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Original Article

Nutritional profile of kian marine worm from Kei islands Maluku as a potential high protein food resource

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Abstract

The nutritional content of kian marine worm has never been reported. This study aimed to profile the nutritional content of worms from the Kei Islands, Maluku. Nutritional profiles were tested by proximate assays, atomic absorption spectroscopy (AAS), and High-Performance Liquid Chromatography (HPLC) of amino acids. The proximate analysis resulted in 71.16% of protein, 12.05% of water, 2.63% of carbohydrates, 2.21% of fat, 2.14% of crude fiber and 0.44% of ash. Mineral contents of Kian marine worm were 785.28 mg/kg potassium, 585.14 mg/kg magnesium, 180.98 mg/kg calcium, 0.89 mg/kg sodium and 0.44 mg/kg phosphorus. Kian marine worms contained 9 essential amino acids and 11 essential amino acids with levels of essential amino acids up to 206.94 mg/g and non-essential amino acids was 233.21 mg/g. Nutritional content in kian marine worms can be used as a potential high protein food resource.

Keywords: Potential food, Kei islands, kian marine worm, Maluku, protein

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Introduction

The world's population has an estimated increase of 1.05% or 81 million people per year (United Nations, 2015). Indonesia as a developing country has a growth rate percentage every year up to 1.49% or 3.5-4 million people (Badan Kependudukan dan Keluarga Berencana Nasional (BKKBN), 2016). The increase in Indonesia's population and globally has an impact on the ability to provide human necessities, especially in food production. This case has an effect on the lack of fulfillment of the basic nutritional requirements of inhabitants and caused several parts of society with low nutrient status. Indonesia as a developing country is trying to solve the problem of low nutrition or malnutrition, especially stunting issues in infants and toddlers (Hayati et al., 2012).

Maluku is one of Indonesia's regions with a low nutritional status with a high number of toddlers who are stunted according to WHO standards (Beal et al., 2018). Stunting is impairing growth in children, including body and brain growth due to long-term malnutrition, which resulted in children with shorter than healthy children at their age and slow response to cognitive achievement (Ni'mah & Nadhiroh, 2015). Based on Basic Health Research in 2018, toddlers under five years old under stunting in Maluku province reached 31.4% (Ministry of Health Republic of Indonesia, 2018). Based on the results of Nutrition Status Monitoring, the percentage of stunting in Maluku increased at children under five years old from 29% in 2016 and up to 30% in 2017 (Patty, 2019).

Improvements in nutritional status should be made by improving food intake. Food consumed by the people must be classified as functional foods, namely foods that benefit the health of the body (A. Pamungkas et al., 2014). Functional foods has have a composition of essential nutrients required by the body including sufficient macronutrients and micronutrients. Macronutrients are nutrients that are needed by the body in large amounts, namely of carbohydrates, protein and fat. Micronutrients are nutrients that needed by the body in small amounts, namely vitamins and minerals (Hans & Jana, 2018). Protein is an important component on in improving nutritional status. Protein is closely related to growth and development process (Sediaoetama, 2012). Protein contains amino acids which have an essential role in metabolic processes such as the formation of neurotransmitters, purine/pyrimidine that arrange DNA chain (Rose, 2019), precursors for hormone formation, muscle activity (contraction and relaxation), regulating gene expression, etc (Wu, 2009). Several metabolic processes and biochemical pathways that lack or lose amino acid amine groups should be replaced through food consumption (Rose, 2019).

Indonesia has a high abundant abundance of biodiversity which contains a wide range of natural resources (Husen et al., 2017) especially in the marine field. *The worm is not local wisdom, but consuming it as a meal can be classified as local wisdom.* Based on the results of interviews with indigenous people of the Kei Islands, the existence of marine worm namely kian marine worms in the Kei Islands is very abundant, there are several places as habitats for these worms such as Wab Village, Hoat Sorbay District. The Wab's society has consumed ian marine worms with various cooking methods like smoke Kian marine worm (Ngabalin &

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Talakua, 2017). However, the community in several Southeast Maluku Districts still lacks information about the benefits and the nutritional value of Kian marine worms.

The Kian marine worm is classified in the phylum of Nemertea. Marine worms as one of seafood has have higher nutrition compared with terrestrial organism especially it has superior source of various nutrients, such as protein, amino acids, fiber, vitamin and minerals (Hosomi et al., 2012). The benefit of consuming marine worms as local food in economic value is increasing the number of regional income because it will decrease dependency over imported foods (Rossi et al., 2017) and stimulate local economic development by creating jobs in some area (Coelho et al., 2018). Unfortunately, the beneficial of marine worms have not been used optimally yet in Indonesia. Moreover, the nutritional content of Kian marine worms from the Kei Islands has not been reported. The nutritional value of Kian marine worm can be used as information to develop a food candidate with high protein content.

Methods

Collection and preparation sample

Kian marine worm (Fig. 1) located in Uf beach were obtained by observing the presence of holes in the beach sand then digging these holes. 100 g of Kian marine worm were dried under the sunlight for 8 days, then oven for 3 days at 50ºC. Smashed using a blender to produce sea worm powder.

Figure 1. Kian marine worms from Kei island, Maluku

Proximate test

The proximate test includes testing the level of water, ash, crude protein, fat, crude fiber, and carbohydrate. The proximal test used proximate test protocol (Basu, 2013).

Water level

Measurement of water content used a gravimetric method. 5 g of kian marine worm powder were dried at 100ºC for 4-7 hours or until in constant weight, then cooled in a desiccator, then weighed.

$$\text{Water level (\%)} = \frac{(\text{initial weight} - \text{final weight})}{\text{final weight}} \times 100\%$$

Ash level

Measurement of ash levels used the gravimetric method. 5 g of kian marine worm was placed in a muffle furnace at 550ºC for 24 hours until it become became white ash. The final weight was measured.

$$\text{Ash level (\%)} = \frac{\text{final weight}}{\text{initial weight}} \times 100\%$$

Crude fiber level

Crude fiber level test used the gravimetric method. 4 g of kian marine worm added with 50 ml H_2SO_4 1.25%, boiled then destructed for 30 minutes. Added 50 ml of 3.25% NaOH and boiled for 30 minutes. Filtered using Whatman paper, the precipitate result was washed with H_2SO_4 1.25%, hot water, and 96% ethanol, respectively. The weight of filter paper was measured as the initial weight of paper. Filter paper then dried at 105ºC, and weighed as filter paper with residue.

$$\text{Crude fiber level (\%)} = \frac{(\text{weight of filter paper+residue}) - \text{filter paper}}{\text{sample weight}} \times 100\%$$

Protein level

Protein levels test used acid-base titration method. 0.25 g of Kian marine worm added with 0.25 g of selenium and 3 ml of concentrated H_2SO_4, destructed for 1-2 hours at 400ºC until the solution got clear. Added 50 ml of distilled water and 20 ml of NaOH 40%, distilled at 100ºC. Add 10 ml of 2% H_3BO_3 and 2 drops of bromocresol green-methyl red into distillate. Titrated with HCl 0.1 N.

Lipid level

Lipid content test used gravimetric extraction method. This test used a fat sleeve, soxhlet tube extractor chamber and benzene as a solvent. The result then dried in an oven at 105ºC and then the weight was measured.

$$\text{Lipid level (\%)} = \frac{\text{lipid weight}}{\text{sample weight}} \times 100\%$$

Carbohydrate level

Carbohydrate level calculation (%) = 100% - (water level + ash level + protein level + lipid level + crude fiber level)

Mineral levels test

Mineral assay used a spectrophotometric method. Measurements used atomic absorption spectroscopy (AAS) (Kryazhov et al., 2014) at 421.4 nm of wavelength.

$$\text{Mineral level (ppm)} = \frac{\text{absorbance x volume}}{\text{regression slope x sample weight}}$$

Amino acid level test

Amino acid level was tested using the High-Performance Liquid Chromatography (HPLC) method. 50 µl of the prepared sample was injected into the HPLC column at 40 ºC, Shim-pack VP ODS 5 µL 150 x 4.6 mm, flow rate 1 ml/minute, acetonitrile 60% as mobile phase, 0.1 M phosphate buffer, and wavelength at 450 nm. The amino acid level was shown in mg/g dry sample.

Data analysis

Data were analyzed descriptively to determine the nutrition content of Kian marine worm as potential high protein food resources.

Results

Based on the proximate test (Tab. 1), Kian marine worm contained high level of protein. Protein level in Kian marine worm reached up to 71.16%. The water level was 12.05% of the body's dry weight. Kian marine worms also contained fat, crude fiber, and carbohydrates with the percentage 2.21%, 2.14%, and 2.63%, respectively.

Table 1. Nutritional information of Kian marine sea worm based on proximate test

Proximate composition	Percentage (%)
Water	12,05
Ash	0,44
Protein	71,16
Lipid	2,21
Crude fiber	2,14
Carbohydrate	2,63

Based on HPLC analysis of 20 amino acids, the essential amino acid levels of Kian marine worm reached 206.94 mg/g and levels of non-essential amino acids reached 233.21 mg/g (Tab. 2). Amino acids are important components for the body and are involved in various metabolic processes in the body.

Table 2. Amino acid profile of Kian marine sea worm based on HPLC

Amino acid	Level (mg/g)
Threonine (Thr)	14.20
Valine (Val)	39.87
Methionine (Met)	12.20
Isoleucine (Ile)	21.50
Leucine (Leu)	30.14
Phenylalanine (Phe)	15.90
Histidine (His)	29.32
Lysine (Lys)	40.74
Tryptophan (Trp)	3.07
∑*essential amino acid*	206.94
Asparagine (Asn)	3.52
Serin (Ser)	17.13
Glutamic acid (Glu)	55.77
Proline (Pro)	14.24
Glycine (Gly)	17.86
Alanine (Ala)	24.45
Tyrosine (Tyr)	20.03
Argginine (Arg)	27.09
Aspartic acid (Asp)	45.73
Glutamine (Gln)	3.19
Cysteine (Cys)	4.20
∑ *non-essential amino acid*	233.21

Furthermore, mineral tests on Kian marine worms showed high potassium (K) level (Tab. 3). The potassium level of Kian marine worms was 785.28 mg/kg. Kian marine worms contained calcium (Ca) level at 180.98 mg/kg, magnesium (Mg) at 585.14 mg/kg, sodium (Na) at 0.89 mg/kg, and phosphorus (P) at 0.44 mg/kg.

Table 3. Mineral level in Kian marine sea worm

Minerals	Level (mg/kg)
Calcium (Ca)	180,98
Potassium (K)	785,28
Magnesium (Mg)	585,14
Natrium (Na)	0,89
Phosphorus (P)	0,44

Discussion

Kian marine worm, originaly from the Kei Islands, Southeast Maluku Regency is one of Maluku local wisdom. The existence of Kian marine worms in the Kei Islands is very abundant. Based on a proximate test, Kian marine worm contained 71.16% of protein. Protein level in Kian marine worm was higher than in Bangka-Belitung worm (*Xenosiphon* sp.) with 38.72% protein (Fakhrurrozi, 2011), wawo worm (*Palola* sp.) from Ambon with 54.72% protein (J. Pamungkas, 2015), and sea worms from Kendari, *Siphonosoma australe-australe* with 56.35% protein (Nurhikma et al., 2017). Protein is a crucial nutrient in the regeneration of cells and tissues (Erviani & Arif, 2017). The implication of lack protein is increasing of susceptibility over disease and causes growth disorder in children namely stunting (Raiten & Bremer, 2020). Proteins also have an important role in the formation of biomolecules, such as enzymes (Alberts et al., 2002). Protein is closely related to the immune system, low protein intake causes on a decrease of immune system (Akram et al., 2020). The water level in Kian marine worms was lower than in wawo worms (*Palola* sp.) with 10.71% water level (J. Pamungkas, 2015) and Kendari sea worms 13.69% water level (Nurhikma et al., 2017). The high protein level in Kian marine worm caused low water level in the worm's body (Adawyah, 2007; Yuarni et al., 2018).

High-quality of protein is determined by the type and proportion of amino acids. Proteins contained all types of amino acids in portions suitable for growth (Purwaningsih et al., 2013). If one amino acid is unavailable, either essential or non-essential, all the remaining amino acids cannot be used and undergo catabolism. This has an impact on the negative nitrogen balance (Engelking, 2015). Essential amino acids cannot be synthesized in the human body, although it plays an important role. As a result, they must be present in daily food. The essential amino acids for adults consist of lysine, leucine, isoleucine, threonine, methionine, valine, phenylalanine, and tryptophan, while the essential amino acids for children are added with arginine, glycine, and histidine. Non-essential amino acids consist of aspartic acid, glutamic acid, alanine, asparagine, cysteine, glycine, proline, tyrosine, serine, and glutamine (Engelking, 2015).

Essential amino acids have important functions for the body. Lysine and leucine are basic properties for antibodies, maintain tissue function, and improve the immune system (Li et al., 2007). Isoleucine is one of branched chain amino acid which play a major role in enhancing glucose consumption and utilization by up-regulating intestinal and muscular glucose transporters (Zhang et al., 2017). Threonine is widely used for poultry feed in case to optimalization of growth state and intestinal development morphology (Najafi et al., 2017). Feng et al. (2013) also reported that threonine improved growth, digestive and absorption capacity, and enterocyte proliferation and differentiation in juvenile Jian carp. Threonine might be had an essential role on growth and development process in the body. Methionine playsa role in metabolic processes, especially lipid metabolism, activation of endogenous antioxidants in the form of methionine sulfoxide reductase. Methionine also plays an important role in reducing free radicals and oxidative stress by increasing glutathione peroxidase (GPx) biosynthesis (Martínez et al., 2017). Valine is an amino acid with a branched-chain that is very important for metabolism and coordination of muscle tissue and nitrogen balance in the body (Bifari & Nisoli, 2017). Phenylalanine has a function as an anti-depressant. Phenylalanine plays a role in the formation of neurotransmitters such as dopamine, nor-epinephrine, and epinephrine (Akram et al., 2020). The amino acid threonine acts as an immunostimulant by increasing the thymus gland (Abbasi et al., 2014). The regulation of tryptophan is very critical for the maintenance systemic homeostasis related with its integrates essential pathways involved in nutrient sensing, metabolic stress response, and especially immune response (Gostner et al., 2020). Arginine plays in critical role on insulin secretion, growth hormone (Holecek & Sispera, 2016), and also prevent and treat various metabolic diseases such as cardiovascular disease, erectile dysfunction, and gastric hyperacidity (Gad, 2010).

The percentage of lipid levels in Kian marine worm was 2.21% and higher than lipid level of Kekuak (*Xenosiphon* sp.) with only 1.78% (Fakhrurrozi, 2011). Lipid content in Kian marine worms is different along with differences in nutrition in the habitat (Nurhikma et al., 2017; Silaban & Silaban, 2019). Marine lipid is very essential for health due to its function to treat various disease. Méndez et al. (2017) reported ω-3 polyunsaturated fatty acids (PUFAs), eicosapentaenoic (EPA) and docosahexaenoic (DHA) which were contained in marine lipids have been linked to treat cardiovascular diseases dan type 2 diabetes mellitus (T2DM). Kian marine worms also have crude fiber level 2.14%, meanwhile Kekuak (*Xenosiphon* sp.) only 1.06% of crude fiber (Fakhrurrozi, 2011). Carbohydrate level of Kian marine worm was 2.63% lower than *Siphonosoma austral-australe* sea worm with 5.06% carbohydrate level (Nurhikma et al., 2017). Low-carbohydrate diet could be used to improve glucose intake and expenditure in the body thus prevent various disease related with glucose levels such as diabetes (Eiswirth et al., 2018).

Potassium and sodium play an important role in maintaining fluid balance and maintaining body health (Pohl et al., 2013). Potassium also plays a role in nerve transmission of muscle relaxation. Lack of potassium can cause various diseases and increase oxidative stress in the body (Udensi & Tchounwou, 2017). The magnesium content in kian worms was 585.14 mg/kg. Magnesium is an essential mineral for the body because it is a co-factor for more than 300 enzymes that regulate various biochemical activities in the body. About 60% of total magnesium is stored in bones. Deficiency of magnesium can lead to various diseases, especially those related to bones and teeth for example osteoporosis (Castiglioni et al., 2013). Hermawan et al. (2015) stated that substrate significantly affects the ash content of marine worms, the sand substrate contains various minerals. Marine worms are a deposit feeder so they contain a lot of minerals in their bodies because they eat all the sediment in the substrate.

In conclusion, kian marine worm contained high protein level, essential minerals, and both of amino acids essential and non-essential that play an important role in biochemical processes in the body. Kian marine worm can be used as a potential high protein food resource to completing basic nutrition in the body.

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