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Characterization of Physicochemical Properties of Powder Coconut Crab Shells (*Birgus latro* L.) from North Maluku

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ABSTRACT
Coconut crab (*Birgus latro* L.) or in North Maluku language called coconut crab is one of the biological natural resources of high economic value. People consume coconut crab dishes that have a taste similar to lobster, but have a distinctive advantage because this animal consumes coconut meat. Utilization of coconut crab shell waste to date has not been done. While the purpose of this study is to characterize the physical and chemical properties of the purification of coconut crab shell waste. The results compared the waste flour of the shell of an unrelated coconut crab (A) with the shell of a braised crab (B). Obtained total yield 40%, moisture content, ash content, protein, fats, carbohydrates respectively (5.57-5.68%), (49.47-49.24%), (20.42-22.10%), (0.63-0.52%), (23.89-24.20%). While antioxidant activity (30.84%-30.67%), As well as color L* (72.85-70.86), a* (7.25-8.26), b* (8.15-10.21), Coconut crab shell (CC) which is a waste material which is one of the important biopolymers. The comparison of the quality of coconut crab shell waste before being heated has no significant difference, except in protein components and antioxidant activity of 20.74 and 29.95% respectively. Similarly, the brightness level of L*=72.85 in the powder CC is not yet heated, while the cc powder after heating L*=60.13. The micrographs of each treatment also have a slight difference in the shape of round chendering on unheated CC powder, while in cc powder after heating undergo irregular shape.

Keywords: *shallot, fried shallot, Dairi Regency, Dairi shallot, product development, Toba Lake*

1. INTRODUCTION

Coconut crab (*Birgus latro* L.) is one of the biological resources of high economic value. Coconut crabs are one of the decapod groups that spend a lot of time on land. Furthermore, coconut crabs in north Maluku people call it walnut crab, which has a different name in each region [1]. And the initial study was conducted coconut crab breeding in North Maluku [2]. Even mass coconut crab cultivation efforts in several islands in the North Maluku region such as in Posi Village, Patani, Gebe in Central and South Halmahera Regency, Tobololo Village in Ternate and Samada Island in Taliabu Island Regency [3].

Utilization of crustacean waste has been widely developed in research, especially fishery production waste such as blue crab shells and shrimp [4], Also found in lobster shells [5], in addition to shrimp shells and crab shells [6], and on mangrove crab shells [7]. Further characteristics of irradiated crab chitosan and New Zealand Arrow squid pen chitosan [8]. Even chitin and chitosan from bio waste of scampi Macrobrachium rosenbergii and tiger shrimp Penaeus monodon [9].

Utilization of crab shell waste is currently more dominant in chitosan products and has been developed in industries including: as coagulants in drinking water, wastewater treatment, as alating compound, textile industry, increasing color substances in the paper industry, and moisturizing materials, fruit coatings to be planted, pharmaceutical fields such as: the health industry as a drug delivery medium, and components of tools such as: gloves, operating threads, gel forming, and food preservatives and coatings on fruits such as strawberries, duku, tomatoes[10, 11].

There is no information yet about the characteristics of coconut crab shell waste, so the purpose of this study is to obtain the physical and chemical properties of coconut crab shell waste by comparing the material of crab shells before heating and after heating by having different characteristics.

2. MATERIALS AND METHOD

2.1. Materials

The ingredients used in this study are fresh coconut crab shells and processed coconut crab shells obtained from 2 locations in North Maluku (Patani Village and Restaurant in Ternate City), distillate water, and proximate analytical chemicals.

2.2. Coconut Crab Shell Preparation

Raw materials as much as 500 g of waste shells of coconut crabs that have not been heated and that have been heated, then washed with distilled water so that the dirt attached can be removed, then dried in cabinet drying at a temperature of 40 ^{0}C for approximately 48-72 hours, then weighed until obtained a constant weight. Once dry then mashed using a ball-mill for 30 minutes and sifted to the size of 80 mesh and obtained coconut crab shell powder.

2.3. Physico-chemical properties of coconut crab powder

2.3.1. Yield

Coconut crab shell powder yield is calculated based on the comparison between the weight of coconut crab shell powder and the waste weight of coconut crab shell, using the following equation:

$$\text{Yield (\%)} = \frac{Heavy\ Coconut\ Crab\ Shell\ Powder\ (g)}{Coconut\ Crab\ Shell\ Weight\ (g)} \text{ x } 100 \quad (1)$$

2.3.2. Moisture and Macronutrient Content Evaluation

Determination of moisture content (AOAC 930.15) and ash (AOAC 942.05) in coconut crab shell powder in accordance with standard methods (AOAC, 2004). Raw fat content of dry material that is powder is determined gravimetrically after the extraction process of Soxhlet method using hexane. Protein content in powder is determined by extracting samples with 10% (w/v). The filtration process is carried out on supernatan and diluted with distilled water up to 100 ml. This extract is used for protein determination (total nitrogen content × 6.25) in accordance with the Kjeldahl procedure. Carbohydrates (by difference). All parameter measurements are performed with three replays [12].

2.3.3. Antioxidant Activity

Testing the antioxidant activity of coconut crab shell powder using the DPPH method in the form of free radical test. The free radical effects of CHI, CDC and UDC are trivialized according to the Shimada et al method (1992). In short, 1 mL per sample was mixed with 3 mL of Methanol solution of DPPH (300 M). The ingredients mix the reaction in the vortex and are carried out for incubation for 30 minutes. Measured the absorbance value of the solution at a wavelength of 517 nm. A standard solution of ascorbic acid [13] is used. The percentage of DPPH inhibition is calculated using the following equation:

$$\text{DPPH (\%)} = \frac{Abs\ Sample}{Abs\ control}\ x\ 100 \quad (2)$$

2.3.4. Color Measurements

The color values (L*, a*, b*) of coconut crab shell powder are measured by CR 310 Minolta Chroma Meter (Minolta Camera Co., Ltd). Powder is placed on a standard white plate (calibration plate) and the Hunter Lab color scale is used to measure color [6]. Each sample was measured at four different reading positions. The total color difference (ΔE) is calculated as:

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)\ 0.5 \quad (3)$$

3. RESULTS AND DISCUSSION

3.1. Chemical Character of Coconut Crab Shell Powder

Based on Table 1, it is known that coconut crab shell powder has an average yield of shell waste is quite high 66.5%. Coconut crabs have very thick shells especially on the legs and the head that have a very large size (Figure 1). Meanwhile, the water content of powder is quite low 5.84%. This is because both coconut crab shell treatment is done in the process of shrinking size and continued with drying using cabinet drying 40 ^{0}C for approximately 48-72 hours, then reduced size up to 80 mesh.

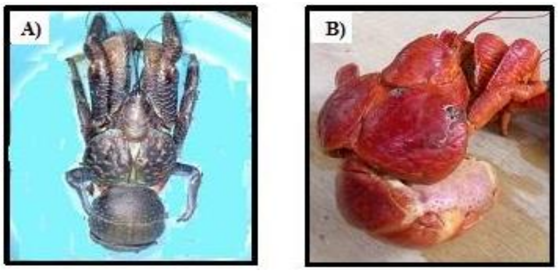

Figure 1 Coconut Crab. A) Before heating, B) After heated

Similarly, the ash powder content of coconut crab shell before heating is quite high 54.462% when compared to coconut crab shell powder after heating. The largest mineral content consists of calcium carbonate and a small amount of calcium phosphate and other metal compounds (Figure 2) using the XRF analysis method. The high mineral content of coconut crab shells is influenced by the habitat where they live, but also has not been done in the demineralization process for the manufacture of coconut crab shell chitosan.

Table 1. Identification of Coconut Crab Shell Powder Content (100 g of ingredients)

Parameters	composition	
	Before heating	After heated
Yield (%)	66.50 ±0.7	64.49 ±0.7
Moisture Content (%)	6.14 ±0.2	5.84 ±0.4
Ash (%)	54.46 ±0.6	49.17 ±0.4
Protein (%)	16.93 ±1.0	20.74 ±0.4
Fat (%)	2.02 ±0.4	1.28 ±0.9
Carbohydrates (%)	22.68 ±1.7	22.97 ±1.3
Antioxidant Activity (%)	18.75 ±1.0	29.95 ±1.3

Code A. Shell Before heating, B. The shell after heating, (% db = dry base)

Meanwhile, fat content is quite low both before and after the pairing only around 2.02% and the average value of protein content is quite high both before and after heating each 16.93-20.74%, this is due to coconut crabs consuming coconut meat. Furthermore, the calculation of carbohydrate levels is done by difference with a value of 22.97%. While antioxidant activity is related to dpph free radical activity which has a very noticeable difference between the shell before it is heated 18.75% and after heating has a content of 29.95%, this is because with the heating process will make the shell of crab skin turn red.

This is thought to be because the pigment content on the skin of coconut crabs contains carotenoid pigments. Similarly, pigments from crab shells and shrimp shells contain carotenoid pigments such as : β-carotene, echinonen, canthaxanthin, lutein, zeaxanthin, fucoxanthin, and astaxanthin (Kouchi et al., 2012; Gimeno et al. 2007).

3.2. Color Analysis Coconut Crab Shell Powder

Based on Table 2, Coconut crab shell waste powder with before and after heating treatment has a significant difference (α=0.05), coconut crab shell powder is brighter in value (L*=72.85) while coconut crab shell powder after heating has a brightness value (L*=60.13). This is because heating causes discoloration of the outer skin from green to higher redness (a*=10.65), but at yellowish values (b*=8.15).

Table 2 Color of coconut crab shell powder

Sampel	Hunter scale			ΔE*
	*L**	*a**	*b**	
Before heating	60.13 ±0.15	7.25 ±0.04	5.28 ±0.02	10.22 ±0.14
after heating	72.85 ±0.21	10.65 ±0.03	8.15 ±0.04	14.14 ±0.19

The values followed by the same letter are not significantly different from each other (α = 0.05).

Based on Table 2, Coconut crab shell waste powder with before and after heating treatment has a significant difference (α=0.05), coconut crab shell powder is brighter in value (L*=72.85) while coconut crab shell powder after heating has a brightness value (L*=60.13). This is because heating causes discoloration of the outer skin from green to higher redness (a*=10.65), but at yellowish values (b*=8.15).

3.3. Morphology Powder Coconut Crab Shell

Figure 2 shows a micrograph of coconut crab shell powder before and after heating seen with SEM magnification 5000 times (20 kv) showing solid aggregate flakes in the absence of porosity. The micrograph structure under electron microscope examination on coconut crab shell powder looks mostly round, this is due to the presence of undenatured protein content. While the structure of the coconut crab shell powder micrograph after heating shows an irregular and partially elongated micrograph and seen a lot of powder on the surface of the micrograph, this is due to the influence of heating causes the occurrence of denaturation properties in the high protein content in the shell of coconut crabs.

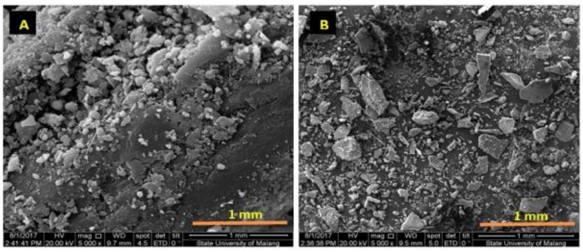

Figure 2. Scanning Electron Microscopy (SEM) Coconut Crab Shell Powder magnification 5000 times.

4. CONCLUSION

Coconut crab shell (CC) which is a waste material which is one of the important biopolymers. The comparison of the quality of coconut crab shell waste before being heated has no significant difference, except in protein components and antioxidant activity of 20.74 and 29.95% respectively. Similarly, the brightness level of L*=72.85 in the powder CC is not yet heated, while the cc powder after heating L*=60.13. The micrographs of each treatment also have a slight difference in the shape of round chendering on unheated CC powder, while in cc powder after heating undergo irregular shape.

REFERENCES

[1] Supyan, S. and Idham, M., 2018, Kondisi Populasi Kepiting Kelapa (*Birgus latro*) Dan Strategi Pengelolaannya di Pulau Ternate. In *Prosiding Seminar Nasional Kemaritiman dan Sumber Daya Pulau-Pulau Kecil* (Vol. 2, No. 1).

[2] Refiani, S. and Tantu, F.Y., 2007. Preliminary study on domestication of coconut crab (Birgus latro). *Jurnal Akuakultur Indonesia*, *6*(2), pp.183-189.

[3] Supyan, S. and Idham, M., 2018, Kondisi Populasi Kepiting Kelapa (*Birgus latro*) Dan Strategi Pengelolaannya di Pulau Ternate. In *Prosiding Seminar Nasional Kemaritiman dan Sumber Daya Pulau-Pulau Kecil* (Vol. 2, No. 1).

[4] Hamdi, M., Hajji, S., Affes, S., Taktak, W., Maâlej, H., Nasri, M. and Nasri, R., 2018. Development of a controlled bioconversion process for the recovery of chitosan from blue crab (Portunus segnis) exoskeleton. *Food Hydrocolloids*, *77*, pp.534-548.

[5] Nguyen, T.T., Barber, A.R., Smith, P., Luo, X. and Zhang, W., 2017. Application and optimization of the highly efficient and environmentally-friendly microwave-intensified lactic acid demineralization of deproteinized Rock lobster shells (Jasus edwardsii) for chitin production. *Food and Bioproducts Processing*, *102*, pp.367-374.

[6] Kumari, S., Annamareddy, S.H.K., Abanti, S. and Rath, P.K., 2017. Physicochemical properties and characterization of chitosan synthesized from fish scales, crab and shrimp shells. *International journal of biological macromolecules*, *104*, pp.1697-1705.

[7] Sakthivel, P., Nedunchezhian, N. and Ponnusamy, P., 2015. Effect of Catalytic Coatings on the Performance, Emission and Combustion Characteristics of Spark Ignition Engines. *International Journal of Vehicle Structures & Systems (IJVSS)*, *7*(4)

[8] Shimada, K., Fujikawa, K., Yahara, K. and Nakamura, T., 1992. Antioxidative properties of xanthan on the autoxidation of soybean oil in cyclodextrin emulsion. *Journal of agricultural and food chemistry*, *40*(6), pp.945-948.

[9] Sayari, N., Sila, A., Abdelmalek, B.E., Abdallah, R.B., Ellouz-Chaabouni, S., Bougatef, A. and Balti, R., 2016. Chitin and chitosan from the Norway lobster by-products: Antimicrobial and anti-proliferative activities. *International journal of biological macromolecules*, *87*, pp.163-171.

[10] Nuryanti, S. D., Dewi, E. R. S., & Ulfah, M. (2019, October). Pemanfaatan Limbah Cangkang Kepiting sebagai Edible Coating Pelapis Buah Tomat. In *Seminar Nasional Sains & Entrepreneurship* (Vol. 1, No. 1).

[11] Mekawati, M. (2000). *Aplikasi Kitosan hasil transformasi Kitin dari limbah Udang (Panaeus merguienenseis) untuk Adsorpsi Ion logam Timbal* (Doctoral dissertation, FMIPA UNDIP).

[12] AOAC, 2005. Official methods of analysis, 17th edn. Association of Official Analytical.

[13] Hafsa, J., Smach, M.A., Charfeddine, B., Limem, K., Majdoub, H. and Rouatbi, S., 2016, Antioxidant and antimicrobial proprieties of chitin and chitosan extracted from Parapenaeus Longirostris shrimp shell waste. In *Annales pharmaceutiques francaises* (Vol. 74, No. 1, pp. 27-33).