POTENTIAL USE OF PEANUT WORM (*Sipuncula*) AS FOOD

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ABSTRACT

It is shown that Peanut worm (*Sipunculus nudus* and *Siphonosoma australe*) contains highly nutritious and diverse ingredients. They include more than 17 mineral elements such as iron, manganese, calcium, zinc, nickel, etc. and high protein content with 18 amino acids such as glycine, alanine, glutamine, taurine, etc. There are 12.77% of lipids consisting of 12 saturated fatty acids, 5 monounsaturated fatty acids and 13 polyunsaturated fatty acids. In addition, the content of water, fiber, carbohydrates and vitamins A, B1, B6, B12, E, etc. in this organism is also quite high. Because of these valuable components, Peanut worm is usually used as functional food and could also be processed into different types of food for the people in the Mangrove Biosphere Reserve.

Keywords: Peanut worm, *Sipunculus nudus*, *Siphonosoma australe*, functional foods.

1. INTRODUCTION

People in some South Asian countries, Southeast Asia and especially some African countries use insects as a food source because they are nutritious and delicious. Recently, there has been an increasing interest in Peanut worm or earth Ginseng, which lives in the topsoil (0.0-100cm), under the canopy of mangroves. "Peanut worm" has a local name (Vietnam): “Sa sung”, “Dia Sam”, “Mat Cat”, etc. Peanut worm belongs to the order molluscs, which lives in estuaries and coastal mangrove forests in our country such as Quang Ninh, Quang Binh, Can Gio, Bac Lieu, Ca Mau. Peanut worm contains more than 17 mineral elements such as iron, manganese, calcium, zinc, nickel.... and high protein content with 18 amino acids including those that are necessary for the human body. Due to the above characteristics, the economic value of Peanut worm (earth ginseng) is very high. Besides, they have economic value because the export price of unofficial routes is very high ($25-35/kg and tends to increase). Fresh Peanut worm used in cooking is gradually being replaced by MSG products because of the natural sweetness from the processed food itself, to ensure better health for everyone. Not only is peanut worm used as food, but also in traditional medicine, peanut worm also has the following uses: kidney tonic, yang, heat clearing, nourishing Pi Vi, increasing energy for the body, treating heat in the body, stealing sweat, swollen gums and pain, etc. However, around the years 2005-2006, when the value of peanut worm was known, the demand for these species was increasing. With this increase, suddenly, especially when buying from traders, the exploitation of peanut worm has become more massive. This leads to the risk of mangrove destruction. The indiscriminate exploitation of Peanut worm not only severely reduces the population of Peanut worm, but also has consequences for the destruction of mangroves and coastal protection forests. In the face of the current status of extremely useful organisms for the precious land of Mangrove Forest, which are in danger of being threatened and reduced,

they may become extinct, if timely measures are not taken to protect, manage and exploit appropriately, and use towards sustainable aquaculture development.

This topic collects, integrates, researches and evaluates the nutritional value of Peanut worm as a food source for people in the world who are undernourished and hungry.

2. MATERIALS AND METHODS

2.1. Subjects of study

Peanut worm (Vietnamese: Sâm đất) belongs to the phylum Sipuncula. Species *Sipunculus nudus* (*S. nudus*) lives in intertidal zones, on sandy and sandy bottoms [1], in mangroves [2]. They live under rocks, crevices, in mangroves, or hide in mollusc shells, mollusc shells, or burrow in sand and mud. In fact, through research in Vietnam, we found: they can dig to build nests, with the mouth of the nest like a tiny mountain top.

a. Species *Siphonosoma australe australe* (Keferstein, 1865) has been identified as a subspecies of *Siphonosoma australe* (Keferstein, 1865), which was described by Edmonds (1955) from specimens collected from the Fiji Islands [3]. Later, Cutler (1994) described the morphology, distribution and biological characteristics in more detail [4].

b. Species: *Sipunculus nudus,* Cutler (1994) described the morphology, distribution and biological characteristics in more detail; They live in soil layer 0-30 cm in Mangrove Forest in southern Vietnam.

2.2. Contents, location, scope of research

- Determine the average density and biomass of Peanut worm in the area.
- Nutrient content in meat of species of Peanut worm
- Learn the status of exploitation and use of Peanut worm resources as a basis, contributing to the exploitation and rational use of resources in a sustainable way.

Location Study

- World Biosphere Reserve, Can Gio Mangrove Forest
- World Biosphere Reserve, Thanh Phu Mangrove, Bến Tre Province (Southern)
- Mat-Ganh Hao's Mangrove Forest, Bac Lieu Province (Southern)
- Alluvial ground (remains of mangrove forest) Van Don, Quang Ninh province (Northern region)
- River mouth, Gianh river tidal area, Quang Binh province (Central region)

Research Methods

- Survey combined with integrated method (secondary data) (160 samples)
- Survey by site, by zoning (8 areas × 8 samples = 64), according to the characteristics, where there is still forest compared to where there is no forest: Under the plant association (Mấm, Duoc, Ban).

Specific methods

+ Peanut worm sampling method

Use a measuring frame of 1 m^2 to accurately determine the sampling limit. Use a hoe to dig, turn the soil over and collect samples of Peanut worm. Samples are stored in boxes marked with separate symbols for each measurement plot in each tidal zone and different forest types.

In order to keep the soil peanut worm samples alive, the boxes contain absorbent cotton wool and some soil at the sampling site.

+ Sampling method of soil, mud, organic remnants

Use special tools to collect soil samples at a depth of 20 cm and 40 cm in the measuring plots with the presence of Peanut worms and where there is no presence of Peanut worms. After that, the collected soil samples were analyzed at the Department of Soil Resources, the Institute of Geography in Ho Chi Minh City, the National Institute of Science and Technology.

+ Analytical methods to identify species

- Compared with standard samples in terms of morphology
- Combination of PCR method

+ Analytical, physicochemical, biological (University laboratory) criteria

- Total protein, soluble protein, minerals, non-replaced amino acids

+ Methods of determining viability and conservation:

- Experimental arrangement in greenhouse, combined with field culture: experiment $10m^2$/plot, with border to keep the plots
- Monitor the growth of individual biomass: weigh 10 individuals at random

+ Peanut worm sampling method

Use a measuring frame of 1 m^2 to accurately determine the sampling limit. Use a hoe to dig, turn the soil over and collect samples of Peanut worm. Samples are stored in boxes marked with separate symbols for each measurement plot in each tidal zone and different forest types. In order to keep the Peanut worm samples alive, the boxes contain absorbent cotton wool and some soil at the sampling site.

+ Methods to study the composition of food in the intestines:

Collect samples of Peanut worm in the field, dissect immediately, take the intestines and stomach of Peanut worm soaked in 5% formaline. The feed composition study sample must be fixed with formaline immediately after sample collection so that the food composition in the intestines cannot be fully digested. The analysis sample is taken so as to ensure representativeness between geographical areas and tidal zones.

Using a Nikon E 600 fluorescence microscope with 10 × 10 magnification; 40 × 10; 100 × 10 to observe and analyze the food composition in the intestines of Peanut worm.

$$m = N / n$$

Where: m is the average density of Peanut worm (individual/m^2);

N is the total number of individuals of Peanut worm collected in all sample plots.

n is the total number of sample plots surveyed.

+ Nutritional analysis method:

Collect and preserve live samples by putting peanut worm into a sample container with damp cotton soaked in water in the forest soil, and the moist soil was taken right at the sampling site. Then immediately brought to the laboratory for analysis of total protein by AOAC method 2002 and analysis of amino acid content by HPLC method (high pressure liquid chromatography).

Statistical processing, finding reliability: experiment 4 times, CV < 15%; $p < 0.05$

+ Methods of data analysis and processing:

Using Microsoft Excel and Stagraphic Plus 3.0 software to process and evaluate the collected data, draw graphs, build correlation equations between the criteria: length, stem diameter and weight of Peanut worm at Can Gio and Thanh Phu, Quang Binh, Quang Ninh.

3. RESEARCH RESULTS

3.1. Integrating research results related to the possibility of using Peanut worm as food: The ability to provide essential nutrients

Research overview in Vietnam

In the coastal area of Vietnam, 21 species of Peanut worm Sipuncula are known. The most common are genera Phascolosoma, Sipunculus and Siphonosoma in tidal and subtidal areas. In coral reefs, species of Aspidosophon, Cloeosophon and Lithacrosiphon are common, in which *Aspidosiphon steenstrupii* is the species that destroys coral reefs. Some species are used as food, such as the earthworm *Phascolosoma arcuatum*, which is highly concentrated in the mud in the mangroves, and the worm *Sipunculus nudus*, which lives in the intertidal zone, in the bedrock.

Do Van Nhuong (1998) recorded 20 species in Vietnam. They live in the bottom of mangrove forests in Mong Cai (Quang Ninh) and Can Gio (Ho Chi Minh City). Peanut worms are concentrated in certain areas and thrive in all four seasons (Mong Cai) or only dry and rainy seasons (Can Gio) [5]. Bui Quang Nghi (2009) also discovered Peanut worm in the mangrove areas of Ben Tre province and studied the ecology of this animal [6]. Le Huy Ba et al. (2006) found and conducted research (for student, MS student and PhD student in Peat worm environment from 1990 to present at Can Gio mangrove forest, Thanh Phu mangrove forest), Ben Tre, Nha Mat, Bac Lieu and Tay Ngoc Hien mangrove forests, Ca Mau [7]. Since then, Le Huy Ba et al. proposed a project to assess the risk of extinction and build a conservation database towards commercial farming of this species in mangroves in Vietnam, firstly for HCMC from 2013 to 2015 [5-7].

In 2004, Nguyen Thi Thu Ha et al. studied *Sipunculus nudus* species in relation to the geological and environmental features of the coast of Quang Ninh [8]. According to the results of this study, *Sipunculus nudus* lived in the subtidal zone with few aquatic plants, light waves and winds, weak alkalinity, high and stable salinity and with low heavy metals and sand in the sediments accounting for 80%.

Bui Quang Nghi et al. (2009) showed that Peanut worms are distributed in clay-mud soil with a density of 13.3 individuals/m^2 in Ben Tre [6]. Le Huy Ba et al also have researched on Peanut worm in Can Gio mangrove forest and there is a research project on conservation of this species at the above site [9]. In 2007, studies on *Sipuncula* sp. in Nha Trang Bay in Khanh Hoa province by Murina showed that there were 8 species belonging to 6 genera and 5 families, of which three species were newly recorded for the coastal area. They are Aspidosiphon muelleri kovalevskii, Aspidosiphon (Akrikos) mexicanus and Onchnesoma steenstrupii steenstrupii [10]. The report of the Asia-Pacific Network for Global Change Research Project (2011) also showed that there are 20 species of 11 genera and 5 families at the same site [11]. The latest published work in this area is by Adrianov and Maiorova (2012) which records the same number of species, genera and families as published by APN, but there are 15 new species for Nha Trang Bay and one new species for the East Sea, i.e Nephasoma pellucidum [12]. On the topic of resource assessment in Vietnam, there are research results by Nguyen Huu Khanh [13], Nguyen Quang Hung et al studying biological characteristics and proposing solutions for sustainable use of natural resources of peanut worm (*Sipunculus nudus*) in Quang Ninh [14] and research to secure and develop peanut worm resources in Vietnam [15].

Especially in 2015, the Intellectual Property Office of Viet Nam issued a Decision on the granting of Geographical Indication Registration Certificate No.00047 for Van Don peanut worm products (Quang Ninh) [16].

3.2. Nutritious value of Peanut worm

A number of studies in China and Vietnam have recorded that Peanut worm body contains a lot of protein and 18 amino acids including essential amino acids for the body [17].

In dry body of Peanut worm, there are about 10.3% free amino acids, including glycine (3.2%), alanine (2.5%), glutamic acid (0.25%), succinic acid (0.35%) (which are amino acids that create sweet taste for worms). Among other amino acids are taurine (3.2%), gamma-aminobutyric acid, serine, aspartic acid, minerals (1.2%). Research at Guangzhou Agricultural University found that when hydrolysing Peanut worm with papain yeast, a mixture containing a lot of oligopeptides (60.60%) and many minerals such as P, Fe, Mg, Mn, Zn, Cu will be obtained. Oligopeptides are made up of amino acids, including essential amino acids for the body. This mixture has very strong antioxidant activity when tested with 1,2,3 phentriol (Journal of Food Science and Biotechnology No.03-2007). Another study recorded the anti-aging ability of Peanut worm extract with saline, then collected the sediment with alcohol and tested it on mice and drosophilia flies. It was observed that the survival time of rats was significantly increased when fed food containing wormwood extract and the survival time of drosophilia was also prolonged when the concentration of 0.156% extract was added to the feed. Research at the University of Oceanography, Qingdao (China) on the composition of the wormwood showed that the methanol extract of the wormwood extract included 4 compounds such as cholesterol, stearic acid, cyclo-(L-Pro-L-Ala) and Thymidine (Chinese Journal of Marine Drugs No. 05-2008). Determination of Immune System Activity in Rats of polysaccharides extracted from wormwood was studied at Guangdong University of Oceanography and found that these crude polysaccharides have the ability to help counteract weight loss of thymus glands and spleen induced by cyclophosphamide, while protecting mice against leucocytopenia, and improving phagocytic activities (Journal of Guangdong Ocean University No. 04-2007). The self-healing ability of Sipinculus nudus has been studied at the Institute of Histology and Embryology, University of Palermo (Italy) and has recorded some active processes of type I and type II granulocytes to create wound closure. The first stage of progression occurs after 24 h involving type I activity and after 70 h in type 2 cells. These studies help to learn more about the body's cell activities during injury and the potential for using cytokines extracted from wormwood to promote wound healing (ISJ Issue 2-2005).

3.3. The potential of Peanut worm as a food source

3.3.1. Species *Siphonosoma australe australe*

Research results show that *Siphonosoma australe australe* lives in tidal areas along rivers or mangroves with water depth from 0.76 to 1.62 m. At water depth < 0.76 m, we did not find their burrow. It proves that *Siphonosoma australe australe* does not live in the high-tide area. This species lives in mud or sand caves encountered depth of 0.62 - 0.77 m, where the soil temperature is from 24.7 - 25.8 °C, the salinity is 13.92 - 19,930/00 and the pH of water from 7.32 to 8.51. Samples were obtained from all 10 study sites, on sandy beaches and where there are perennial mangroves. However, according to Zhou and Li, this species lives in the bottom mud from the intertidal zone to a depth of 600 m and in caves up to 50 m deep [4].

- Correlation between body size and bio-mass

When analyzing the size and weight of 266 individuals of *Siphonosoma australe australe*, we divided the collected samples into three size groups based on the length of the largest and the smallest Peanut worm, each distance in the size group. size is 90 mm: 210 - 300 mm (small group), 305 - 399 mm (medium group), 426 - 509 mm (large group). The results show that the body length ranges from 210 - 509 mm, with an average of 353.3 mm; weight from 17.7 to 58.8 g, average 33.4 g [17].

On the other hand, our results show:

- In the small size group, the length ranges from 210 - 300 mm and the corresponding weight is 17.7 - 21.9 g, accounting for 34.2%.

- In the medium size group, the length ranges from 305 - 399 mm and the corresponding weight is 25.6 - 53.7 g, with the most dominant amount (51.23%).

- In the large size group, the length ranges from 426 to 509 mm with the corresponding weight of 33.5 - 58.8 g, accounting for the lowest amount (14.6%).

Thus, the most commonly encountered size group is the medium size group (305-399 mm), followed by the small size group and the lowest probability is the large size group.

Specifically, in 20 analyzed samples representing size groups, the average body length was 213.8 ± 55.4 mm. Most of the individuals in this group have a body length greater than 130 mm (ranging from 33.6-317.5 mm). The mean body mass was 33.4±13.4 g (ranged from 16.49 g up to 56.74 g). We also observed a positive correlation between body length and body mass.

Through the integrated method, we found that the ratio between the proboscis length and the body length ranges from 25% to 47%, the average ratio is 36% (the length of the spout is less than half of the body length). Compared with that described by Cutler (1994), the analyzed samples had a larger body length (317.5 mm vs 200 mm, while the number of longitudinal muscle bands (LMBs) was less (15-17 vs. 15-20) This difference is within the allowable range when determining the species and subspecies of the genus Siphonosoma.When morphologically describing the species *Siphonosoma australe australe* in Nha Trang Bay, APN's report (2007) stated that they have body length is 150 mm, trunk length is equal to proboscis length and has 15-16 longitudinal muscle bands (APN, 2007). Adrianov and Maiorova (2012) also reported the body length of 150 mm and thetrunk length was shorter than the spout length with 50 rows of hooks and 15-16 longitudinal bands.These results are all within the minimum and maximum values we have shown above.

3.3.2. Sipunculus nudus Linnaeus, 1766

Distribution of *Sipunculus nudus:* Research results show that *Sipunculus nudus* is distributed in the lower part of Gianh river in Quang Binh province, found in the tidal area with a depth of 1.2 - 1.8 m. This species lives in burrows with sandy soil with a depth of 0.45 - 0.55 m, where the soil temperature is 25.2 - 25.7 °C, the salinity is 16.3 - 17.90/00 and the pH of water is 7.61 – 8.03. Compared with *Siphonosoma australe australe*, *Sipunculus nudus* species is distributed at lower tide level (low-tidal zone), the soil in which *Sipunculus nudus* species lives is sandy loam [17].

Diameter and length characteristics: Because the population of this species is very rare, it is not possible to collect many samples for statistical analysis. Analytical samples (descriptor denominator SD 3, morphological sample SD 41 and SD 42) had body lengths of 119.69 mm and 148.29 mm; weight 9,065 g and 8,201 g, average 8.6 g; hose length 44.54 mm and 36.08 mm; average body length 164.2 mm; body diameters 10.56 mm and 9.72 mm; The body when alive is gray-pink, when dead it is milky white. The body is worm-shaped but not segmented, the front has a proboscis that can be retracted or stretched very quickly [17].

Body diameter, length, and bio-mass characteristics

Besides, the resuts showed that the average density of Peanut worm in the survey area is 11.89 individuals/m^2, distributed mainly in high and mid-tidal areas but not in the low-tidal areas. Density of Peanut worm is highest in the mid-tidal zone (22 worms/m^2) [17].

In the other hand, in Thanh Phu mangrove forest, in the naturally regenerated forests of Mam and Da lime, we found worms with the average weight and the largest length, while in the pure mangrove forest, the average weight and length is smallest.

In Can Gio, Peanut worms in mangrove forest also have the smallest weight and length, but peanut worms have the largest average weight and length in the naturally regenerated forests of Avicenia and *Acrostichum aureum* L.

3.3. Nutritional value of Peanut worm species

Peatnut worm samples in the intertidal zone of Gianh River were sent for analysis at the Center for Analysis and Experimentation of Ho Chi Minh City (CASE). The results of the nutritional composition of two Peanut worm species showed that the average total protein content of *Siphonosoma australe australe* species was 11% and Sipunculus nudus species was 9.79% (compared to fresh meat weight). In particular, in Peanut worm meat, there are also 18 kinds of amino acids, including 8 non-replaceable amino acids that are essential for the human body such as methionine, valine, lysine, leucine, isoleucine, histidine, phenylalanine, threonine with rather high content (Table 1).

Table 1. Results of analysis of protein composition and amino acids present in species *Siphonosoma australe australe*

No.	Parameter	Symbol	Unit	Result
I	Protein		%	11
II	Arginine	ARG	%	0.91
III	Cystine	CYS	%	0.02
IV	Total amino acids			
1	4-Hydroxyproline	HYD	mg/g	0.5
2	Alanine	ALA	mg/g	5.3
3	Aspartic acid	ASP	mg/g	11.1
4	Glutamic acid	GLU	mg/g	17.6
5	Glycine	GLY	mg/g	6.0
6	Histidine	HIS	mg/g	2.5
7	Isoleucine	LLE	mg/g	4.0
8	Leucine	LEU	mg/g	7.7
9	Lysine	LYS	mg/g	7.0
10	Methionine	MET	mg/g	1.5
11	Phenylalanine	PHE	mg/g	4.4
12	Proline	PRO	mg/g	4.2
13	Serine	SER	mg/g	3.9
14	Threonine	THR	mg/g	3.7
15	Tyrosin	TYR	mg/g	4.5
16	Valine	VAL	mg/g	4.5
Total				88.6

(Note: CV = 11%, $p < 0.05$)

Table 2. Results of analysis of protein composition and amino acids in *Sipunculus nudus*

No.	Parameter	Symbol	Unit	Result
I	Protein		%	9.79
II	Arginine	ARG	%	0.96
III	Cystine	CYS	%	0.02
IV	Total amino acids			
1	4-Hydroxyproline	HYD	mg/g	0.4
2	Alanine	ALA	mg/g	4.0
3	Aspartic acid	ASP	mg/g	7.5
4	Glutamic acid	GLU	mg/g	13.9
5	Glycine	GLY	mg/g	4.8
6	Histidine	HIS	mg/g	1.8
7	Isoleucine	LLE	mg/g	3.2
8	Leucine	LEU	mg/g	5.6
9	Lysine	LYS	mg/g	5.3
10	Methionine	MET	mg/g	1.3
11	Phenylalanine	PHE	mg/g	3.3
12	Proline	PRO	mg/g	2.9
13	Serine	SER	mg/g	2.9
14	Threonine	THR	mg/g	3.1
15	Tyrosin	TYR	mg/g	2.8
16	Valine	VAL	mg/g	3.2
Total				66.2

Table 3. Comparison of amino acid content in species *Siphonosoma australe australe* and species *Sipunculus nudus*

No	Parameter	Symbol	Unit	*Siphonosoma australe australe*	*Sipunculus nudus*
I	Protein		%	11	9.79
II	Arginine	ARG	%	0.91	0.96
III	Cystine	CYS	%	0.02	0.02
IV	Total amino acids				
1	4-Hydroxyproline	HYD	mg/g	0.5	0.4
2	Alanine	ALA	mg/g	5.3	4.0
3	Aspartic acid	ASP	mg/g	11.1	7.5
4	Glutamic acid	GLU	mg/g	17.6	13.9
5	Glycine	GLY	mg/g	6.0	4.8
6	Histidine	HIS	mg/g	2.5	1.8
7	Isoleucine	LLE	mg/g	4.0	3.2
8	Leucine	LEU	mg/g	7.7	5.6
9	Lysine	LYS	mg/g	7.0	5.3
10	Methionine	MET	mg/g	1.5	1.3
11	Phenylalanine	PHE	mg/g	4.4	3.3
12	Proline	PRO	mg/g	4.2	2.9
13	Serine	SER	mg/g	3.9	2.9
14	Threonine	THR	mg/g	3.7	3.1
15	Tyrosin	TYR	mg/g	4.5	2.8
16	Valine	VAL	mg/g	4.5	3.2
Total				88.6	66.2

(Note: CV = 14%; $p < 0.05$)

It is noted that the content of amino acids in each species is different. The total amino acid ratio in the species *Siphonosoma australe australe* was 88.6 mg/g which was higher than that in the species *Sipunculus nudus* (66.2 mg/g). Considering each amino acid separately, *Siphonosoma australe australe* also gave higher results (Table 3). Among them, Glutamic amino acid accounted for the highest content. 17.6 mg/g in *Siphonosoma australe australe* and 13.9 mg/g in *Sipunculus nudus* species. This is an amino acid that plays an important role in metabolism of nerve cells and brain while helping to detoxify waste products secreted by brain activity.

Table 4. Comparison of flesh compositions of *Siphonosoma australe australe* and *Sipunculus nudus*

TT	Analytical indicators	*Siphonosoma australe australe*	*Sipunculus nudus*
1	Initial humidity (%)	73.03	80.63
2	Bonding humidity (%)	7.72	10.50
3	Total humidity (%)	75.11	82.67
4	VCK (%)	24.89	17.33
5	CP (%NT)	20.10	13.86
6	CP (%VCK)	80.73	79.94
7	Ash (%NT)	1.75	2.92
8	Ash (%VCK)	7.02	16.87
9	CF (%NT)	0.03	0.14
10	CF (%VCK)	0.12	0.83
11	EE (%NT)	0.21	0.23
12	EE (%VCK)	0.84	1.30
13	NfE (%VCK)	11.29	1.06

(CV=17%; $p<0.05$)

Whereas:

VCK (%): Content of dry matter in the analyzed sample (%)

CP (%NT): Total protein content as-is (%)

CP (%VCK): Total protein content on dry matter (%)

Ash (%NT): Total mineral content as-is (%)

Ash (%VCK): Total mineral content on dry matter (%)

CF (%NT): Total fiber content as-is (%)

CF (%VCK): Total fiber content on dry matter (%)

EE (%NT): Total lipid content as-is (%)

EE (%VCK): Total lipid content on dry matter (%)

NfE (%VCK): Non-nitrogen derivative content on dry matter (%)

According to the analysis results, *Siphonosoma australe australe* was observed to contain quite high mineral content (7.02%), especially in *Sipunculus nudus* species this content accounts for up to 16.67% dry matter which is sufficient for the daily need of human body.

In addition, the analysis results also showed that the lipid content in the flesh of Peanut worm accounts for 0.84% and 1.30%, respectively for *Siphonosoma australe australe* and *Sipunculus nudus*. Lipids are solvents that transport fat-soluble vitamins (such as vitamins A. D. E. and K). The entry of these vitamins into the body largely depends on the content of lipids in the food. This means that when dietary lipids are low, the absorption of these vitamins is reduced. This makes lipids important as fat-soluble vitamins are vital for vision functions, immune response, hematopoiesis growth and anti-aging, etc. Another important ingredient in the flesh of Peanut worm is fiber which is accounted for 0.83% (in *Sipunculus nudus* species) and 0.12% (in *Siphonosoma australe australe* species).

In 2004 a group of scientists from the University of Natural Sciences - Vietnam National University Ho Chi Minh City conducted an analysis of the components of *Sipunculus nudus* and found that in the meat of this species contains 17 mineral elements such as sodium, potassium, iron, zinc, etc.; 7 kinds of irreplaceable amino acids, 10 other amino acids that are essential for human. This result is similar to our analysis results for peanut worm living in Gianh river - Quang Binh [17].

The results of meat analysis in the laboratory - Faculty of Animal Husbandry and Veterinary Medicine. University of Agriculture and Forestry - Hue University provided the evaluation data on the nutritional composition of the meat of two species of peanut worms including dry matter content, total protein content, total mineral content, total fiber content, total lipid content and also non-nitrogen derivatives content. The total protein content as-is in the species *Siphonosoma australe australe* was 20% higher than that in the species *Sipunculus nudus* (13.86%). When analyzing the total protein index calculated by dry matter, the same results were obtained for *Siphonosoma australe australe* species at 80.73% and *Sipunculus nudus* at 79.94%. This result also shows that the protein content in peanut worm is very high (Table 5).

Table 5. Composition of amino acids present in peanut worm (General)

No	Analytical indicators	mg/g	No	Analytical indicators	mg/g
1	ASP (Aspactic)	22.08	10	TYR (Tyrozine)	83.59
2	GLU (Glutamic)	46.35	11	VAL (Valine)	18.6
3	SER (Serine)	34.94	12	MET (Methionine)	23.69
4	GLY (Glysine)	8.22	13	CYS (Cystine)	10.52
5	HIS (Histidine)	49.54	14	ILEU (Isoleusine)	12.45
6	ARG (Arginine)	92.92	15	LEU (Leusine)	21.29
7	THR (Threonine)	4.10	16	PHE (Phenylalanine)	31.59
8	ALA (Alanine)	13.96	17	LYS (Lysine)	24.24
9	PRO (Proline)	5.29		Method	HPLC

(analytical sample 4 replicates; CV= 12%; $p < 0.095$)

Thus, compared with the peanut worm species in the central Gianh river and in the mangroves in the south, they are relatively similar. However, there is more than 1 type of amino acid compared to the species in the southern mangroves. In which, the amino acid content in the southern mangroves is much higher than in the central region, the Gianh river mouth.

3.4. Community review of Peanut worm food

Currently, in the area along the Gianh River, there is a place specializing in processing specialties of Peanut worm. This is a destination for connoisseurs to enjoy delicious and exotic dishes. The shop owner said that the source of Peanut worm that they bought was from people

from Quang Nam and Binh Dinh who came here to dig and sell it to the shop. It is known that Sa Sung seafood is increasingly popular with customers [17]. In the past, when monosodium glutamate was not yet born, people still used safflower to make delicious pho broth. Today, Peanut worm is on the menu of seafood restaurants, especially grilled dishes. Processing Peanut worm must be very meticulous, because it has to be turned out and rubbed thoroughly with salt to remove the sand and fishy smell. Fresh Sa Sung can be processed into dishes such as sweet and sour stir-fry or fried, grilled food.

4. CONCLUSION

From the results of many experiments over many years, combined with many other studies, we firmly concluded that Peanut worm is a nutritious ingredient with many diverse and rich ingredients such as protein, essential amino acids, lipid, mineral elements, fiber and vitamins. Therefore, Peanut worm is a valuable food source and therefore should be properly protected and conserved.

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TÓM TẮT

TIỀM NĂNG SỬ DỤNG SÁ SÙNG (*Sipuncula*) LÀM THỰC PHẨM

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Nghiên cứu chỉ ra rằng Sá sùng (*Sipunculus nudus* và *Siphonosoma austral*e) có chứa các thành phần dinh dưỡng cao và đa dạng. Chúng bao gồm hơn 17 nguyên tố khoáng như sắt, mangan, canxi, kẽm, niken, v.v. và hàm lượng protein cao với 18 loại axit amin như glyxin, alanin, glutamine, taurine, v.v. Có 12,77% lipid bao gồm 12 axit béo no, 5 axit béo không bão hòa đơn và 13 axit béo không bão hòa đa. Ngoài ra. hàm lượng nước, chất xơ, carbohydrate và vitamin A, B1, B6, B12, E… trong loại sinh vật này cũng khá cao. Vì có các thành phần dinh dưỡng quý giá này nên Sá sùng thường được dùng làm thực phẩm chức năng và cũng có thể tạo sinh kế cho người dân trong khu dữ trự sinh quyển rừng ngập mặn.

Từ khóa: Sá sùng, *Sipunculus nudus*, *Siphonosoma australe*, thực phẩm chức năng.