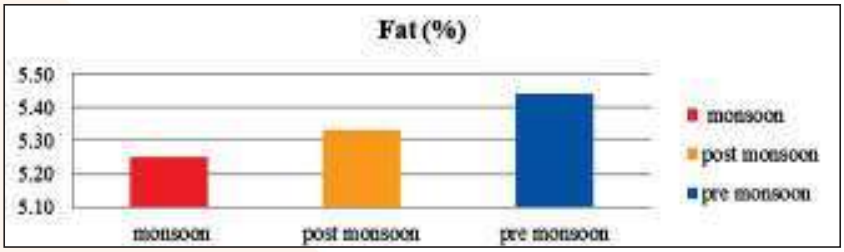

Figure 4: Seasonal fat value of P.viridis

Ash: The ash content of P.viridis was 2.27±0.18 (Table 1). 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.

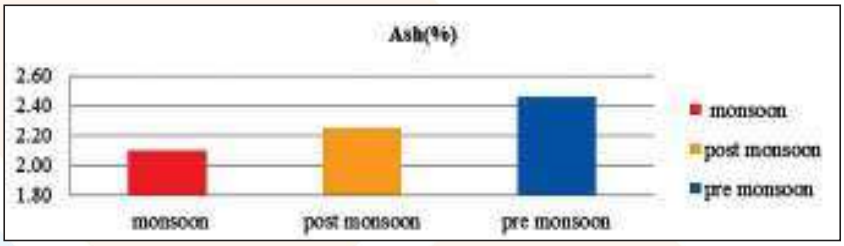

Figure 5: Seasonal ash value of P.viridis

Moisture: The moisture content of P.viridis was 74.53±0.37 (Table 1). The highest value (74.89%) was found during the monsoon season and lower value (74.15%) at post monsoon period.

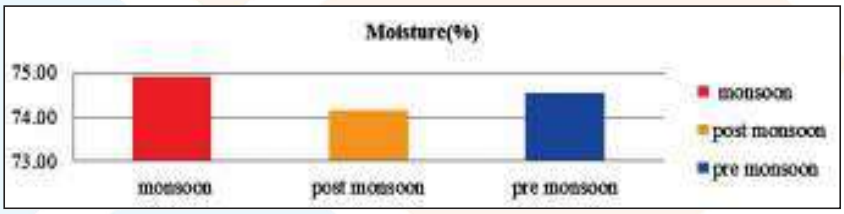

Figure 6: Seasonal moisture value of P.viridis

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.

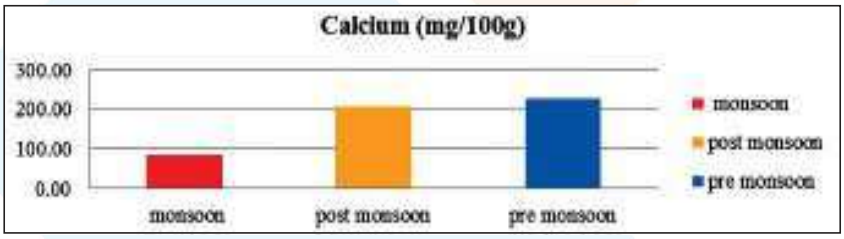

Figure 7: Seasonal calcium value of P.viridis

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.

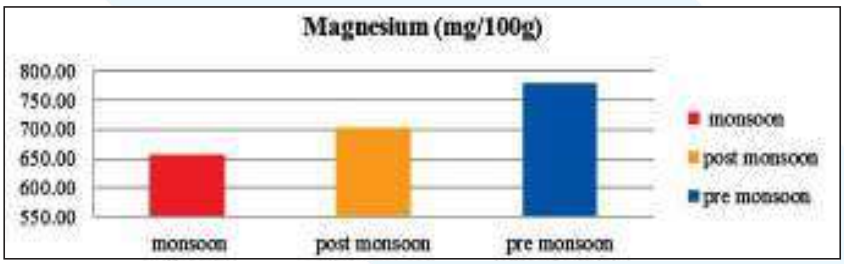

Figure 8: Seasonal magnesium value of P.viridis

Iron: The iron content of P.viridis was 10.01±3.64 (Table 1). The highest value (12.32mg/100g) was found during the pre monsoon season and lower value (5.81mg/100g) at monsoon period.

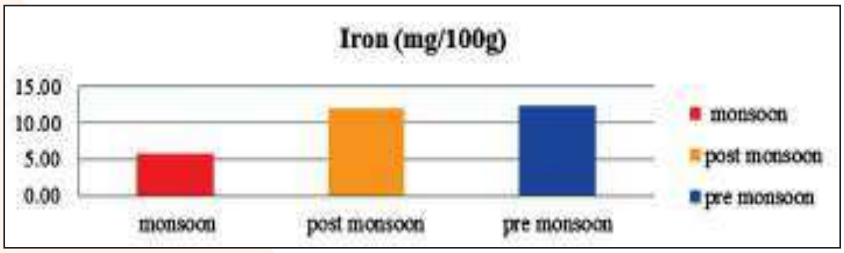

Figure 9: Seasonal Iron value of P.viridis

Zinc: The iron content of P.viridis was 5.42±2.22 (Table 1). The highest value (7.12mg/100g) was found during the pre monsoon season and lower value (2.90 mg/100g) at monsoon period.

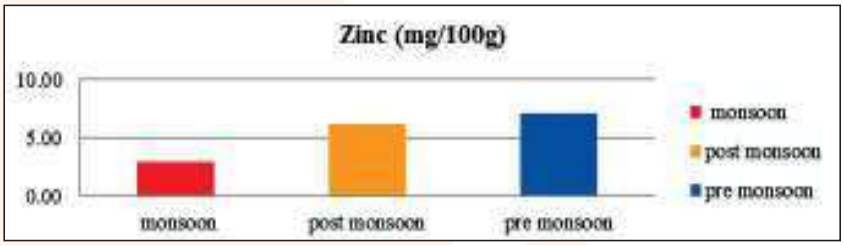

Figure 10: Seasonal Zinc value of P.viridis

Phosphorous: The phosphorous content of P.viridis was 387.99±149.77 (Table 1). The highest value (560.00 mg/100g) was found during the monsoon season and lower value (286.44 mg/100g) at pre monsoon period.

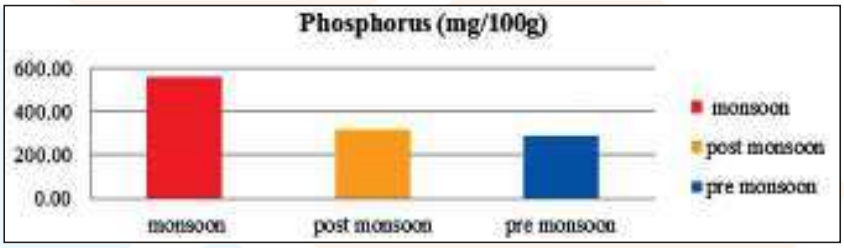

Figure 11: Seasonal phosphorous value of P.viridis

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

Discussion

The present study provided a detailed seasonal nutritional status profile of the green mussel Perna viridis 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]. Perna viridis 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 Perna viridis 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 Perna viridis 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.

Conclusion

The green mussel Perna viridis 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 Perna viridis 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 Perna viridis grown under cultured conditions. In summary, no statistically significant inter-seasonal differences in basic chemical parameters and fat quality indices descriptive of an edible part of the green mussels were determined. Finally we can conclude that culture of green mussel Perna viridis at Maheshkhali estuary exhibit a natural biological performance and emphasizing their suitability as estuarine aquaculture candidates.

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