MARINE WOOD BORER NUTRIENTS FROM MANGROVE FOREST OF WEST KALIMANTAN INDONESIA FOR NEW FOOD SOURCES

Farah Diba
Forestry Faculty
Tanjungpura University, Indonesia
farahdiba@fahutan.untan.ac.id
ORCID ID: 0000-0002-3906-6168

Bayu Wanamukti
Forestry Faculty
Tanjungpura University, Indonesia
bwanamukti@fahutan.untan.ac.id

Rosmiati
Forestry Faculty
Tanjungpura University, Indonesia
rosmiati@fahutan.untan.ac.id

Gusti Eva Tavita
Forestry Faculty
Tanjungpura University, Indonesia
getavita@fahutan.untan.ac.id

Khairul Adha A Rahim
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak, Malaysia
email: akhairul@frst.unimas.my

Chen Cheng Ann
Borneo Marine Research Institute
Universiti Malaysia Sabah
Malaysia
email: chengann@ums.edu.my

Abstract

Marine wood borer is one of wood destroying organisms which found in mangrove forests. They have an important function as bio-indicators on environment. The purpose of this research is to analysis the nutritional content of fresh marine wood borer and flour from marine wood borer. The method used consists of the inventory of marine wood borer at the Polaria mangrove forest, Mempawah Regency West Kalimantan Indonesia, and analysis of fresh marine borer nutritional content and marine borer flour. The analysis included of moisture content, ash content, protein, fat and carbohydrate which was carried out by proximate analysis method. The results showed that fresh marine wood borer weight was 780 gr. The yield of marine wood borer meat preparation was 88.46%. The average value of proximate analysis of fresh marine wood borer consist of moisture content was 13.58%, fat content was 3.90%, protein content was 10.60%, ash content was 16.17% and carbohydrate content was 55.75%. Meanwhile on marine wood borer flour obtained the moisture content was 4.57%, fat content was 6.28%, protein content was 40.65%, ash content was 26.54% and carbohydrate content was 21.96%. Analysis proximate showed that fresh marine wood borer obtained the higher results compared to the marine wood borer flour. This value includes the moisture content, and carbohydrates content. Nutrients analysis showed that marine wood borer has a potential to become a source for a food for human.

Keywords

food source, marine wood borer, mangrove forest, proximate analysis, West Kalimantan

1. Introduction

Mangrove forest in West Kalimantan has been used for ecotourism. One of the exotic places was located in Polaria Mangrove Forest in Mendalok village, Sungai Kunyit sub district, Mempawah Regency, West Kalimantan, Indonesia. This mangrove forest has a huge biodiversity on flora and fauna especially on marine wood borer. These unique animals were live on mangrove wood and classified as Phylum Bivalvia. Muslich et al (1988) stated marine wood borer was found in mangrove forest on vegetation of Bakau (*Rhizophora* sp) and Api-Api (*Avicennia* sp) and living in environment with water salinity around 10-30 ppm with temperature 10-30°C. Fillho et al (2008) stated they are tolerant to changes in salinity, temperature and oxygen availability and was abundant on January until April and have more decrease density on July. The live cycle of marine wood borer was from one year until several years. Eaton and Hale (1996) stated the shape of marine wood borer was like a worm, with length around 10-90 cm and have a soft body. This organism makes a hole in a wood and lives inside the wood. Waterburry et al (1983) stated marine wood borer can burrow into wood from18 cm until 200 cm and used the wood for shelter and food sources.

Marine wood borer also known as termite's sea and it's had a high protein and carbohydrate. The community in Luzon Island used marine wood borer as a food source (Anwar and Rosmawati 2013). Syaputra et al (2007) stated that the people in Bangka used marine wood borer as food and the local name was temilok brubus, and Hardinsyah et al (2006) stated the people in Papua eat marine wood borer and they said the local name was tembelo koo. Meanwhile in Philipine the people eat marine wood borer and said the local name was tamilok (Betia 2011). Marine wood borer can be used as medicine to overcome some diseases. Trindade-Silva et al (2009) stated the people in North Brasil used marine

wood borer as medicine for skin disease and infectious diseases. They called the marine wood borer as turu. The Kamoro tribe in Mimika Regency, Papua Province used marine wood borer as medicine for influenza, cough, rheumatic, increased the breast milk and man vitality (Hardinsyah et al 2006). The research on nutrition of marine wood borer from Indonesia especially from West Kalimantan was never been conducted. In fact, the marine wood borer was abundant and could be used as a food source. The objective of research was to analyses the nutrition of fresh marine wood borer, analyses the nutrition of marine wood borer flour and comparation the nutrition bet- ween fresh marine wood borer and marine wood borer flour.

2. Materials and Methods

The research was conducted in Polaria Mangrove Forest at Mendalok village, Sungai Kunyit sub district, Mempawah Regency, West Kalimantan Province, Indonesia. The forest area consists of three zone vegetations, i.e. *Rhizophora* sp, *Avicennia* sp and *Bruiguira* sp. The process of marine wood borer flour was conducted on Laboratory of Forest Technology, Faculty of Forestry, Tanjungpura University. Analysis of marine wood borer nutrition was conducted at Laboratory of Food Chemistry, Faculty of Agriculture, Tanjungpura University.

2.1. Inventory and sampling of marine wood borer

Inventory and sampling of marine wood borer was conducted on zona 1 of mangrove forest which consists of *Avicennia marina* species. This is the outer zone of Polaria mangrove forest in Mendalok village. The inventory and sampling were conducted by searched for logs which severely attacked by marine wood borer. The logs were opened carefully to find the marine wood borer. These organisms removed with forceps and collected in cool box containers. The morphological and ecological characteristics of the boring organisms recorded and photographed in their natural habitats.

2.2. Yield of marine wood borer

The weight of all marine wood borers which collect from the forest was measured. Then the head and pallet of each marine wood borer was removed. After that, all the body of marine wood borer was collected and measured to find the yield of marine wood borer. The powder of marine wood borer was made from the it's body and analysis the nutrients of marine wood borer and the powder of marine wood borer was conducted with proximate analysis. The yield of marine wood borer was measured with Halidah (2014) formula as follow:

$$\text{Yield (\%)} = \frac{\text{weight of marine wood borer body}}{\text{weight of marine wood borer body with head and pallet}} \times 100$$

2.3. Process of marine wood borer flour

The process of making a flour of marine wood borer was conducted based on Damayanti et al (2008) with some mo- dification. This process was held on Forest Technology Laboratory, Forestry Faculty, Tanjungpura University. Marine wood borer was clean with sterile water and boil for 20 minutes. After that the sample was put inside the oven for 24 hours with temperature 80°C. Then the sample was put in desiccator for 10 minutes and refinery with mortar and filtered to get marine wood borer flour. This flour then used for analysis the nutrition in another laboratory.

2.4. Analysis the nutrients of fresh marine wood borer and marine wood borer flour

The analysis of the nutrition of fresh marine wood borer and marine wood borer flour was held on Laboratory of Food Chemistry, Faculty of Agriculture, Tanjungpura University. Analysis of nutrition consists of carbohydrates, protein, lipid, moisture content and ash content. The analysis was conducted based on proximate analysis by AOAC (2005). The ash content and moisture content were analysis with oven methods, the lipid was analysis with soxhlet methods, the protein was analysis with kjedahl methods and carbohydrates was analysis with by difference methods.

3. Results and Discussion

3.1. Yield of marine wood borer

There were five logs of *Avicennia* sp found which attacked by marine wood borer. The first log was 100 cm length and Ø 34 cm, the second logs was 200 cm length and Ø 38 cm, the third log was 93 cm length and Ø 27 cm, the fourth log was 300 cm length and Ø 43 cm and the last log was 400 cm length and Ø 62 cm. Total gram of marine wood borer from each log was difference. The first log was found 170 grams, the second log was 135 grams, the third log was 90 grams, the fourth log was 105 grams and the last log was 280 grams. The total number of marine wood borer collected from five logs was 780 grams. The length of marine wood borer was from 2 cm until 60 cm. Most of the logs which attack by marine wood borer were found near the beach.

This situation occurs because the environment was suitable for the marine wood borer to growth inside the logs. Maldonaldo dan Skinner (2016) stated the distribution of marine wood borer in mangrove forest of Rio de Janeiro was mostly in the wood near the beach and flooded with water. Hoppe (2002) found marine wood borer in mangrove forest

of Baltic in the logs near the beach with length 20-60 cm. Figure 1 show the log which attack by marine wood borer.

Figure 1. The log of *Avicennia marina* in mangrove forest Mempawah Regency West Kalimantan Indonesia which attack by marine wood borer

The total weight of fresh marine wood borer from Polaria mangrove forest in Mendalok village was 780 grams. The weight of fresh marine wood borer without head and pallet was 690 grams. The yield of marine wood borer to process into marine wood borer flour was 88.46%. This yield was high and as potential for a food source. Sipe et al (2000) stated marine wood borer's head shape is like a crescent moon and has a hard shell. The function of the head shell of marine wood borer was as a wood drill. Meanwhile the function of pallet was as a breathing process. Therefore, the marine wood borer head and pallet are not used as food.

3.2. Nutrition of fresh marine wood borer

The nutrition of fresh marine wood borer was analysis with proximate analysis; consist of moisture content, lipid, protein, ash and carbohydrate. The average moisture content of fresh marine wood borer from Polaria mangrove forest in Mendalok village was 13.58%. The research from Leiwakabessy (2011) on moisture content of marine wood borer from Andai beach at Manokwari Regency, West Papua was 82.72%. High water content in the marine wood borer body is related to the environmental conditions in which marine borer grows in wood which is submerged in water. The moisture content value of marine wood borer from Polaria mangrove forest was lower than the moisture content of marine wood borer from Papua Barat. Cragg et al (2009) stated the moisture content is one of the most important characteristics of food ingredients because water can affect the appearance, texture and taste of food. The water content in the food ingredients also determines the freshness and durability of the foodstuff. High water levels result in being easily attacked by fungi, bacteria, mold and yeast and there will be changes in food. The moisture content of marine wood borer from Mendalok mangrove forest Mempawah Regency was low and it is good to use as a food source.

The average lipid value of fresh marine wood borer from Polaria mangrove forest in Mendalok village was 3.90%, this value was higher than Leiwakabessy (2011) research which average lipid value only 0.28%. Lipid was storage energy in the body of marine wood borer. The amount of lipid was one indicator of the quality of the food source. Cakrawati and Mustika (2012) state lipid is one of the energy sources for human. Supply of lipid to energy was 2.22 higher the protein and carbohydrate. Lipid plays a role in providing energy, fat soluble vitamins, and a source of essential fatty acids. The function of lipid as the formation of cell membranes, emulsifying agents, body heat insulators, protecting body organs and together with proteins as a means of transport in metabolism.

The average protein value of fresh marine wood borer from Polaria mangrove forest in Mendalok village was 10.60% meanwhile from Leiwakabessy (2011) research was 7.21%. Syaputra (2012) state protein was important because its plays a role as body building agent and a regulator in the body. The main function of protein is for tissue growth and maintenance, formation of essential compounds (hormones, enzymes, haemoglobin, blood clotting ingredients), regulation of water balance in the body, maintaining body neutrality, formation of antibodies and detoxification processes and transport of nutrients in the body. Aslamyah and Karim (2013) stated the protein of soil worm *Lumbricus sp* was 60-72%, meanwhile the result of research from Damayanti et al. (2008) stated the protein value of *Lumbricus rubellus* was 63%. This research showed that the protein value of marine wood borer was lower than soil worm.

The average ash content of fresh marine wood borer from Polaria mangrove forest in Mendalok village was 16.17%. The research from Leiwakabessy (2011) on ash content of marine wood borer fr[illegible] at Manokwari Regency, West Papua [illegible] showed that ash content of marine [illegible] mangrove forest in Mendalok villag[illegible] Andai beach at Manokwari Regency, W[illegible] the result of combustion of organic matter that is processed at high temperature. Combustion results produce good minerals and are widely known for their use as raw material for animal feed.

The average carbohydrate value of fresh marine wood borer from Polaria mangrove forest in Mendalok village was 55.75%, this value was higher than Leiwakabessy (2011) research which average lipid value only 7.72%. Mardalena dan Suryani (2016) stated carbohydrate was an organic compound which consists of carbon, hydrogen and oxygen. Carbohydrate plays a role as source of energy (glucose). The proximate analysis of fresh marine wood borer from Polaria mangrove forest in Mendalok village Mempawah regency West Kalimantan showed that the average value of lipid, protein, ash and carbohydrate was higher than marine wood borer from Andai beach at Manokwari Regency, West Papua.

3.3. Nutrition of flour marine wood borer

The raw material of marine wood borer was 403.46 gram and resulted in 4.12-gram flour of marine wood borer. The nutrition of flour made from marine wood borer then analysis with proximate analysis. The average value of moisture content was 4.57%, lipid was 6.28%, protein was 40.65%, ash content was 26.54% and carbohydrate was 21.97%. The flour of marine wood borer was shown on Figure 2.

Figure 2. The flour of marine wood borer

Leiwakabessy (2011) produced flour from marine wood borer with value of moisture content was 6.63%, lipid was 14.26%, protein was 42.77%, ash content was 5.88% and carbohydrate was 30.46%.The nutrients of flour from marine wood borer have fulfiled the standard for uses as a food source both for human and animal. The value of protein was high (40.65%) and carbohydrate was high (21.97%). These results showed that the flour from marine wood borer was potential as flour for animal feed such as for chicken, fish and bird. Marine wood borer has a sweet taste and the flour of marine wood borer is an innovation for high quality aquatic products from mangrove forest to be used as food sources. Anwar and Rosmawati (2013) conducted a research on made flour from marine wood borer on species *Bactronophorus thoracites*. The research found that the protein was 53.29%. Meanwhile Dewi et al (2017) made flour from soil worm *Lumbricus rubellus* and found that the flour has antioxidant and good for animal feed. The comparison of proximate analysis between fresh marine wood borer and flour of marine wood borer was shown in Table 1.

Proximate analysis	Value (%)			
	Fresh mwb from West Kalimantan*	Fresh mwb from West Papua**	Flour mwb from West Kalimantan*	Flour mwb from West Papua**
Moisture content	13.58%	82.72%	4.57%	6,63%
Lipid	3.90%	0.28%	6.28%	14,26%
Protein	10.60%	7.21%	40.65%	42,77%
Ash	16.17%	2.07%	21.97%	5,88%
Carbohydrate	55.75%	7.72%	26.53%	30,46%

*This research **Leiwakabessy (2011) Mwb : marine wood borer

Based on the nutrients of flour of marine wood borer has fulfil the standard for uses as a food source both for human and animal feed. Aslamsyah and Karim (2013) stated the use of flour from soil worm as feed for bandeng fish (milkfish/ *Chanos chanos*) has increase the protein and weight body of fish. The flour from soil worm has higher protein and lipid compare to the flour of fish feed. The flour from marine wood borer has a potential as food source for fish. The fish feed was the highest cost on fish farming and use the flour from marine wood borer as a fish feed will reduce the cost. The nutrients of flour marine wood borer were high, protein was 40.65%), carbohydrate was 26.53% and lipid was 6.28%. Nutrients analysis of fresh marine wood borer and flour marine wood borer from Polaria mangrove forest at Mendalok village Sungai Kunyit sub district Mempawah Regency, West Kalimantan showed that its potency as a food source for human and animal.

4. Conclusion

The nutrition of fresh marine wood borer from Polaria mangrove forest at Mendalok village Sungai Kunyit sub district Mempawah Regency, West Kalimantan Indonesia was high and good for a food source. The average value of protein was 10.60%, lipid was 3.90%, moisture content 13.58%, ash 16.17% and carbohydrate was 55.75%. The nutrients of flour of marine wood borer consist of moisture content was 4.57%, lipid was 6.28%, protein was 40.65%, ash content was 26.54% and carbohydrate was 21.97%. Both of fresh marine wood borers and flour of marine wood borer has a potential as a food source for animal feed and human.

Acknowledgments

The authors would like to say thank you to Forestry Faculty, Tanjungpura University, Indonesia and SEAMEO BIOTROP for funding this research.

References

[1] Anwar L.O dan Rosmawati, 2013. Karakteristik Hidrolisat Protein Tambelo (Bactronophorussp.) yang Dihidrolisis Menggunakan Enzim Papain. Jurnal Biogenesis Vol 1(2) :133-140

[2] Aslamyah S. dan Karim MY. 2013. Potensi tepung cacing tanah lumbricus sp. Sebagai pengganti tepung ikan dalam pakan terhadap kinerja pertumbuhan, komposisi tubuh, kadar glikogen hati dan otot ikan bandeng Chanos forsskal. Jurnal Iktiologi Indonesia, 13 (1):67-76

[3] Association of Official Analytical Chemist [AOAC]. 2005. Official Methods of Analysis (18Ed). AOAC Inc. Mayland. USA

[4] Betia J. 2011. Palawan's Kinilaw na Tamilok. Journeyingjames Press. Philipines

[5] Cragg SM, Jumel MC, Al-Horani FA, Hendy IW. 2009. The life hystory characteristic of the wood-boring bivalve Teredo bartchi are suited to the elevated salinity, oligotrophic circulation in the Gulf of Aqaba, Red Sea. Journal of Experimental Marine Biology and Ecology. 375(1-2):99-105.

[6] Cakrawati, D. & Mustika, N.H. (2012). Bahan Pangan Gizi dan Kesehatan. Bandung: Alfabet

[7] Damayanti E, Sofyan A dan Julendra H. 2008. Daya Anti Mikroba Tepung Cacing Tanah Lumbricus rubellus dan Potensi sebagai Aditif dalam Pakan Ternak. Jurnal Biosfera 25 (3): 123-128

[8] Dewi NWS., Mahendra AN, Putra QWK, Jawi IM, Sukrama DM, Kartini NL. 2017. Ethanolic extract of the powder of red earthworm (Lumbricus rubellus) obtained from several organic farmlands in Bali, Indonesia: Analysis of total phenolic content and antioxidant capacity. Bali Medical Journal (Bali Med J) Vol 3 (3):S80-S83

[9] Eaton RA, Hale MDC. 1993. Wood, Decay, Pests and Protection. Chapman and Hall

[10] Fillho CS, Tagliaro CH, Beasley CR. 2008. Seasonal abundance of the shipworm Neoteredo reynei (Bivalvia, Teredinidae) in mangrove driftwood from a northern Brazilian beach. Iheringia, Sér. Zool. Porto Alegre, 98:17-23

[11] Halidah, 2014. Avicennia marina (Forssk.) Vierh Jenis Mangrove yang Kaya Manfaat. Balai Penelitian Kehutanan Makassar. 11(1): 37 – 44

[12] Hardinsyah, Sumule A, Letsoin J. 2006. Jenis dan jumlah konsumsi tambelo, siput dan kerang oleh penduduk di kawasan Muara Mimika, Papua. Jurnal Gizi dan Pangan 1:1-12

[13] Hoppe K. 2002. Teredo Navalis – The cryptogenic shipworm. In Invasive aquatic species of Europe. Distribution, impacts and management. Eds E. Leppäkoski, S. Gollasch and S. Olenin. Kluwer Academic Publishers, The Netherlands

[14] Leiwakabessy J. 2011. Komposisi kimia dan identifikasi senyawa antioksidan dari ekstrak tambelo (Bactronophorus thoracites). Tesis. Institut Pertanian Bogor

[15] Maldonado, G. C., & Skinner, L. F. 2016. Differences in the distribution and abundance of Teredinidae (Mollusca: Bivalvia) along the coast of Rio de Janeiro state, Brazil. Brazilian Journal of Oceanography, 64(4), 375-386

[16] Mardalena I dan Suryani E. 2016. Ilmu Gizi. Kementerian Kesehatan Republik Indonesia

[17] Muslich, M .1988. Laju Serangan Pholadidae dan Teredinidae Pada Beberapa Jenis Kayu. Jurnal Penelitian Hasil Hutan. Pusat Penelitian dan Pengembangan Hasil Hutan. Bogor

[18] Sipe AR, Wilbur AE, Cary SC. 2000. Bacterial Symbiont Transmission in the Wood Boring Shipworm Bankia setacea (Bivalvia: Teredinidae). Applied and Environmental Microbiology 66 (4);1685-1691

[19] Syaputra D, Ibrahim B, Poernomo D. 2007. Produk fermentasi ikan dari cacing kapal Bactronophorus sp segar. Jurnal Sumberdaya Perairan, 1:12-14

[20] Syaputra D. 2012. Ekstrak glikogen temilok (Bactronophorus thoracites) sebagai ko-presipitan asam deoksiribonukleat. Thesis. IPB Bogor

[21] Trindade-Silva AE, Machado-Ferreira E, Senra MVX, Vizzon VF, Yparraguirre LA, Leoncini O and Soares CAG. 2009. Physiological traits of the symbiotic bacterium Teredinibacter turnerae isolated from the mangrove shipworm Neoteredo reynei. Journal Genetics and Molecular Biology 32(3):572-581

[22] Waterbury JB, Calloway CB, Turner RD. 1983. A cellulolytic nitrogen fixing bacterium cultured from the gland of deshayes in shipworms. Science, 221:1401-1403