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Study on Biochemical Composition of Sea Snail *Hemifusus colosseus* (Lamarck, 1816) (Mollusca: Gastropoda: Melongenidae) in Tam Giang Lagoon, Thua Thien Hue, Vietnam

Tran Ngoc Anh Thu[1], Tran Van Thien[1], Nguyen Tran Trung[2], Tran Quoc Dung[2*]

[1]Nguyen Tri Phương Secondary School, 63 To Huu Street, Hue City, Thua Thien Hue Province, Vietnam
[2]Faculty of Biology, University of Education, Hue University, 34 Le Loi Street, Hue City, Thua Thien Hue Province, Vietnam
tranquocdung@hueuni.edu.vn

Abstract: *Hemifusus colosseus* (Lamarck, 1816) is a species of sea snail, a marine gastropod molluscs belonging to the family Melongenidae, class Gastropoda, phylum Mollusca. This species is harvested for human consumption. It is considered as a delicacy for their delicious meat, high nutritional and commercial value. The aim of this study is to determine the biochemical compositions of sea snail *H. colosseus* in Vietnam, for which no data are available at present. Samples were collected from Tam Giang Lagoon, Thua Thien Hue, Vietnam. Soft tissues were dissected from shell and used for biochemical composition determination. The total protein content was determined by the Kjeldahl method, the total lipid content was made by the gravimetric method, while the total carbohydrate content was calculated by the Bertrand method. The mineral contents were determined using Atomic Absorption Spectroscopy (AAS). The total protein was found to be the major content followed by carbohydrate and lipid in the sea snails *H. colosseus*. The concentrations of main macrominerals (K, Na, Mg, P, and Ca) and microminerals (Zn, Fe, and Se) were also determined. This study reveals that the sea snail *H. colosseus* is a good source of protein with high level and low lipid. Furthermore, the sea snail has also a high mineral content.
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1. Introduction

Sea snails are excellent sources of protein, carbohydrate, lipid, minerals, vitamins, etc. which render them highly nutritious. Many species of sea snails are important source of food for human beings, and other animals such as fishes, prawns, birds, ducks, etc. (Pati et al., 2015).

Many works were carried out on the biochemical composition of sea snails such as *Hemifusus pugilinus* along the Porto Novo coast, Nigeria (Kumar et al., 1986); rapa whelk *Rapona venosa* in North East coasts of Dardanelles at the Marmara sea, Turkey (Celik et al., 2014), and from the Bulgarian Black Sea coast (Popova et al., 2017); *Babylonia zeylanica*, *Murex virgineus*, *Babylonia spirata* and *Trochus radiatus* along the Kanyakumari coast (Margret et al., 2013); *Babylonia zeylanica* from Puducherry Southeast coast, India (Jayalakshmi et al., 2016); *Hexaplex trunculus* from the Bizerte lagoon, Northern Tunisia (Gharsallah et al., 2010); periwinkle (*Tympanotonus fuscatus* and *Pachymelania aurita*) and rock snail (*Thais coronata*) from Akwa Ibom State, Nigeria (Inyang et al., 2018), cultured spotted babylon (*B. areolata*) at the Fisheries Research Institute Pulau Sayak, Kota Kuala Muda, Kedah, Malaysia (Noordin et al., 2014), *Telescopium telescopium*, *Cerithidea cingulate* and *C. obtusa* of Tekkali Creek (Bhavanapadu Mangroves), Andhra Pradesh, India (Chakravarty et al., 2015); *Turbo militaris*, *Lunella undulata*, and *Lunella torquata* from Northern New South Wales, Australia (Lah et al., 2017); *Hexaplex trunculus* from the Tunisian Mediterranean coasts (Zarai et al., 2011); *Thais bufo, T. hippocastanum* and *T. rudolphi* from the Sindh coast of Pakistan (Ali et al., 2018); *Purpura bufo* of Visakhapatnam coast, India (Darwin et al., 2017), etc. *Hemifusus colosseus* (Lamarck, 1816) (synonym of *Pugilina colosseus* Lamarck, 1816; *Fusus colosseus* Lamarck, 1816), commonly known as Giant stair shell (Cole, 2017) and Colossal false fusus, and "Ốc kèn láng" (in Vietnamese), is a species of sea snail, a marine gastropod molluscs belonging to the family Melongenidae, class Gastropoda, phylum Mollusca (MolluscaBase, 2019). This species is distributed in the tropical Indo-West Pacific: from Indonesia to the Philippines and East China Sea (Poutier, 1998),

Vietnam (Hyllerberg et al., 2003; Do et al., 2014). They were found in benthic zone at a depth 0-50 m (Poutier, 1998).

This species is harvested for human consumption. They are considered as a delicacy for their delicious meat, high nutritional and commercial value. In Vietnam, they are very expensive, their cost is higher than any other snails. Local people prefer to have it for their meals by different ways of cooking and soak it in rice wine or grain alcohol with other precious ingredients such as seahorse (Hippocampus), sea snake (Elapidae), etc. for a tonic function.

The aim of this study is to determine the biochemical constituents of sea snail *H. colosseus* in Tam Giang Lagoon, Thua Thien Hue, Vietnam, for which no data are available at present.

2. Material and Methods

Sample collection

Figure 1. *H. colosseus*. A. Dorsal View; B. Ventral View

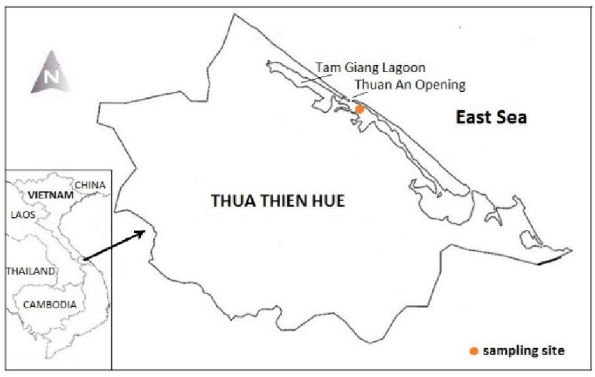

Figure 2. Map of Sampling Site for Specimen's *H. colosseus* in this Study

Five sea snails *H. colosseus* were captured from Tam Giang Lagoon, Thua Thien Hue, Vietnam; near to Thuan An Opening (Figure 1 and Figure 2) were used for this study. Specimens were transferred to the laboratory at the Department of Genetics, Faculty of Biology, University of Education, Hue Universiy, in cool case containing dry ice, and cleaned with distilled water. All specimens were conspicuously identified as classified in the World Register of Marine Species (MolluscaBase, 2019). Soft tissues of all sea snails were dissected from shell and stored in -20°C until further utilized.

Estimation of biochemical compounds

The biochemical compounds in the sea snails *H. colosseus* was studied by adopting the standard procedures. The total protein content was determined by the Kjeldahl method (AOAC, 1990), the total lipid content was made by the gravimetric method (AOAC, 1990), while the total carbohydrate content was calculated by the Bertrand method. All determinations were repeated three times. The total carbohydrate, lipid, and protein contents estimated were presented in percentages of the fresh weight. The mineral contents (potassium (K), sodium (Na), magnesium (Mg), phosphorus (P), Ca (calcium), zinc (Zn), iron (Fe), selenium (Se), lead (Pb), cadmium (Cd), mercury (Hg), and arsenic (As)) were determined using Atomic Absorption Spectroscopy (AAS) (AOAC, 1990). The quantity of minerals was expressed as milligram per 100 gram (mg/100 g) wet sample.

3. Results and Discussion

Biochemical compounds

Protein, carbohydrate, lipid are major biochemical compounds that be essential for the living body. The total protein content of the soft tissue of the sea snails *H. colosseus* was found to be 20.70±0.61%. The total carbohydrate and lipid contents were observed to be 1.50±0.10% and 0.37±0.01%, respectively (Figure 3 and Table 1). The results of the present study revealed that the protein composition was high, followed by carbohydrate and lipid.

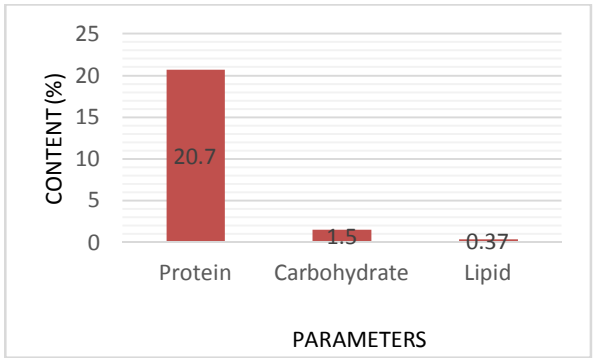

Figure 3. Major Biochemical Compounds of the Sea Snails *H. colosseus* from Tam Giang Lagoon, Thua Thien Hue, Vietnam

Protein is part of every living cell, and it plays many critical *roles* in the body. *Protein* can be found

in plant sources like beans, nuts, seeds, etc. or animal sources such as dairy products and meat. Edible sea snail is a source of high quality protein. Lah et al. (2016) observed that the protein value of three species of turbinid snails: *T. militaris*, *L. undulata*, and *L. torquata* to be relatively high (16.19%, 18.49%, and 18.03% of the fresh weight, respectively). In sea snail *R. venosa* was reported to contain a high amount of protein ranging from 18.62 to 24.09% (Popova et al., 2017). The protein content of *B. areolata* reported by Noordin et al. (2014) was 22.40%. The total protein contents in *T. telescopium*, *C. cingulate* and *C. obtusa* were found as 21.01, 13.08 and 20.38%, respectively (Chakravarty et al., 2015). In addition, total protein content of *H. colosseus* in the present study, was higher than those described for some land snail species: *Helix* snails (7.2-12.8%) (Gomot, 1998); *Archachatina marginata*, *Archachatina marginata*, *Achatina achatina* and *Limicolaria* spp. (18.66-20.56%) (Fagbuaro et al., 2006); *Helix pomatia* (12.96 and 13.70 %) (Ikauniece et al., 2014). On the other hand, this value was found to be high when compared to some edible marine gastropods and commercial shellfishs in Vietnam (Table 1).

Carbohydrates are the most important source of energy for animal body, including starches, sugars, and fiber. The carbohydrate contents were found to be 0.80%, 0.58% and 0.84% in three sea snail species, *T. telescopium*, *C. cingulata* and *C. obtuse*, respectively (Chakravarty et al., 2015). Noordin et al. (2014) estimated that the carbohydrate content in *B. areolata* was 2.4%. The carbohydrate values of the foot tissue from *T. militaris, L. undulata*, and *L. torquata* were recorded as 3.02%, 3.51% and 2.92%, by Lah et al. (2016). In the sea snail *H. colosseus*, generally the carbohydrate content was found to be high when compared to some sea snails but to be low when compared to other some sea snails.

Table. 1. Major Biochemical Compounds of the Sea Snail *H. colosseus* from this Study as Compared to Other Edible Marine Gastropods and Commercial Shellfish in Vietnam

Species	**Protein (%)**	**Carbonhydrate (%)**	**Lipid (%)**	**Reference**
Sea snail *H. colosseus*	20.70	1.50	0.37	
Apple snail *Pila*	11.11	8.30	0.70	Vietnam Ministry of Health, 2007
Oyster	9.50	4.90	2.30	Vietnam Ministry of Health, 2007
Manodonta	4.60	2.50	1.10	Vietnam Ministry of Health, 2007
Sea crab	17.50	7.00	0.60	Vietnam Ministry of Health, 2007
Freshwater crab	12.30	2.00	3.30	Vietnam Ministry of Health, 2007
Sentinel crab	11.90	-	0.70	Vietnam Ministry of Health, 2007
Sea cucumber	21.50	0.20	0.30	Vietnam Ministry of Health, 2007
Chlamys nobilis	13.35-19.71	0.63-0.94	0.60-0.95	Lam, 1994

-: *Not reported*

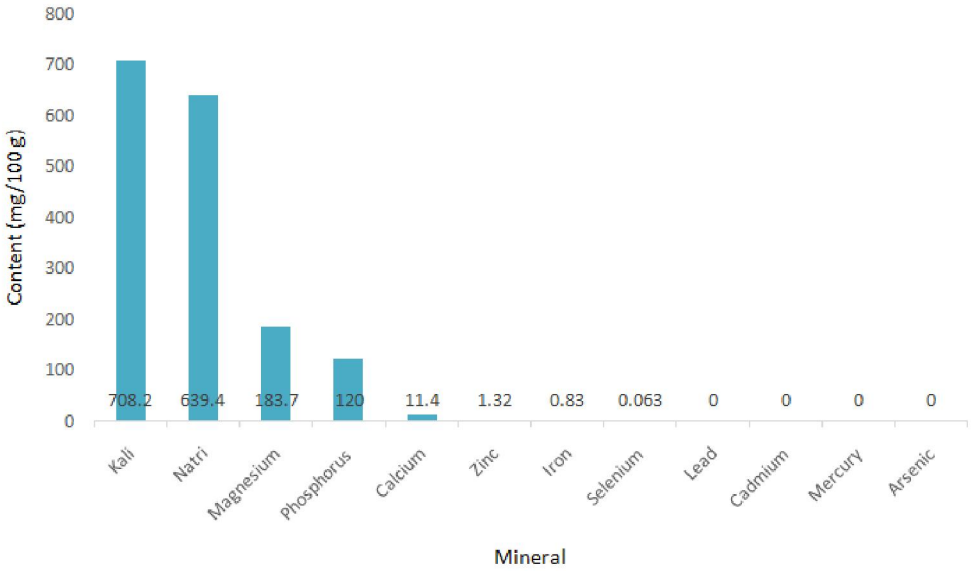

Figure 4. Mineral Contents of the Soft Tissue of the Sea Snails *H. colosseus* from Tam Giang Lagoon, Thua Thien Hue, Vietnam

Table. 2. Mineral Contents of the Sea Snail *H. colosseus* from this Study as Compared to Other Edible Marine Gastropods and Commercial Shellfish in Vietnam

Species	Macrominerals (mg/100 g)					Microminerals (mg/100 g)			Reference
	K	Na	Mg	P	Ca	Zn	Fe	Se	
Sea snail *H. colosseus*	708.2	639.4	183.7	120.0	11.4	1.32	0.83	0.0630	
Apple snail *Pila*	-	-	-	64.0	1310.0	-	-	-	Vietnam Ministry of Health, 2007
Oyster	223.0	380.0	42.0	82.0	37.0	13.40	1.90	77.0000	Vietnam Ministry of Health, 2007
Monodonta	314.0	56.0	9.0	107.0	668.0	1.37	1.50	24.3000	Vietnam Ministry of Health, 2007
Sea crab	322.0	316.0	48.0	191.0	141.0	1.40	3.80	-	Vietnam Ministry of Health, 2007
Freshwater crab	266.0	453.0	1.4	171.0	120.0	-	-	-	Vietnam Ministry of Health, 2007
Sentinel crab	329.0	293.0	34.0	229.0	89.0	3.54	0.74	0.0374	Vietnam Ministry of Health, 2007
Sea cucumber	-	-	-	22.0	118.0	-	1.40	-	Vietnam Ministry of Health, 2007

-: *Not reported*

Together with proteins and carbohydrates, *lipids* are an important part of living cells. Lipids provide *more than twice the energy of carbohydrates* or *proteins*. In the present study, total lipid content of soft tissue was 0.37%. This value was lower than that of sea snail *B. areolata* (2.70%) (Noordin et al., 2014); *T. militaris* (5.57%), *L. undulate* (5.20%), and *L. torquata* (8.46%) (Lah et al., 2016). This outcome was also lower than those described for some land snail species: *Helix* snails (0.4-1.8%) (Gomot, 1998); *Archachatina marginata*, *Archachatina marginata*, *Achatina achatina* and *Limicolaria* spp. (1.17-1.43%) (Fagbuaro et al., 2006). In addtion, total lipd content of *H. colosseus* in the current study, was found to be low when compared to some edible marine gastropods and commercial shellfishs in Vietnam (Table 1). The low lipid content is a good attribute because it qualifies *H. colosseus* to be a low-lipid food and preventing them from easily becoming rancid during storage.

Mineral estimation

M*inerals* are inorganic substances that are very important for living. Both types of minerals, macrominerals and microminerals, have various roles in metabolism and body functions. Minerals are essential for the proper function of cells, tissues, organs and must be supplied by the diet.

The quantity of minerals was reported in the soft tissue of the sea snails *H. colosseus* were given in Figure 4 and Table 2. Totally, eight minerals were detected, including five macrominerals and three microminerals.

Macrominerals content

The most abundant macrominerals in the sea snail *H. colosseus* were potassium (708.2±7.1 mg/100 g), sodium (639.4± mg/100 g) and magnesium (183.7±12.7 mg/100 g). Potassium is one of the main electrolytes, essential to both cellular and electrical function. Along with sodium, potassium regulates the water balance and the acid-base balance in the blood and tissues, and plays a critical role in the transmission of electrical impulses in the heart (Kowey, 2002).

The potassium concentration value was significantly higher compared to several previous findings: 224.8 mg/100 g in *H. trunculus* (Zarai et al., 2011); 225.5 mg/100 g in *B. areolata* (Noordin et al., 2014); 305.0 mg/ 100 g in *L. torquata*, 333.0 mg/100 g in *L. undulate*, and 273.0 mg/100 g in *T. militaris* (Lah et al., 2017). Similarly, the concentration of sodium was also significantly higher than that of *H. trunculus* (270 mg/100 g) (Zarai et al., 2011); *B. areolata* (107.5 mg/100 g) (Noordin et al., 2014); *L. torquata* (301 mg/100 g), *L. undulate* (270 mg/100 g), and *T. militaris* (400 mg/100 g) (Lah et al., 2017). In general, sodium contents were considerably higher in shellfish than in finfish (Vlieg, 1991). Magnesium is an active component of several enzyme systems. It is also a constituent of bone, teeth, enzyme cofactor, etc. (Soetan, 2010; Fairweather-Tait, 2015). The magnesium concentration in the sea snail *H. colosseus* was also higher than that of *H. trunculus* (178.7 mg/100 g) (Zarai et al. (2011); *B. areolata* (27.5 mg/100 g) (Noordin et al., 2014); *L. torquata* (69.0 mg/100 g), *L. undulate* (65.0 mg/100 g), and *T. militaris* (77.0 mg/100 g) (Lah et al., 2017).

Phosphorus is one of the most important minerals in animal nutrition. It plays a critical role in forming cell membrane and nucleic acids, generation of ATP, cell signaling through protein phosphorylation or dephosphorylation, urinary buffering, and bone mineralization (Cheng et al., 2016; Takeda, 2004). The present study revealed that the phosphorus concentration was 120.0±1.6 mg/100 g. Zarai et al. (2011) reported the phosphorus concentration in *H. trunculus* was found as 95.20 mg/100 g. Noordin et al. (2014) assessed the phosphorus concentration which was 132.9 mg/100 g in the sea snail, *B. areolata*. Lah et al. (2017) investigated that the phosphorus concentration in *L.*

torquata, *L. undulate*, and *T. militaris* were 153, 164, and 122 mg/100 g, respectively. In the sea snail *H. colosseus*, generally the phosphorus concentration was found to be high when compared to some sea snails but to be low when compared to other some sea snails.

Calcium is important for the formation of bones and teeth, regulation of nerve and muscle function, blood coagulation, enzyme activation (Soetan et al., 2010). The calcium concentration in the sea snail *H. colosseus* was 11.4±0.1 mg/100 g. Zarai et al. (2011) reported value of 647.7 mg/100 g wet samples for *H. trunculus*, which was significantly higher compared to the current finding. Noordin et al. (2014) also reported calcium value at 26.7 mg/100 g for *B. areolata*, which was significantly lower compared to the current study. In other study, Lah et al. (2017) reported calcium values at 239.0, 44.0, and 61.0 mg/100 g for *L. torquata*, *L. undulate*, and *T. militaris*, respectively; which were significantly lower compared to the present finding. Among the five macrominerals, the calcium concentration was lowest. Fishery products are generally considered poor sources of calcium and magnesium (Lah et al., 2017). The sea snail *H. colosseus* is not a very rich source of calcium but it appears to be a very good source of other macroelements, which are considered essential macrominerals for human consumption.

These macrominerals have also been reported in other sea snails and sea food. Potassium, sodium and magnesium as among the most predominant minerals in edible marine gastropods and commercial shellfishs in Vietnam (Vietnam Ministry of Health, 2007) (Table 2).

Microminerals content

Among three detected microminerals, zinc (1.32±0.01 mg/100 g) followed by iron (0.83±0.02 mg/100 g) and selenium (0.063±0.007 mg/100 g). Whereas, lead, cadmium, mercury, and arsenic were found absent totally.

Zinc is an important micromineral which functions as a cofactor and is a constituent of many enzymes in living organism (Soetan et al., 2010). In this study, zinc concentration in the sea snail *H. colosseus* (1.32 mg/100 g) was higher than that of *T. militaris* (1.22 mg/100 g) (Lah et al., 2017), but significantly lower compared to previous findings in *H. trunculus* (112.80 mg/100 g) (Zarai et al., 2011); *B. areolata* (3.35 mg/100g) (Noordin et al., 2014); *L. torquata* (1.40 mg/100 g), and *L. undulate* (1.52 mg/100 g) (Lah et al., 2017).

Iron is among the major microminerals found in all species and serves vital functions, such as carrying oxygen in hemoglobin to the tissue of vertebrates (Erkan, 2011; Lah et al., 2016). The iron concentration was 0.83 mg/100 g. This result was much lower than that of *H. trunculus* (81.00 mg/100 g) (Zarai et al., 2011); *B. areolata* (2.82 mg/100g) (Noordin et al., 2014); *L. torquata* (3.24 mg/100 g), *L. undulate* (4.11 mg/100 g), and *T. militaris* (1.93 mg/100 g) (Lah et al., 2017).

In addition, *H. colosseus* also contains trace amount of selenium. Selenium is a constituent element of the entire defence system that protects the living organism from the harmful action of free radicals and regulates the thyroid hormone (Fairweather-Tait, 2015; Soetan et al., 2010). The selenium concentration (0.0630 mg/100 g) was lower than that of *B. areolata* (0.0780 mg/100 g) (Noordin et al., 2014); but significantly higher than that of *L. torquata* (0.0177 mg/100 g), *L. undulate* (0.0144 mg/100 g), and *T. militaris* (0.0177 mg/100 g) (Lah et al., 2017).

Zinc, iron and selenium were main microminerals reported in edible marine gastropods and commercial shellfishs in Vietnam (Vietnam Ministry of Health, 2007) (Table 2).

The results from present study reveal that the sea snail *H. colosseus* in Tam Giang Lagoon, Thua Thien Hue, Vietnam is a good source of protein with high level and low lipid. Furthermore, the sea snail has also a high mineral content. The macrominerals were potassium, sodium, magnesium, phosphorus and calcium, and the microminerals were zinc, iron, and selenium.

Corresponding Author
Dr. Tran Quoc Dung
Faculty of Biology, University of Education, Hue University, 34 Le Loi, Hue City, Vietnam
Telephone: 84 0234 3823183
Email: tranquocdung@hueuni.edu.vn

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