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A COMPARISON OF MACRONUTRIENT LEVELS IN GREEN MUSSEL *(PERNA VIRIDIS)* AND BROWN MUSSEL *(MODIOLUS METCALFEI* HANLEY*)*

THAMNOON ROCHANABURANON

Department of General Science, Faculty of Science, Chulalongkorn University, Phya Thai Road, Bangkok, Thailand and Aquaculture Research Methodology Program, Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo, Philippines

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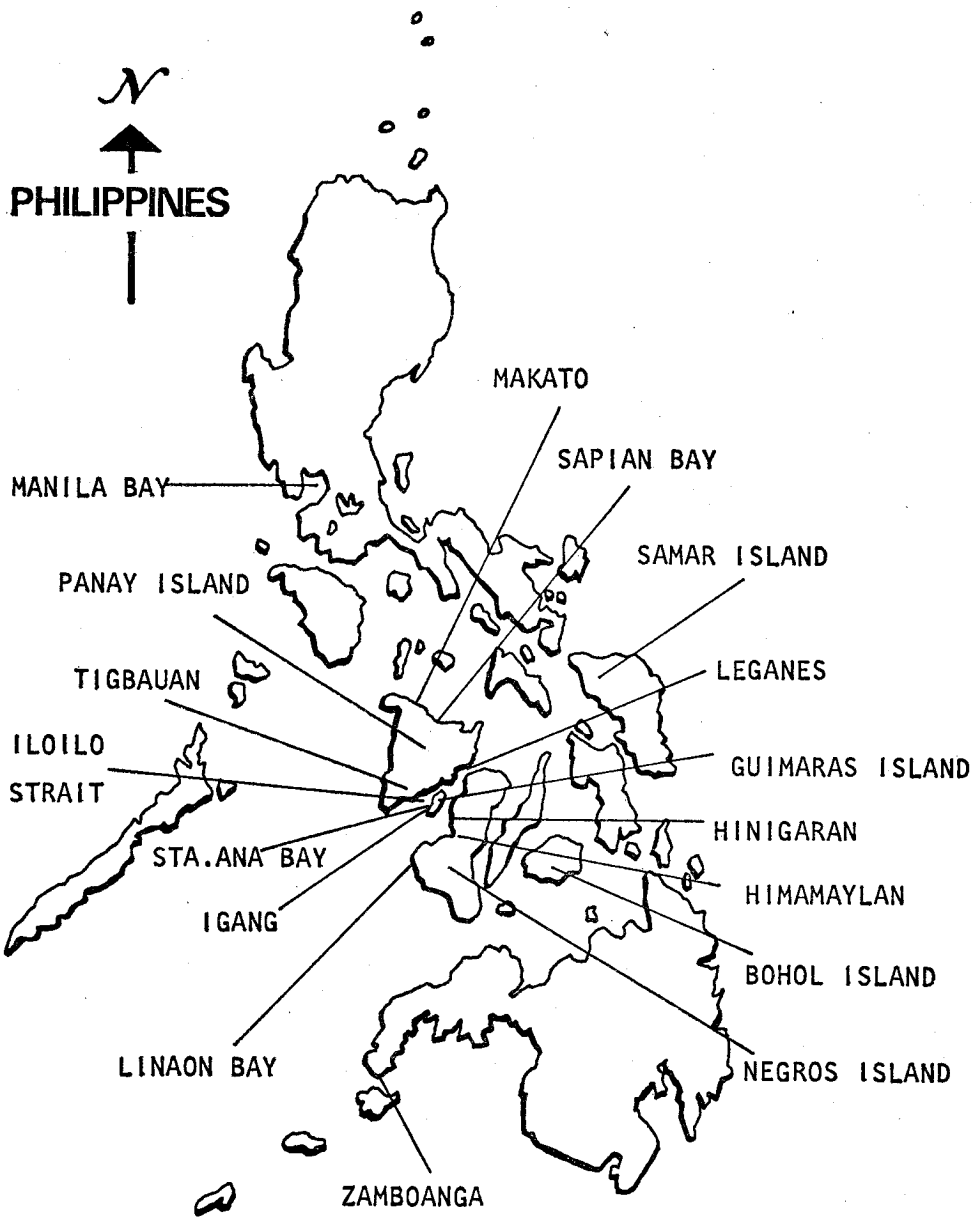
Summary

*Two species of mussel from Panay Island, Philippines, have been analyzed for moisture, crude protein, crude fat, ash, carbohydrate, crude fibre and minerals (calcium and phosphorus). Results showed that the brown mussel (**Modiolus metcalfei**), both the marketable size and the small ones, have higher protein content (71.49 and 67.10% dry weight) than the maketable-size green mussel (**Perna viridis**), 63.94%. The green mussel contained more fat but less ash, crude fibre and minerals than the brown mussel.*

Introduction

Protein derived from fishmeal has been shown to be very efficient nutrient, although rather difficult to obtain and expensive. Besides fish, meat, poultry and plant protein, shellfish is one of the possible protein sources to be utilized. Among the latter, mussel seems to be much cheaper than the others such as shrimp which are well acceptable in terms of food and feed nutrition for aquaculture. The green mussel (Tahong in Tagalog), *Perna viridis*, formerly known as *Mytilus smaragninus* and the brown mussel, *Modiolus metcalfei*, are the species which have some status in aquaculture area. The former is a species popularly consumed by man and the latter is used as food for other economically important species such as *Penaeus monodon* Fabricius and *Scylla serrata* Forskal. Besides these, the common green mussel, *Mytilus edulis*, proved to be very good and acceptable food for rearing the prawn, *Crangon crangon* L. and the shrimp, *Palaemon elegans* Rathke from early juvenile up to complete reproductive cycle in the laboratory[1]. Kanazawa[2] has revealed that brown mussel fed to prawn gave a high growth rate. Knowledge of mussel macronutrient contents, namely moisture, protein, fat, carbohydrate, crude fibre, ash and minerals leads to a better understanding of their nutritional values, leading in turn to improvement of diet for feeding different commercial species.

Natural population of the green mussel, *Perna viridis*, within the Philippine archipelago (Fig. 1) are found only in scattered pockets. Natural settlements appear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HINIGARAN
STA.ANA BAY
HIMAMAYLAN
IGANG
BOHOL ISLAND
LINAON BAY
NEGROS ISLAND
ZAMBOANGA

Fig. 1.

restricted to estuarine areas in Manila Bay, the Northern shores of Panay Island, the Iloilo strait, the western shore of Negros Island, and western Samar Island. The shallow subtidal species of brown mussel, *Modiolus metcalfei*, is more widespread than *P. viridis* and is normally found embedded in muddy substrates, attached to each other just below low tide levels. It is observed to occur together with the green mussel in all known green mussel areas. However, very low numbers have been found in clusters of green mussel growing off-bottom. In purely known mussel areas the spats do not settle on the surface of the bamboo fish corals or other similar structures in the water. This settlement preference evolved as a survival mechanism, since in a brown mussel bed living mussel valves provide refuge from the muddy bottom which smooths a newly settled mussel[3,4]. However, it appears that most of the green mussel live just below the surface in the protective area where the water is clean and less turbid whereas the brown mussel occupies the silty bottom within the less protective area.

Both endogenous and exogenous factors may be responsible for difference in macronutrient levels and biochemical composition of the mussels. The endogeous factors consist of genetic difference, physiological status, reproductive cycle, feeding habit, etc. The exogenous factors are habitat, abundance of food available, temperature, size, dissolved organic matter/debris, soil composition, starvation, and time available for feeding, etc. Bayne *et al.*[5] stated that biochemical content is dependent on size and growth of the animal. Changes in body weight are mainly due to changes in carbohydrate or glycogen content. The seasonal cycles for storage and utilization of glycogen resources reflect the complex interactions between food supply and temperature, and between growth and the annual reproductive cycle. According to biochemical data[5], glycogen accumulates mainly during the reproductive period. After the mussel become spent the metabolic energy demand is low. Whenever abundant food is available in the plankton there is a marked increase in glycogen with the highest accumulation in the mantle. Protein and lipid resources are also built up. Lipid level is generally higher in the adult female than in the male or the young mussel presumably due to the fatty resources in the eggs. Organic matter and debris supplies a large part of the mussel's diet and bacteria may be utilized as food also. *Mytilus edulis* is capable of assimilating dissolved organic solutes present in the environment. Other factors such as brackish estuaries condition or mangrove area is known to be suitable for mussel growth but this is probably a function of improved feeding conditions rather than salinities[5]. Animals in poor condition such as in the laboratory are considered to be under stress and starvation. During the starvation individuals of all size showed a reduction in carbohydrate and lipid. This reduction was particularly marked in smaller individuals, which probably have less carbohydrate and lipid than the larger ones. Genetic differences are very prominent among the bivalves. There is an impressive amount of genetic differentiation among samples less than one meter apart, indeed among individuals of different sizes. Microgeographic variation demonstrated genetic heterogeneity over small distances, primarily over tidal flats, in estuaries, and among different levels in the intertidal zone where exposure time, temperature, heat transfer and water retention are dramatically different.

The objective of this work is to compare the macronutrient levels (moisture, crude protein, crude fat, crude fibre, crude carbohydrate, ash and mineral) between *Perna viridis* and *Modiolus metcalfei*, in order to see whether there are any differences in these parameters due to genetic factors, size, and habitats.

Materials and Methods

Both green and brown mussels were collected from the field and preconditioned in the mussel laboratory at SEAFDEC, Tigbauan prior to the analysis. They were classified into 3 groups according to their species and sizes : green, brown and small brown mussels, Their collection site and pre-conditioning were recorded and shown in Tables 1 and 2.

TABLE 1. COLLECTION DATA OF GREEN, BROWN AND SMALL MUSSELS

Species (Size)	Collection site	Time and date of collection	Condition of tide	Approximate age of samples (month)	Other observations	
					Depth (meter)	Water current
Green mussel (marketable)	Banate Bay, Panay Island	Afternoon July 23, 1979	Lowtide	12	2	Rapid water exchange, current speed moderate
Brown mussel (marketable)	Estancia, Panay Island	Morning July 21, 1979	Lowtide	8	–	–
Brown mussel (small)	Banate Bay, Panay Is.	Afternoon July 23, 1979	Lowtide	2	Exposure only a few cm.	None

TABLE 2. PRE-CONDITIONING OF GREEN AND BROWN MUSSELS BEFORE ANALYSIS

Mussels were transported from collection sites to Tigbauan and pre-conditioned in flow-through sea water.

Condition	Green Mussel	Brown mussel	Small brown mussel
Temperature (°C)	30.0°	30.5°	27.0°
Salinity (%)	33.3°	30.0°	30.0°
Time & date	10:00 a.m. July 24, 1979	7:00 a.m. July 22, 1979	10:00 a.m. July 24, 1979
Transportation technique	Moist Deutsch sack	Moist Deutsch sack	Moist Deutsch sack packed in mud

After a pre-conditioning period in the mussel laboratory for 3–7 days, the samples were taken out for analysis. The proper pre-conditioning duration was kept less than 24 hours in order to eliminate all undigested food. The number of individuals was limited to its availability. All mussels were measured for their total length (from the tip of umbo to the posterior end of the shell) and mussel flesh weight were not for each species as shown in Table 3.

TABLE 3. SIZE PARAMETERS OF THE GREEN, BROWN AND SMALL BROWN MUSSELS

Sample	Total length range & Mean (cm)	Total wet weight (g)	Dry weight (g) & Dry matter (%)	Total number of individuals
Green mussel	6.37–10.15 8.38	539.32	99.90 18.52	50
Brown mussel	5.14–6.84 5.80	156.21	33.35 21.35	50
Small brown mussel	2.29–4.14 2.99	108.81	24.42 22.44	350

The mussel flesh was chopped and dried in an oven (100–110°C) to constant weight. The sample was homogenized by grinding with a mortar and pestle. The resulting powder was placed in covered glass bottles and stored in a dessicator for subsequent analysis. The method used in proximate and mineral analysis was based on the adapted procedure of the AOAC[6] and Laboratory Manual For Fish Feed Analysis[7]. Protein was analysed by the semi-micro Kjeldahl method; fat, by Soxhlet extraction with ether; moisture, by loss in weight on drying at 105°C; crude fibre, by weak acid and base digestion followed by ignition of the dried residue at 550°C; ash, by ignition at 550°C; and carbohydrate by difference. The ash was dissolved in HCl-HNO_3 solution at just below boiling, made up to volume with distilled water and used in mineral analysis by titration method for calcium and U.V. spectrophotometry for phosphorus.

Results

The results of the determinations are given in Table 4. Moisture is slightly different in the 3 samples, the larger the higher. The two brown mussels contain relatively higher percentage of protein than the green mussel although lower in shell length and wet weight. However, crude fat is higher in the green mussel than the brown and small brown mussels. The small brown mussels seem to have more ash than the green the larger brown mussel. The carbohydrate content of brown mussel is less than the green and the smal. brown ones. The green mussel, however, possesses smaller amount of crude fibre as well as calcium in comparison with the other two brown mussels. Phosphorus content is least in the small brown mussel, followed by the green mussel.

TABLE 4. MACRONUTRIENT CONTENTS OF GREEN, BROWN AND SMALL BROWN MUSSELS EXPRESSED AS PERCENT DRY WEIGHT
Figures are given as mean percentage ± standard deviation.

Macronutrient	Green mussel	Brown mussel	Small brown mussel
Moisture	81.48	78.65	77.56
Crude protein	63.94 ± .431	71.49 ± .395	67.10 ± .614
Crude fat	9.45 ± .050	6.56 ± .252	4.27 ± .242
Crude fibre	0.06 ± .256	0.095 ± .005	0.115 ± .01
Ash	11.49 ± .256	12.51 ± .265	13.98 ± .332
Crude carbohydrate	15.060	9.345	13.790
Calcium	0.305 ± .271	0.356 ± .029	0.414 ± .034
Phosphorus	0.894 ± .036	1.172 ± .126	0.632 ± .019

The following conclusion could be drawn from the experiment based on F-Test and Duncan Multiple Range Test:

1. The green mussel, brown mussel and the small brown mussel have different protein, crude fat and also phosphorus contents ($P < .01$).
2. There is a difference in ash content between the small brown mussel and the green mussel/or the brown mussel ($P < .05$), but there is no significant difference between the green and the brown ones.
3. There is a difference in crude fibre among the 3 groups of mussel ($P < .05$).
4. There is a difference in calcium content among the small brown and the green mussel, but there is neither significant difference between the small and the brown mussel nor between the brown and the green mussel.

Discussion

Fishery products and by-products such as fish meals, condensed fish solubles, fish protein concentrates, and protein from crude waste meal of crab and shrimp provide excellent sources of protein because of their higher values in protein content and quality[8]. Therefore, the results shown in Table 4 suggest that the analyzed mussels *(Perna viridis* and *Modiolus metcalfei)* can be considered as an alternative potential food crop capable of providing cheap animal protein, not only as feed but also as food for the masses. Their protein contents agree with the results given by Catedral[9] on the green mussel *(Mytilus smaragninus)* and Lim[10] on the brown mussel *(Modiolus metcalfei)* in terms of what is considered as high percentage protein, i.e. 63.94, 70.17–77.84 and 63.44% respectively. There is no comparison among differences of protein contents in these mentioned proximate analysis due to different biotic and abiotic concern. Both growth and biological functions of animals depend on the quality of the protein as amino acid constituents rather than absolute percentage of protein[8]. Ramsey[11] mentioned that inspite of lack of research, the limited data available would indicate that alternative sources cannot yet substitute fish protein

with equal efficiency. There are many reasons for their comparative lack of efficiency which go beyond differences in amino acid content of the respective protein. Therefore, this present work is only a preliminary study whose results imply that more considerable concrete works on biochemical analysis of mussel protein have to be followed if it is going to be used as feed or as supplementary diet to enchance growth for other commercial important animals such as *P. monodon* and *Scylla serrata.*

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