



SEASONAL VARIATION IN BIOCHEMICAL COMPOSITION OF GREEN MUSSEL
(*Perna viridis*, LINN. 1758) FROM MOHESHKHALI CHANNEL, THE BAY OF
BENGAL, BANGLADESH

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Abstract: Seasonal variation in biochemical composition of immature (<40 mm in length) and mature (>40 mm) green mussel (*Perna viridis*) from Moheshkhali channel of the Bay of Bengal was studied for one year. Protein, carbohydrate, ash and lipid content (dry weight) of mature mussels were 52.73-70%, 11.02-33.24 %, 9.05-14.22% and 4.52-7.89% respectively. In immature mussels these values were 54.42-64.17%, 17.33-30.11%, and 9.59-11.55% and 5.88-6.95%. Variation in biochemical composition between mature and immature mussels was not significant ($p < 0.05$). However, seasonal variation in biochemical content of mature mussels was more prominent than that in immature ones. Higher values during the pre-monsoon and post-monsoon periods and lower values during the monsoon were found for both mature and immature mussels. Significant positive correlation between protein and lipid, protein and ash, lipid and ash and negative correlation between protein and carbohydrate, carbohydrate and lipid, carbohydrate and ash in both mature and immature mussels were found.

Key words: Biochemical composition, green mussel, *Perna viridis*, Moheshkhali channel, Bay of Bengal

Introduction

The green mussel, *Perna viridis*, locally known as 'chelon' or 'jhenuk', occurs around the St. Martin's Island (Ali and Aziz, 1976), Teknaf, Shahporir Dwip (Ahmed, 1990) and Moheshkhali channel of the Bay of Bengal (Kamal and Khan, 1999). In these areas mussel is being collected from the natural beds and consumed by local tribal people (Kamal *et al.*, 1996). Mussels have been favored by coastal inhabitants in Europe, South America and Australia for many centuries (Boyle, 1981). Since Daniel (1921a,b; 1922) reported biochemical composition of the green mussel, *Mytilus edulis* from the English waters, they were considered as nutritious and delicious food in many developed and developing countries. As a result, studies on biochemical composition in different mussel species have received considerable attention along with mussel culture (Slabyj *et al.*, 1978; Qasim

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et al., 1977; Davy and Graham, 1982; Kamal *et al.*, 1996). As biochemical constituents of aquatic organisms represent their physiological condition in relation to their habitat, mussels are being used in understanding fundamental physiological ecology in coastal environments (Bayne *et al.*, 1976). Mussels are also used as a cheap source of protein for shrimp larvae in commercial hatcheries in many countries (Davy and Graham, 1982).

In comparison with other mussel species, only a few studies on biochemical composition of *P. viridis* have been reported from India (Qasim *et al.*, 1977; Shafee, 1978; Wafar *et al.*, 1976; Nagabushanam and Mane, 1978), Pakistan (Fatima *et al.*, 1986) and Thailand (Rochanaburanon, 1980). A few studies on *P. viridis* have been reported by Kamal (1991), Kamal *et al.* (1996) and Kamal and Khan (1998, 1999, 2000) from the Moheshkhali channel of Bangladesh. The present work was carried out to determine seasonal variation in biochemical composition of *P. viridis* in order to provide nutritional value as human food and larval feed in commercial fish and shrimp hatcheries.

Materials and Methods

Individuals of *P. viridis* were randomly collected at monthly interval between November, 1990 and October, 1991 from piers of the Moheshkhali jetty on Moheshkhali channel at Goracghata (Fig. 1). After encrusting organisms on the outer shells mussels were cleaned off and kept over night in sea water for defecation. Mussels measuring above 40 mm were grouped as mature and below 40 mm as immature following Shafee (1978). For each group, 20-25 individuals were selected for analysis. The mussels were then cut open and wet meat (i.e. soft part) was extracted, homogenized and weighed on a single pan balance nearest to 0.1 g. The homogenate was then placed on an aluminum foil, dried in an oven at 60 °C for 12 to 24 hours and then re-weighed following Pearson (1976). Since the quantity of dry matter from an individual mussel was too small, all of the individuals in the monthly sample were pooled together and divided into

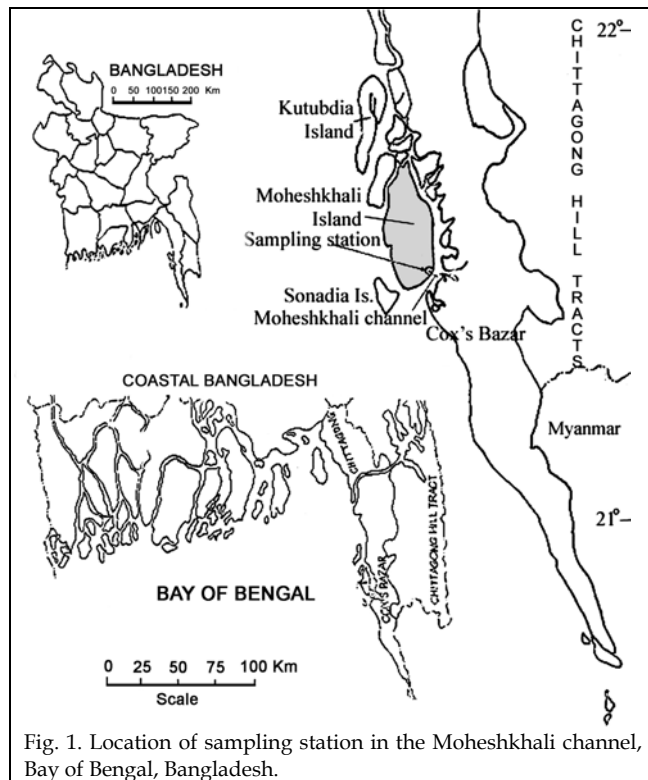


Fig. 1. Location of sampling station in the Moheshkhali channel, Bay of Bengal, Bangladesh.

3 parts as replicates. The dried flesh was ground to a fine powder and kept in dry stopper glass vial for biochemical analysis. The samples were then analyzed to determine the protein, lipid, ash and carbohydrate at the Marine Science Institute Laboratory following Pearson (1976).

Results

The mean monthly biochemical composition of mature and immature mussels in different season has been presented in Table 1. The annual average values for protein, carbohydrate, ash and lipid in mussels were estimated to be 62.1±5.18%, 15.4±7.11%, 11.09±1.29% and 6.37±0.77% respectively (Table 1). Protein was found as the main organic constituent followed by carbohydrate, ash and lipid in both the mature and immature mussels. No significant ($p>0.05$) variation in biochemical composition, except carbohydrate, was found between mature and immature mussels (Fig. 2). Therefore, seasonal variation was estimated on pooled data of mature and immature mussels only and is presented in Fig. 3. Protein and carbohydrate values in the green mussel showed significant seasonal variation ($p<0.05$). Higher protein values were estimated during pre- and post-monsoon season, when carbohydrate values were lower.

Table 1. Monthly and seasonal biochemical bio-chemical composition of mature and immature *P. viridis* between November, 1990 and October, 1991 from Moheshkhali channel, Bay of Bengal.

Season	Month	Biochemical composition (% dry weight)							
		Protein		Carbohydrate		Ash		Lipid	
		MM	IM	MM	IM	MM	IM	MM	IM
MN	M-91	56.32	60.15	29.82	22.85	9.28	11	4.58	6
	J-91	54.61	56.27	31.69	27.11	9.18	10.64	4.52	5.98
	J-91	52.73	54.42	33.24	30.11	9.05	9.59	4.98	5.88
	A-91	60.57	54.9	22.48	29.53	10.95	9.62	6	5.95
	Average	56.06	56.44	29.31	27.40	9.62	10.21	5.02	5.95
	SD	3.35	2.60	4.76	3.30	0.90	0.72	0.69	0.05
PM	S-91	70	NA	8.96	NA	13.25	NA	7.8	NA
	O-91	68.85	NA	11.02	NA	12.93	NA	7.2	NA
	N-90	NA	62.75	NA	20.9	NA	10.06	NA	6.21
	D-90	NA	62.07	NA	20.48	NA	10.59	NA	6.5
	Average	69.43	62.41	9.99	20.69	13.09	10.33	7.50	6.36
	SD	0.81	0.48	1.46	0.3	0.23	0.38	0.42	0.21
PRM	J-91	62.51	63.94	20.17	18.12	11.11	11.12	6.29	6.82
	F-91	59.4	64.17	24.49	17.33	10.11	11.55	6	6.95
	M-91	65.54	NA	15.39	NA	12.32	NA	6.75	NA
	A-91	69.23	NA	9.55	NA	14.22	NA	7	NA
	Average	64.17	64.06	17.40	17.73	11.94	11.34	6.51	6.89
	SD	4.20	0.16	6.42	0.56	1.77	0.30	0.45	0.09
Yr. Average		63.22	60.97	18.9	21.94	11.55	10.63	6.34	6.4
SD		6.30	4.06	9.21	5.02	1.86	0.71	1.13	0.42
Yr. Average for both size		62.1		15.42		11.09		6.37	
SD		5.18		7.11		1.29		0.77	

MM= Mature; IM = Immature; NA= Not available; MN= Monsoon, PM= Post monsoon, PRM= Pre-monsoon

The average highest value (65.92±4.09%) of protein was found during post-monsoon season followed by pre-monsoon (64.13±3.26%) and the lowest during monsoon (56.06±3.35%) season. In the immature mussels protein was the highest (64.06%) during pre-monsoon and the lowest (56.44±2.6%) during monsoon period. In general, the higher protein values were recorded for both the mature and immature mussels during the pre-monsoon and post-monsoon seasons and the lower values during the monsoon season. On yearly average, mature (63.22±6.3%) mussels showed comparatively higher protein values than the immature (60.97±4.06%) one. A significant difference of protein values between mature and immature mussels was found during post-monsoon season (Fig. 2).

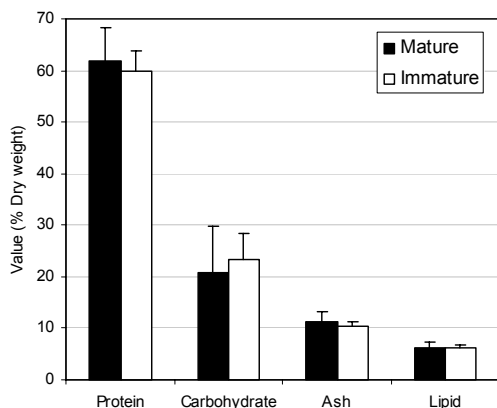


Fig. 2. Life stage (mature vs. immature) variation in biochemical composition of green mussel, *Perna viridis* from the Moheshkhali channel, Bay of Bengal.

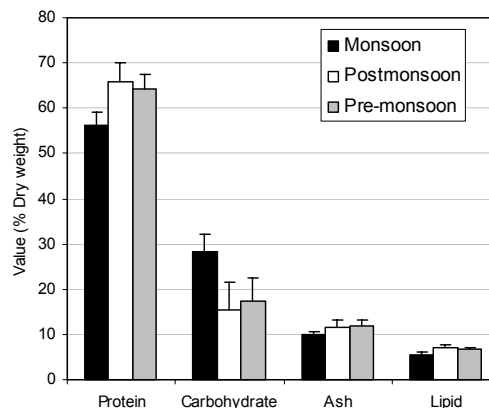


Fig. 3. Seasonal variation in biochemical composition of green mussel, *Perna viridis* from the Moheshkhali channel, Bay of Bengal.

The trend of carbohydrate values for both the mature and immature mussels was found to be higher during monsoon period (Fig. 2) than the other two seasons. For mature mussels the higher values were observed during the monsoon period (29.31±4.76%) following pre-monsoon and post-monsoon periods. On yearly average, the immature mussels contained higher values (21.94±5.02%) than the mature ones (18.9±9.21%).

The maximum and the minimum values of ash were recorded in April (14.22%) and July (9.05%) respectively in the mature mussels while for the immature, maximum and minimum ash values were found in February (11.55%) and July (9.59%) respectively. Although a higher ash content in mature and immature animal was noticed during pre-monsoon and post monsoon period than monsoon. The variation in the values of ash content by life stage (mature and immature one) and by season were statistically insignificant ($p > 0.05$).

In mature mussels, the maximum value was found in September (7.8%) and the minimum in June (4.52%) while in immature ones the maximum lipid value was recorded in February (6.95%) and the minimum in July (5.88%). The higher lipid values were observed during the pre monsoon and the post monsoon and lower values during the monsoon period for both the mature and immature mussels. On yearly average, the lipid values in mature (6.34±1.13%) and immature (6.4±0.42%) did not varied significantly ($p > 0.05$).

Correlation coefficients: Simple Pearson's correlation coefficients among the percentage of protein, carbohydrates, lipid and ash have been shown in Table 2 and Fig. 3-8. Protein

Table 2. Correlation coefficient (r) of different biochemical constituents in *P. viridis* from Moheshkhali channel, Bay of Bengal [figure given in the parenthesis are the value for "t", degree of freedom 8 for the mature and 6 for immature mussels].

Variable	Coefficients of correlations (r)	
	Mature mussels	Immature mussels
P Vs C	-0.99 (-19.85*)	-0.99 (17.19*)
P Vs L	0.95 (8.61*)	0.86 (4.13*)
P Vs A	0.97(11.29*)	0.74 (2.69**)
C Vs L	-0.96(-9.7*)	-0.88 (-4.54*)
C Vs A	-0.98 (-13.93*)	-0.81 (-3.38*)
L Vs A	0.92 (6.64*)	0.76 (2.86*)

P= protein; C= carbohydrate, L= lipid, A= ash. Level of significance: *= Significant at 1% ($p < 0.01$) level; **= Significant at 5% ($p < 0.01$) level

and lipid, protein and ash and, lipid and ash were found to be positively correlated at $p < 0.01$ and $p < 0.05$ level of significance for both the mature and immature mussels. Significant inverse correlation was found between protein and carbohydrate, carbohydrate and ash for both the mature and immature animals at $p < 0.01$.

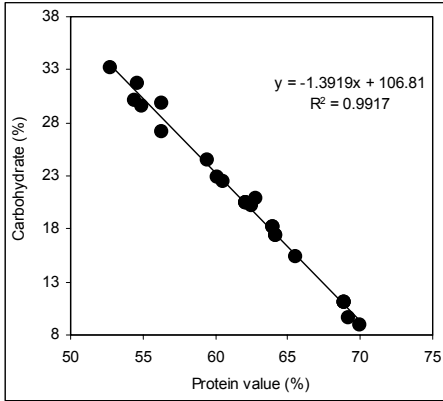


Fig. 4. Inverse relationship between protein and carbohydrate values (%) in *P. viridis*.

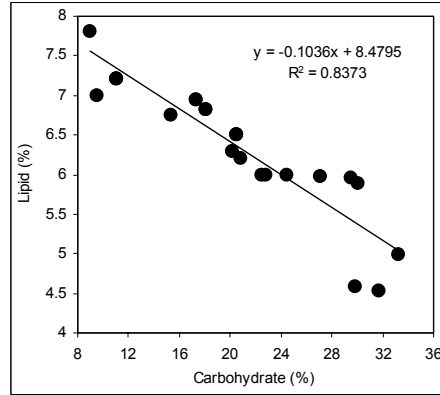


Fig. 5. Inverse relationship between carbohydrate and lipid values (%) in *P. viridis*.

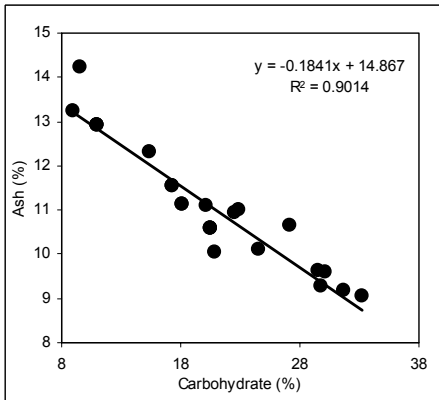


Fig. 6. Inverse relationship between carbohydrate and ash values (%) in *P. viridis*.

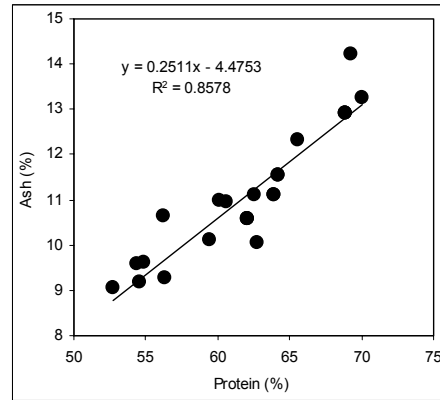


Fig. 7. Positive relationship between carbohydrate and ash values (%) in *P. viridis*.

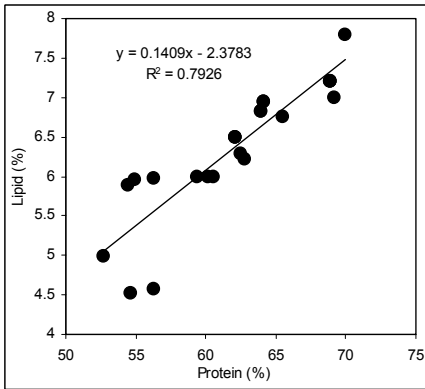


Fig. 8. Positive relationship between protein and lipid values (%) in *P. viridis*.

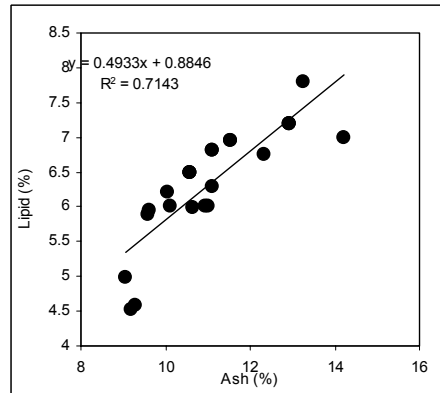


Fig. 9. Positive relationship between ash and lipid values (%) in *P. viridis*.

Table 3. Variance in biochemical composition between mature and immature green mussel (*P. viridis*) from the Moheshkhali channel, Bay of Bengal.

Maturity	Sample size	Variance SD/(SD ²)			
		Protein	Carbohydrate	Ash	Lipid
Mature	10	35.759	76.330	1.1145	3.120
Immature	08	14.453	21.772	0.154	0.445
Variance		2.47	3.51	7.44*	7.01*
F _{0.05}		3.68	3.68	3.68	3.68

* = Significant at 5% level.

Discussion

The higher values of biochemical constituents in both the mature and immature *P. viridis* during the pre-monsoon and post-monsoon period might be due to availability of phytoplankton () which could be associated with higher salinity. While, higher percentage of protein and lipid content during the pre and post monsoon periods were assumed to be due to spawning periods and the lower values of lipid content during the monsoon period due to post spawning period of the mussel.

Qasim *et al.* (1977), Nagabushanam and Mane (1978) and Dare and Edwards (1975) reported that bivalve mollusks contained higher proportion protein and lipid during spawning period and thereafter they started to fall markedly. Gabbott (1975) and Daniel (1921a,b) reported significant relationship between chemical contents and reproductive cycle of bivalve mollusks in different coastal waters. A declination in protein and lipid during the monsoon months was probably related to the metabolic process of mussels such as spawning and non-availability of food. Shafee (1978), Qasim *et al.* (1977), Fatima *et al.* (1986) and Kamal and Khan (2000) have reported similar observation and stated that the declination of protein and lipid percentage occurred after the spawning which again increased during pre-spawning and spawning period synchronized with high phytoplankton abundance during the post and pre monsoon period. Kamal *et al.* (1996) reported similar observation from the Moheshkhali channel.

P. viridis inhabiting Moheshkhali channel has been reported to have two spawning period; one during the post-monsoon period and another in the pre monsoon period with two peaks: one in September and the other in April (Kamal and Khan, 2000). The higher values of protein and lipid content during these periods indicate a direct relationship between biochemical constituents and reproductive cycle in *P. viridis*. This finding is in conformity with that of Nagabushanam and Mane (1978) for *M. viridis* ($\approx P. viridis$) from Ratnagiri on the west coast of India, for *P. viridis* from Ennore estuary, Bay of Bengal, east coast of India (Shafee, 1978) and Fatima *et al.* (1986) for *P. viridis* of Pakistan (Table 4).

Table 4. A comparison of average o biochemical composition in *P. viridis* form different waters (as % dry weight).

Habitat	Protein	Carbohydrate	Lipid	Ash
Manora channel, Northern Arabian sea, Pakistan*	65	12	10	13
Ennore estuary, Bay of Bengal, east coast of India**	58.53	23.62	6.34	11.53
Moheshkhali channel, Bay of Bengal, (present study)	62.1±5.18	15.42±7.11	6.37±0.77	11.09±1.29

Source: * Fatima *et al.* (1986), ** Shafee (1978)

The highest accumulation of carbohydrate during the monsoon period might have resulted to meet starvation and high energy demand for gametogenesis in the next spawning. Similar observations were made by Dare and Edwards (1975) and Fatima *et al.* (1986) where they reported that carbohydrate accumulated mainly during the non-reproductive period which agrees well with the present study.

The seasonal changes of protein and lipid in the mature and immature *P. viridis* were found to follow similar pattern. Hence, a significant positive correlation was found between the percentage of protein and lipid. Similar observation was reported by Fatima *et al.* (1986). However, changes in carbohydrate with protein and lipid followed a different course, i.e. when carbohydrate content decrease, protein and lipid fractions were increased. Thus, reciprocal relationship between percentage of protein and carbohydrate, and lipid and carbohydrate was found in both mature and immature *P. viridis*. Similar reciprocal relationship was also reported for *P. viridis* by Fatima *et al.* (1986) and for *Mytilus edulis* by Dare and Edwards (1975). However, only positive correlation was reported between the carbohydrate and the lipid values in all the oyster species. This variation between mussel and oysters may be related to the form of the reproductive cycle (Walne, 1970).

The yearly average biochemical constituents of both immature and mature mussels found in present study are analogous to the Shafee's (1978) observation (Table 4). The mean values obtained in this study may only be considered as the average of whole body of *P. viridis* since different body parts of the mussel had not been analyzed separately.

Conclusion

The present study highlights the facts that, the biochemical constituents of *P. viridis* follow a sharp seasonal cycle in mature mussels than in immature ones. The highest and lowest values of all the constituents were found during the pre monsoon and post-monsoon, and monsoon season respectively in mature and immature mussels. A positive significant correlation was found between protein and lipid, protein and ash, lipid and ash in both mature and immature mussels. An inverse correlation was found between protein and carbohydrate, carbohydrate and lipid and, carbohydrate and ash. Considering the mean yearly biochemical composition found in the present study, *P. viridis* should be explored to use as an alternative source of animal protein.

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