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Nutritional values of the Indonesian mole crab, *Emerita emeritus*: are they affected by processing methods?

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Abstract. Marine mole crabs (*Emerita emeritus*) belong to a small genus of crustacean species. They are edible and could be developed to meet human nutritional needs. We determined the effects of various processing methods including boiling, steaming, and grilling on morphology and nutritional contents, and determined the optimal processing method. Fresh and processed marine mole crab samples were analyzed for their proximate, mineral, fatty acid, cholesterol, and amino acid compositions. Mole crabs are typically gray and have an oval body with a carapace length of 29.29 mm, a telson length of 20.78 mm, a telson width of 10.10 mm, and a weight of 7.34 g. They contain 74.90% moisture and 25.1% dry matter (38.52% protein, 8.76% fat, 35.63% ash, and 17.08% carbohydrate). The three processing methods had significant ($p < 0.05$) effects on the proximate, micro-mineral and saturated fatty acid. In contrast, they had no significant ($p > 0.05$) effects on the macro-mineral, total fatty acid, poly and monounsaturated fatty acid, total cholesterol, total amino acid and amino acid composition of the samples. Steaming was the optimal processing method yielding 25.00 g/100 g amino acids, 11.04 g/100 g minerals, 71.86 g/100 g fatty acids, and 2.11 g/100 g cholesterol
Key Words: biochemical composition, hippidae, Indonesia, mole crab, processing treatment.

Introduction. The fisheries and marine sector of the economy in Indonesia have great potential to be developed as a source for meeting community nutritional needs. One fishery commodity with high nutritional content is a group of crustacean species such as the marine mole crab, which belongs to the Hippidae family and lives in the intertidal zone (swash zone) (Wardiatno et al 2014). In Indonesia, marine mole crabs are found in southern coastal areas of Jawa Island such as Samas and Congot. Mursyidin (2007) identified marine mole crabs located in the coastal areas of Samas and Congot as *Emerita talpoida* and *Emerita analoga*. However, Wardiatno et al (2015) discovered six species of mole crabs in Indonesian waters. Since marine mole crabs contain high levels of nutrients, they could serve as a new food source. Mursyidin (2007) showed that *E. talpoida* and *E. analoga* contained 11.80% and 12.94% omega-6 fatty acid from total fat. Kardaya et al (2011) also showed that diets including 12.5% or 25% mole crab meat reduced cholesterol levels in mice (*Mus musculus*). These results indicate that mole crab has high potential as a source of animal nutrition.

Marine mole crabs are generally consumed in the form of “rempeyek”, a deep-fried Javanese cracker. The most commonly used processing methods applied to aquatic organisms include heating by boiling, steaming, roasting in an oven, frying, or grilling with charcoal (Garcia-Arias et al 2003).

Processing factors can affect the nutritional value of aquatic products. Jacoeb et al (2008) showed that the proximate and amino acid contents decreased in the mantis shrimp (*Harpiosquilla raphidea*) after boiling. Devi & Sarojnalini (2012) also reported that the proximate and mineral contents of *Amblypharyngodon mola* decreased after frying, steaming, and curry-making. In contrast, Santoso et al (2008) showed that the solubility of the minerals calcium (Ca) and zinc (Zn) increased in vannamei shrimp (*Litopenaeus vannamei*) after boiling. Similarly, Kocatepe et al (2011) showed that the proximate content of anchovy (*Engraulis encrasicolus*) increased after roasting, frying, and oven heating. Because information and data related to the effects of processing methods on the nutritional content of marine mole crab are limited, a comparative study on the effects of processing methods including boiling, steaming, and grilling was needed. In the present study, we evaluated nutritional parameters including the proximate, fatty acid, amino acid, mineral, and cholesterol contents of marine mole crabs (*Emerita emeritus*) before and after processing.

Material and Method

Sample materials. Marine mole crabs were collected from the coasts of Bocor, Bulus Pesantren, Kebumen District in Central Java, Indonesia (see Figure 4 in Wardiatno et al 2015). The marine mole crabs were cleaned and put in plastic bags before being frozen. The frozen samples were transported using a coolbox containing ice and stored at –18°C until subsequent analysis and processing.

Sample preparation. Whole mole crabs were divided individually into four portions including a fresh sample and portions to be boiled, steamed, or grilled.

Boiling. Mole crab samples were boiled in water in a pyrex baking pan for 10 min with a sample to water ratio of 1:4 (250 g sample:1000 mL water), and stored in plastic bags at –18°C until further analysis.

Steaming. Mole crab samples (300 g) were steamed in a stainless steel steamer containing boiling water for 10 min, and stored in plastic bags at –18°C until further analysis.

Grilling. Mole crab samples (300 g) were grilled on burning coals for 10 min and stored in plastic bags at –18°C until further analysis.

Morphological characterization. The morphological parameters observed in this study included body shape and color and morphometric measurements included telson length, telson width, carapace length, and weight.

Proximate analysis. The proximate chemical compositions of the samples were determined using a standard procedure (AOAC 2005). The crude protein content was calculated by multiplying the total nitrogen by a factor. The carbohydrate content was estimated by the difference.

Determination of mineral contents. Ash was determined by combustion of samples in a muffle furnace at 550°C for 12 h (AOAC 2005). The residue was dissolved in nitric acid (HNO_3) with 50 g L^{-1} of lanthanum chloride ($LaCl_3$), and the mineral constituents were analyzed separately using an atomic absorption spectrophotometer (Shimadzu AA-7000). Phosphorus (P) content was determined by the phosphomolybdate method (AOAC 2005) using a spectrophotometer (UV-VIS Spectrophotometer 200-RS).

Fatty acid analysis. The fatty acid compositions of the samples were determined using a gas chromatograph (Shimadzu) (AOAC 2005).

Cholesterol analysis. Cholesterol analysis was performed by dissolving fat extract in isopropanol before analysis using high performance liquid chromatography (HPLC) (Shimadzu LC-6A) (AOAC 2005).

Amino acid analysis. The amino acid compositions of the samples were determined using HPLC (Shimadzu LC-6A) (AOAC 2005).

Statistical analysis. Each batch of products was prepared twice. Determinations were carried out in triplicate, and errors were reported as the standard deviation from the mean. The experimental design of this study was a completely randomized design, and a relevant statistic software was used for analysis. P values less than 0.05 were considered statistically significant, and additional analysis was done using the advanced Duncan test.

Results and Discussion

Morphology of raw materials. The morphological parameters of mole crabs examined in the present study were shape, color, and morphometric measurements including telson length, telson width, carapace length, and weight. The body of the marine mole crab is slightly round (oval) and gray and has a uropod, antennae, a bilaterally symmetric abdomen, and a telson under the thorax that is elongated and tapered. Average morphometric values of the marine mole crabs examined in the present study included a carapace length of 29.28±1.63 mm, a telson length of 20.78±1.72 mm, a telson width of 10.10±0.82 mm, and a weight of 7.32±1.05 g. These results were consistent with the results of Boonruang & Phasuk (1975), who showed that the carapace lengths of female mole crabs from the coast of Thailand ranged from 11–35 mm.

Effects of processing treatments on nutritional values

Proximate composition. The proximate compositions of fresh and processed marine mole crabs are presented in Table 1. The proximate composition of mole crabs decreased after processing, with the exception of water content. The water content of boiled mole crabs was higher (77.23%) than that of fresh mole crabs (74.90%). These results are consistent with those of Adeyemi et al (2013) for boiled *Trachus trachurus*; however, they differed from the results of Marimuthu et al (2012), who showed that the water content decreased after processing. High water levels could be influenced by cooking methods. Musaiger & D'Souza (2008) reported that the effect of the cooking method, such as boiling, on water absorption could cause muscle tissue in fish fillets to be weakened so that the water level would have a high value. The results of our variance analysis showed that the effects of the processing methods on moisture, protein, ash, fat, and carbohydrates were significant ($p < 0.05$).

Table 1

Proximate composition of fresh and processed marine mole crab (*Emerita emeritus*)

Composition	*Marine mole crab*			
	Fresh	*Boiled*	*Steamed*	*Grilled*
Water(%)[1]	74.90±0.28^{c}	77.23±0.43^{d}	68.39±0.23^{b}	62.67±0.81^{a}
Ash (%)[2]	35.63±0.99^{b}	34.63±0.99^{b}	32.50±1.13^{a}	31.59±0.08^{a}
Fat (%)[2]	8.76±1.09^{c}	2.95±0.49^{a}	4.32±0.29^{ab}	5.65±0.95^{b}
Protein (%)[2]	38.52±1.04^{b}	38.40±0.83^{b}	37.20±0.31^{b}	35.13±1.45^{a}
Carbohydrate (%) (by difference)[2]	17.08±1.40^{a}	24.02±0.97^{b}	25.98±1.21^{bc}	27.62±1.29^{c}

Note: Numbers followed by different superscipts (a, b, c) in the same row indicate a significant difference ($p < 0.05$); [1]wet basis; [2]dry basis.

Mineral composition. The higher content of macro-minerals than micro-minerals in the mole crabs was consistent with the results of Barrento et al (2009) obtained for *Cancer pagurus* from the Scottish Coast and the English Channel. Our analysis showed that the processing methods used did not have a significant ($p > 0.05$) effect on the total mineral content (Figure 1).

The highest macro-mineral content was found in the steamed mole crabs (10,955.04 mg g^{-1}) and the lowest content was in the grilled mole crabs (10,052.60 mg g^{-1}); however, the macro-mineral content was not significantly affected ($p > 0.05$) by the three processing methods. The highest micro-mineral content was found in the steamed mole crabs (81.57 mg g^{-1}) and the lowest content was in the fresh mole crabs (43.64 mg g^{-1}). The processing methods had significant ($p < 0.05$) effects on the micro-mineral contents. Additional analysis using Duncan's test indicated that the effects of the boiling, steaming, and grilling methods on the micro-mineral contents were significant ($p < 0.05$) relative to the unprocessed fresh mole crabs.

Calcium (Ca) and magnesium (Mg) were the predominant macro-minerals in mole crabs, whereas the predominant micro-minerals were iron (Fe) and copper (Cu). This mineral composition differed from those of octopus, squid, and cuttlefish in which only Mg and Cu were predominant (Lourenco et al 2009). The mineral contents in aquatic organisms can be affected by differences in the proportion of food intake. Wardiatno et al (2012) stated that the proportion of food intake depended on the physiological needs of the invertebrates or endogenous factors such as sex, age, and environmental condition as well as mineral solubility in water and food.

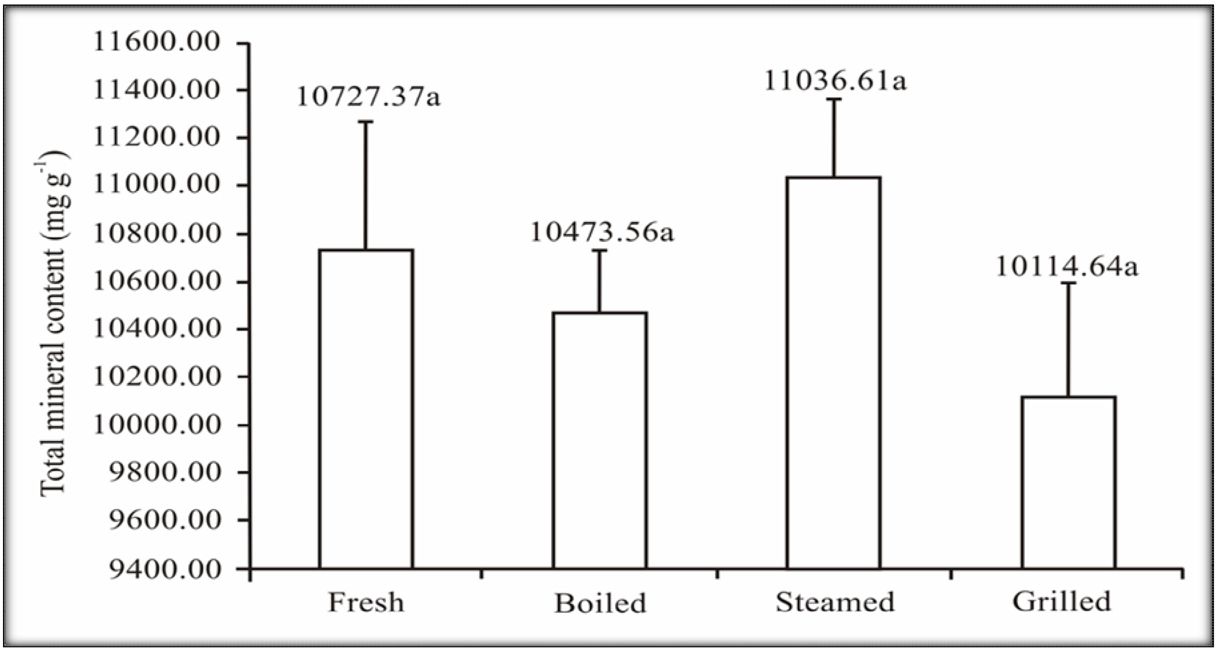

Figure 1. Total mineral contents of fresh and processed marine mole crab (*E. emeritus*). Numbers followed by the same letters above the bars indicate a non significant difference ($p > 0.05$).

The highest levels of Ca and Mg were produced by the steaming method; however, the effects of the processing methods on the Ca and Mg levels were not significant ($p > 0.05$). Similar results were also shown by Marimuthu et al (2012), who reported no significant change in mineral content in roasted fish compared to fresh fish. Ca plays a role in bone formation (Winarno 2008) and Mg plays a role in the structure and function of the human body. The recommended daily consumption of Mg for adults is 0.25 mmol (6 mg kg^{-1}) body weight (Schlingmann et al 2004).

The highest Fe content was produced by the steaming method, whereas the highest Cu content was found in the fresh mole crabs. Fe is the most abundant micro-mineral in animals and plants and functions in oxygen transport and electron transfer. Fe and Cu interact in Fe-transport by ceruloplasmin (Cu-containing protein) and Cu and Fe also interact in the intestine with the transport competition. Therefore, iron and copper can not be given at the same time because there will be competition in the process of absorption in the intestine (Ridwan 2012). The maximum micro-mineral concentration considered acceptable for human consumption is 500 mg 100 g^{-1} (Oksuz et al 2009). Fe contents in the boiled, steamed, and grilled mole crabs were significantly different with that of the fresh crabs. It means that the processing methods had significant effect on the Fe content.

Fatty acid composition. The fatty acids detected in this study included saturated, monounsaturated, and polyunsaturated fatty acids. Our analysis showed that the total fatty acid content was not significantly affected ($p > 0.05$) by the processing methods. The highest level of saturated fatty acids was found in the steamed mole crabs, the lowest was in the grilled mole crabs, and the effects of the processing methods on the saturated fatty acid content were significant ($p < 0.05$) (Figure 2). Although the saturated fatty acid contents of the boiled and fresh mole crabs were not significantly ($p > 0.05$) different, the saturated fatty acid contents of the steamed and the grilled mole crabs were significantly ($p < 0.05$) different from those of the fresh and boiled mole crabs.

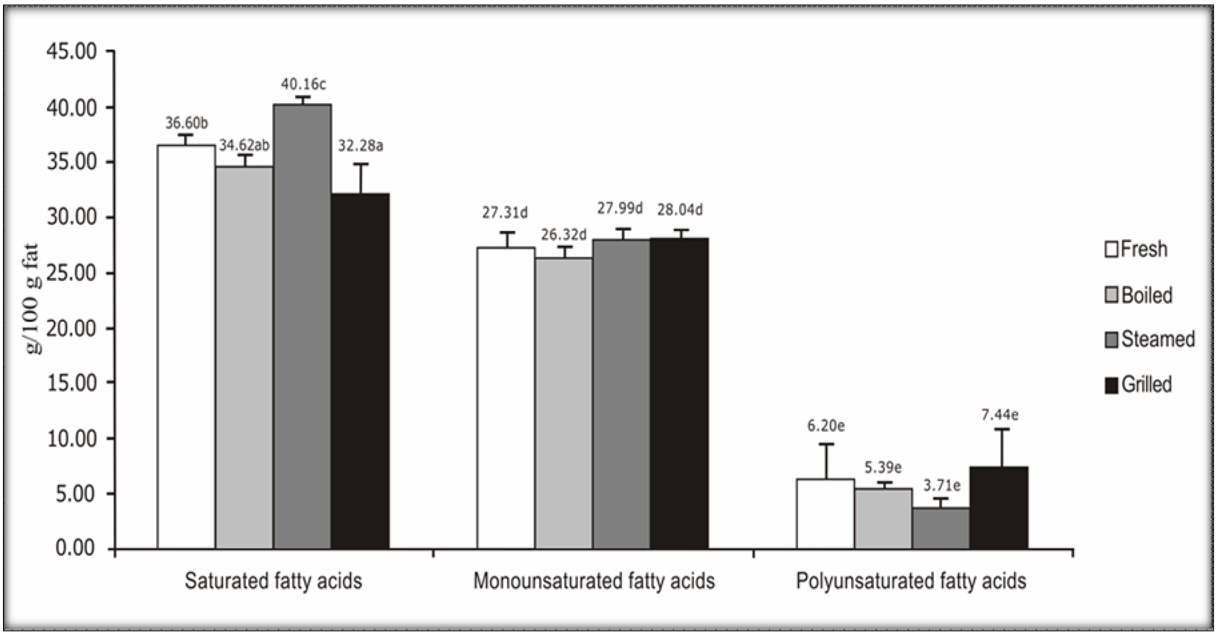

Figure 2. Saturated and unsaturated fatty acid contents of fresh and processed of the mole crab (*Emerita emeritus*). Numbers followed by different letters (a, b, c, d, e) above the bars indicate a significant difference ($p < 0.05$).

Myristic acid (C14:0) and palmitic acid (C16:0) were the predominant saturated fatty acids in mole crabs. Tsape et al (2010) reported that C16:0 and stearic acid (C18:0) were predominantly found in the muscle and cephalothorax of *Nephrops norvegicus*, *Palinurus vulgaris*, and *Penaeus kerathurus*. Saturated fatty acids are present in various proportions in different organisms. Ozogul & Ozogul (2007) reported that C16:0 was the main constituent of saturated fatty acids accounting for 53–65% of the total saturated fatty acids. Rustan & Drevon (2005) reported that C16:0 is found in plants, animals, and microorganisms, whereas C14:0 is generally the main component in animals and plants. Our results showed that the levels of C14:0 and C16:0 were significantly affected ($p < 0.05$) by the three processing methods.

Palmitoleic acid (C16:1) and oleic acid (C18:1n9c) were the predominant monounsaturated fatty acids in mole crabs. The high levels of C16:1 and C18:1n9c were similar to those found in shrimp from Brazil (Sanchez-Camargo et al 2011). C16:1 is commonly found in animals, plants, microorganisms, and is a major component in some seed oils (Rustan & Drevon 2005). C18:1n9c is an unsaturated fatty acid that is commonly found in food such as margarine, which is approximately 47% C18:1n9c. In addition, C18:1n9c constitutes one third of chicken meat fat (Desnelli & Zainal 2009). The C16:1 and C18:1n9c contents of mole crabs were not significantly affected ($p > 0.05$) by the processing methods.

The polyunsaturated fatty acid contents were not significantly affected ($p > 0.05$) by the processing methods (Figure 2). Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were the predominant polyunsaturated fatty acids present in the mole crabs. Ouijifard et al (2012) showed that the contents of C18:1n9, α-linoleic acid (C18:3n3), EPA, and DHA were higher than those of other monounsaturated and polyunsaturated fatty acids in *Litopenaeus vannamei*. The levels of EPA and DHA in mole crabs were not significantly affected ($p > 0.05$) by the processing methods.

Cholesterol composition. Cholesterol is a complex compound, 80% of which is produced in the body and 20% is generated outside of the body. Cholesterol is produced in the liver and is used to build cell walls. It consists of low-density lipoprotein (LDL), often referred to as bad cholesterol, and high-density lipoprotein (HDL), often referred to as good cholesterol. The cholesterol composition of marine mole crabs is presented in Figure 3. The cholesterol levels in mole crabs were reduced by all of the processing methods, but the reductions were not significant ($p > 0.05$). The lowest cholesterol level was produced by the grilling method and the highest level was found in the fresh mole crabs. Our results are consistent with those of Savage et al (2002), who reported that cholesterol levels were significantly affected by oxidation in meat, eggs, and processed seafood.

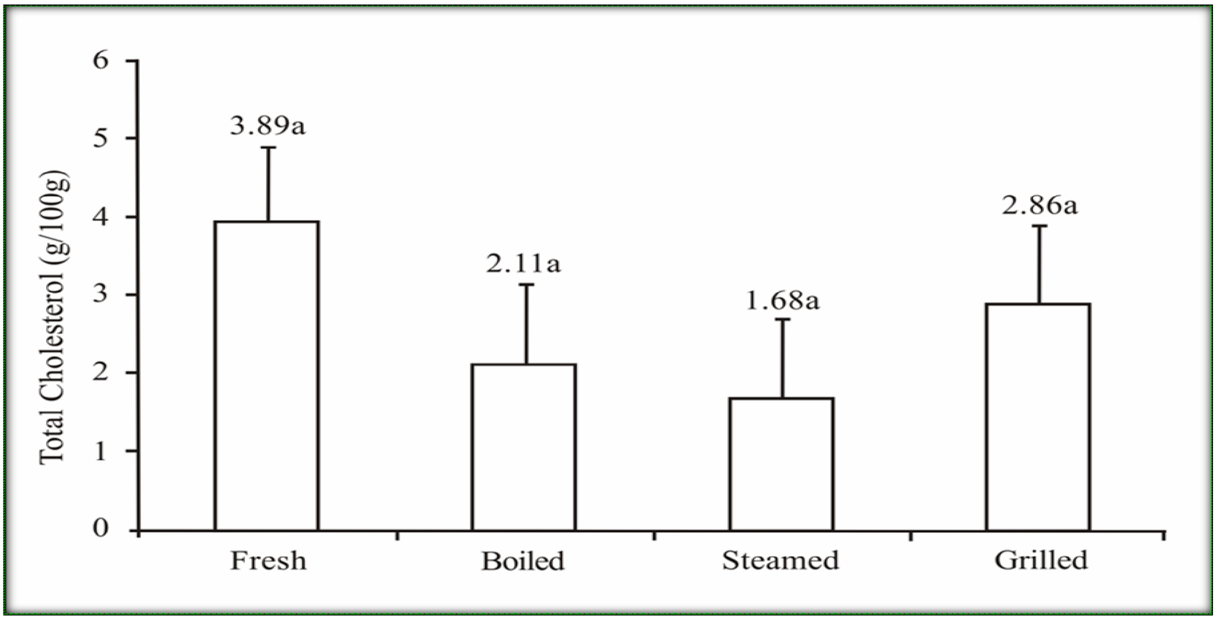

Figure 3. Total cholesterol contents of fresh and processed of the mole crab (*E. emeritus*). Numbers followed by the same letters above the bars indicate a non significant difference ($p > 0.05$).

Amino acid composition. Amino acids include non-essential, semi-essential, and essential amino acids. Non-essential amino acids can be produced by the body, but essential amino acids are obtained from foods that contain protein (Winarno 2008). The total amino acid content of mole crabs increased after boiling and steaming, but decreased after grilling. The decrease in amino acid content could be caused by protein denaturation during processing and the use of high temperature (Basmal et al 1997). The levels of total amino acids in mole crabs were not affected significantly by the processing methods. The essential amino acid content was the highest in the boiled mole crabs and the lowest in the grilled mole crabs (Figure 4). The processing methods did not have significant ($p > 0.05$) effects on the levels of essential amino acids. Leucine and lysine were the predominant essential amino acids, and their levels were not significantly affected ($p > 0.05$) by the processing methods.

A semi-essential amino acid can substitute for an essential amino acid, but does not replace it perfectly. The level of semi-essential amino acids was highest in the boiled mole crabs and lowest in the grilled mole crabs (Figure 4). The total semi-essential amino acid content was not significantly affected ($p > 0.05$) by the processing methods. The semi-essential amino acids detected in this study included histidine and arginine, which are beneficial for the human body. Popovic et al (2007) suggested that histidine helps in the formation of red and white blood cells, whereas arginine is commonly found in meat and beans. The histidine and arginine levels in mole crabs were not significantly affected ($p > 0.05$) by the processing methods.

The total non-essential amino acid contents in mole crabs were not significantly affected ($p > 0.05$) by the processing methods (Figure 4). The predominant non-essential amino acids were glutamic and aspartic acids. Glutamic acid is often used as a flavoring because it contains monosodium glutamate, a salt derivative of glutamic acid, which can be used as a flavor enhancer (Ardyanto 2004). Aspartic acid is useful in the biosynthesis of urea, glucogenic precursor, and pyrimidine (Linder 2010). The aspartic and glutamic acid levels in mole crabs were not significantly affected ($p > 0.05$) by the processing methods.

The cooking processes tended to increase the amino acid content. This effect can be influenced by the heating method used. Oduro et al (2011) reported that amino acid residues that were sensitive to decomposition temperatures would generally increase with increased temperature, oxygen availability, and reduced saccharide content in the material.

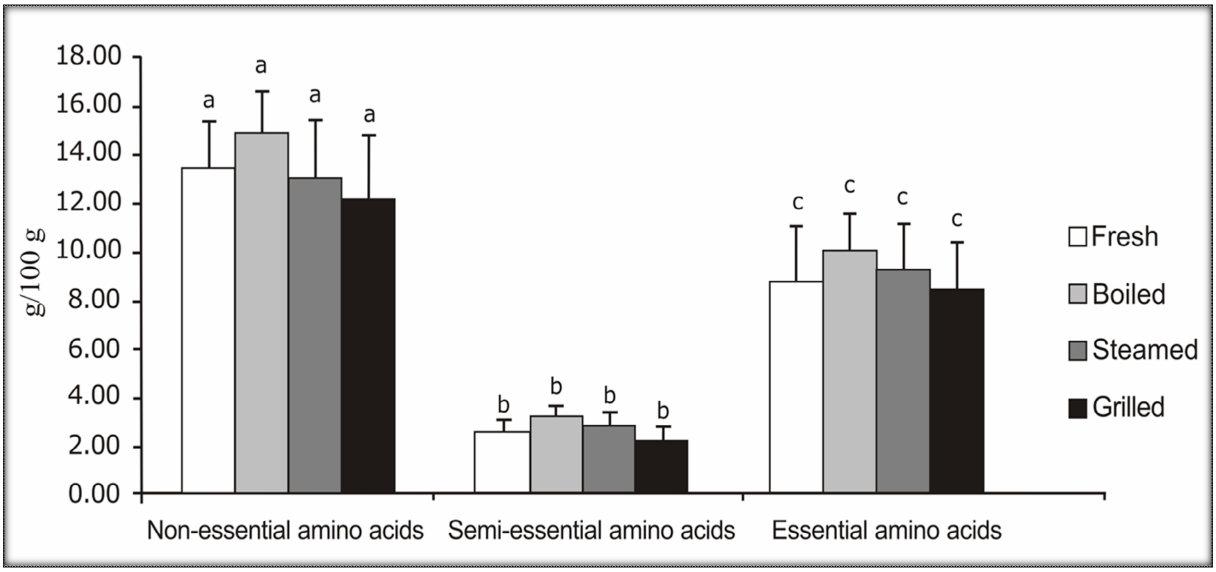

Figure 4. Amino acid contents of fresh and processed marine mole crabs (*E. emeritus*). Numbers followed by different letters (a, b, c) above the bars indicate a significant difference ($p < 0.05$).

Conclusions. Marine mole crab has a slightly round (oval) body that is gray and has a uropod, antennae, a bilaterally symmetric abdomen, and a telson under the thorax which is elongated and tapered. The marine mole crabs examined in this study had an average carapace length of 29.28 mm, telson length of 20.78 mm, telson width of 10.10 mm, and telson weight of 7.4 g. Our results showed that processing methods had significant ($p < 0.05$) effects on the proximate, micro-mineral, and saturated fatty acid composition. However, no significant ($p > 0.05$) differences in the macro-mineral, total fatty acid, poly and monounsaturated fatty acid, total cholesterol, amino acid content and amino acid composition were caused by the processing methods. The steaming method was the optimal processing method. Further research should be directed towards identifying the digestibility of fatty acids and amino acids and mineral solubility. Studies addressing the content of other nutrients, such as vitamins, and bioactive components that can be used as health supplement products, would also be valuable.

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References

AOAC, 2005 [Official Methods of Analysis]. 19th Edition, Association of Official Analytical Chemists, Washington, DC., USA.

Adeyemi O. T., Osilesi O. O., Onajobi F., Adebawo O., Oyedemi S. O., Afolayan A. J., 2013 Effect of processing on the proximate and mineral compositions of *Trachurus trachurus*: a fish commonly consumed in Nigeria. Journal of Emerging Trends in Engineering and Applied Sciences 4(3):378-385.

Ardyanto T. D., 2004 [MSG and health: history, effect and controversion]. Inovasi 1(16):52-56 [in Indonesian].
Basmal J., Bagus S. B. U., Taylor K. D. A., 1997 [The effect of boiling, salting and storage on lysine degradation in processed fish]. Jurnal Penelitian Perikanan Indonesia 3(2):54-62 [in Indonesian].
Barrento S., Marques A., Teixeira B., Anacleto P., Carvalho M. L., Vaz-Pires P., Nunes M. L., 2009 Macro and trace elements in two populations of brown crab *Cancer pagurus*: ecological and human health implications. Journal of Food Composition and Analysis 22:65-71.
Boonruang P., Phasuk B., 1975 Species composition and abundance distribution of anomuran sand crabs and population bionomics of *Emerita emeritus* (L.) along the Indian Ocean Coast of Thailand (Decapoda: Hippidae). Phuket Marine Biological Center, Research Bulletin 8:1-19.
Desnelli, Zainal F., 2009 [Oxidation reaction kinetics myristic acid, stearic, and oleic in the medium coconut oil, palm oil, and without medium]. Jurnal Penelitian Sains 12(1C):12107 (1-6) [in Indonesian].
Devi W. S., Sarojnalini C., 2012 Impact of different cooking methods on proximate and mineral composition of *Amblypharyngodon mola* of Manipur. International Journal of Advanced Biological Research 2(4):641-645.
Garcia-Arias M. T., Alvarez-Pontes E., Garcia-Linares M. C., Garcia-Fernandez M. C., Sanchez-Muniz F. J., 2003 Cooking-freezing-reheating (CFR) of sardine (*Sardina pilchardus*) fillets: effects of different cooking and reheating procedures on the proximate and fatty-acid compositions. Food Chemistry 83:349-356.
Jacoeb A. M., Cakti N., Nurjanah, 2008 [Changes in the composition of proteins and amino acids in mantis shrimp meat (*Harpiosquilla raphidea*) by boiling]. Buletin Teknologi Hasil Perikanan 9(1):1-20 [in Indonesian].
Kardaya D., Ralahalu T. N., Zubir, Purba M., Parakkasi A., 2011 [Testing of the mole crab (*Emerita analoga*) as a cholesterol-lowering ingredient in mice (*Mus musculus* BALB /C)]. JITP 1(2):76-87 [in Indonesian].
Kocatepe D., Turan H., Taşkaya G., Kaya Y., Erden R., Erdoğdu F., 2011 Effects of cooking methods on the proximate composition of black sea anchovy (*Engraulis encrasicolus*, Linnaeus 1758). GIDA 36(2):71-75.
Lourenco H. M., Anacleto P., Afonso C., Ferraria V., Martins M. F., Carvalho M. L., Lino A. R., Nunes M. L., 2009 Elemental composition of cephalopods from Portuguese continental waters. Food Chemistry 113:1146–1153.
Linder M.C., 1991 Nutritional biochemistry and metabolism. British: Prentice Hall, pp. 87-108.
Marimuthu K., Thilaga M., Kathiresan S., Xavier R., Mas R. H. M. H., 2012 Effect of different cooking methods on proximate and mineral composition of striped snake head fish (*Channa striatus*, Bloch). Journal Food Science and Technology 49(3):373–377.
Mursyidin D. H., 2007 [The content of omega-6 fatty acids in the mole crabs (*Emerita* spp.) of the south coast of Yogyakarta]. Bioscientiae 4(2):79-84 [in Indonesian].
Musaiger A. O., D'Souza R., 2008 The effect of different methods of cooking on proximate, mineral and heavy metal composition of fish and shrimps consumed in the Arabian Gulf. Archivos Latinoamericanos de Nutricion 58(1):103-109.
Oduro F. A., Choi N. D., Ryu H. S., 2011 Effects of cooking conditions on the protein quality of chub mackerel *Scomber japonicus*. Fisheries and Aquatic Science 14:257-265.
Oksuz A., Ozyilmaz A., Aktas M., Gercek G., Motte J., 2009 A comparative study on proximate, mineral and fatty acid compositons of deep seawater rose shrimp (*Parapenaeus longirostris*, Lucas 1846) and red shrimp (*Plesionika martia*, A. Milne-Edwards, 1883). Journal of Animal and Veterinary Advances 8(1):183-189.
Ouijifard A., Seyfabadi J., Abdolmohammad A. K., Rezaei M., 2012 Growth and apparent digestibility of nutrients, fatty acids and amino acids in Pacific white shrimp, *Litopenaeus vannamei*, fed diets with rice protein concentrate as total and partial replacement of fish meal. Aquaculture 342-343:56-61.

Ozogul Y., Ozogul F., 2007 Fatty acid profiles of commercially important fish species from the Mediterranean, Agean and Black Seas. Food Chemistry 100(4):1634-1638.
Popovic P. J., Zeh H. J., Ochoa J. B., 2007 Arginine and immunity. The Journal of Nutrition 137(6 Suppl 2):1681S-1686S.
Ridwan E., 2012 [Study of the interaction of iron with other micro nutrients in supplements]. Panel Gizi Makanan 35(1):49-54 [in Indonesian].
Rustan A. C., Drevon C. A., 2005 Fatty acids: structures and properties. Encyclopedia of Life Sciences, pp. 1-7 (doi: 10.1038/npg.els.0003894).
Sanchez-Camargo A. P., Meireles M. A. A., Lopes B. L. F., Cabral F. A., 2011 Proximate composition and extraction of carotenoids and lipids from Brazilian redspotted shrimp waste (*Farfantepenaeus paulensis*). Journal of Food Engineering 102:87–93.
Santoso J., Nurjanah, Irawan A., 2008 [The content and solubility of minerals in the squid *Loligo* sp. and in the shrimp *Litopenaeus vannamei*]. Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia 15(1):7-12 [in Indonesian].
Savage G. P., Dutta P., Rodriguez-Estrada M. T., 2002 Cholesterol oxides: their occurrence and methods to prevent their generation in foods. Asia Pacific Journal of Clinical Nutrition 11(1):72–78.
Schlingmann K. P., Konrad M., Seyberth H. W., 2004 Genetics of hereditary disorders of magnesium homeostasis. Pediatric Nephrology 19:13-25.
Tsape K., Sinanoglou V. J., Miniadis-Meimaroglou S., 2010 Comparative analysis of the fatty acid and sterol profiles of widely consumed Mediterranean crustacean species. Food Chemistry 122:292-299.
Wardiatno Y., Santoso J., Mashar A., 2012 Biochemical composition in two populations of the mantis shrimp, *Harpiosquilla raphidea* (Fabricius 1798) (Stomatopoda, Crustacea). Ilmu Kelautan 17(1):49-58.
Wardiatno Y., Nurjaya I. W., Mashar A., 2014 [Habitat characteristics of the sand crabs (Family Hippidae) in sandy coast of Cilacap District]. Jurnal Biologi Tropis 14(1):1-8 [in Indonesian].
Wardiatno Y., Ardika P. U., Farajallah A., Butet N. A., Mashar A., Kamal M. M., Renjaan E. A., Sarong M. A., 2015 Biodiversity of Indonesian sand crabs (Crustacea, Anomura, Hippidae) and assessment of their phylogenetic relationships. AACL Bioflux 8(2):224-235.
Winarno F. G., 2008 [Food chemistry and nutrition]. Jakarta: PT Gramedia Pustaka Utama] [in Indonesian].

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