Original Research Article

Nori Preference Level Based on the Condition of the Raw Material *Eucheuma cottonii* seaweed

ABSTRACT

Aims: To determine the level of preference of panelists for Nori based on the condition of raw materials of dry and semi-dried *Kappaphycus alvarezii* (formerly *Eucheuma cottonii*) seaweed.
Study design: The research was conducted experimentally
Place and Duration of Study: Organoleptic tests were carried out in the Laboratory of Fisheries Product Processing Faculty of Fisheries and Marine Sciences, University of Padjadjaran. Physical tests and chemical tests conducted at the Laboratory of Research and Biological Resources and Biotechnology Research Institute at the Society (LPPM), IPB, between March 2019 and April 2019.
Methodology: The research was conducted experimentally consisted of 3 treatments with 20 semi-trained panelists as replication from Fisheries students of Fisheries and Marine Science Faculty, University of Padjadjaran who had experienced the organoleptic assessment. Hedonic tests were to determine the level of panelists preference for the products which included appearance, aroma, texture, and flavor, the results were statistically analyzed using Friedman Test and Bayes Test. Physical tests (thickness and hardness) and chemical tests (water content and crude fiber content) were carried out on the most preferred treatment product and analyzed descriptively.
Results: The organoleptic test results of Nori from *Kappaphycus alvarezii* (formerly *Eucheuma cottonii*) seaweed with dry raw material conditions had the highest average value on each characteristic compared to other treatments, appearance of 7.70, aroma of 7.00, texture of 7.50, and flavor of 7.90. The Bayes test results on the treatment of Nori from *Kappaphycus alvarezii* (formerly *Eucheuma cottonii*) seaweed with dry raw materials conditions having the highest alternative which was 8.54 with the most influential taste criteria for the assessment. The thickness of the Nori was 0.108 mm, the hardness was 1916.16 gf, water content of Nori was 17.23% and crude fiber content was 10.10%.
Conclusion: The treatment of Nori with raw materials of dry conditions was the most preferred by panelists.

Keywords: [Nori, Eucheuma cottonii, Raw Materials, Dried, Semi-Dried]

1. INTRODUCTION

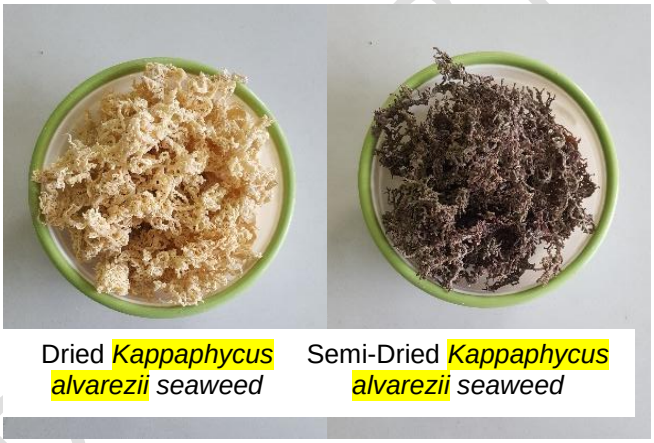
Seaweed is an important commodity for the Indonesian economy. This is because the seaweed commodity has economic value and the magnitude of the potential development of seaweed cultivation in Indonesia. Seaweed has the potential to be developed considering

the nutritional value it contains. Seaweed can be used as food, pharmaceutical, cosmetic and textile industries [22].

Nori is one of the foods made from seaweed. Nori is dried seaweed, in the form of thin sheets with high nutritional value. Nori is not a foreign item in Indonesia because there are many processed Nori products with various brands sold in supermarkets. So far, Nori has only been produced in Japan, Korea and China [18]. The raw material of seaweed used to make imported Nori is *Porphyra/Pyropia* seaweed. *Porphyra/Pyropia* lives in subtropical climates so it does not exist in Indonesia [18]. So, it is necessary to look for other types of seaweed that are easily cultivated or found in Indonesia as raw materials for Nori.

Commercial economic seaweed in Indonesia are *Eucheuma*, *Gracilaria*, *Gelidium*, *Hypnea* (Rhodophyta), and *Sargassum* (Ochrophyta, Phaeophyceae) [16]. *Kappaphycus alvarezii* (formerly *Eucheuma cottonii*) is a type of seaweed that is cultivated by the community. This type of seaweed is widely cultivated because the handling of seaweed post-harvest is relatively easy and simple. Also, the production technology is relatively cheap and easy. This species can be used as an industrial raw material and can be processed into food that can be consumed directly [27].

The potential of *Kappaphycus alvarezii* seaweed in Indonesia can be developed as a raw material for making Nori. The use of different types of seaweed can affect the resulting Nori characteristics such as different appearance, aroma, texture, and taste. There are two types of post-harvest seaweed are traditionally done, namely semi-dried seaweed and dried seaweed [2]. The raw material for seaweed *Kappaphycus alvarezii* semi-dry and dry processing can produce different Nori characteristics.



(a) (b)

Figure 1. (a) Dried *Kappaphycus alvarezii* seaweed, (b) Semi-Dried *Kappaphycus alvarezii* seaweed

Several studies have been carried out in making Nori using *Kappaphycus alvarezii* seaweed generally using raw materials with dry conditions which have a moisture content of 13.39% - 15.13% [2], while raw materials *Kappaphycus alvarezii* seaweed is also available in semi-dried conditions which have a moisture content of 32% [24]. Therefore, it is necessary to research on Nori produced from dried *Kappaphycus alvarezii* seaweed and semi-dried *Kappaphycus alvarezii* to find out the best Nori product that is preferred.

2. MATERIAL AND METHODS

2.1 Time and Place of Research

The research was conducted from March 2019 until April 2019. Organoleptic tests were carried out in the Laboratory of Fisheries Product Processing Faculty of Fisheries and

Marine Sciences, University of Padjadjaran. Physical tests and chemical tests conducted at the Laboratory of Research and Biological Resources and Biotechnology Research Institute at the Society (LPPM), IPB, between March 2019 and April 2019.

2.2 Materials and Tools

The material used in this research was based on McHugh (2003) modification, as follows [15]: dried *Kappaphycus alvarezii* seaweed, semi-dried *Kappaphycus alvarezii* seaweed, rice water, clean water, salt, sugar, pepper, flavoring, fish sauce, olive oil and sesame oil. The tools used in this research were analytic balance, basin, blender, measuring cup, plastic spatula, boiling pot, gas stove, baking sheet, oven.

2.3 Research Methods

The research was conducted experimentally consisted of 3 treatments with 20 semi-trained panelists as replication from Fisheries students of Fisheries and Marine Science Faculty, University of Padjadjaran who had experienced the organoleptic assessment. Hedonic tests were to determine the level of panelists preference for the products include appearance, aroma, texture, and flavor, the results were statistically analyzed using Friedman Test and Bayes Test. Physical tests (thickness and hardness) and chemical tests (water content and crude fiber content) were carried out on the most preferred treatment product and analyzed descriptively.

2.4 The Treatment Based on Condition of the Raw Material of *Kappaphycus alvarezii* Seaweed

The treatment in this study was:
Treatment A: Dried *Kappaphycus alvarezii* seaweed 100%
Treatment B: Semi-dried *Kappaphycus alvarezii* seaweed 100%
Treatment C: Dried *Kappaphycus alvarezii* seaweed 50% plus semi-dried *Kappaphycus alvarezii* seaweed 50%
Hedonic tests determined the level of panelists preference for the products which included appearance, aroma, texture, and flavor.

2.5 Procedure

The procedure for making Nori from *Kappaphycus alvarezii* modified in Teddy 2009, as follows [25]: dried *Kappaphycus alvarezii* seaweed and semi-dried *Kappaphycus alvarezii* seaweed weighed 50 g, soaked with rice water for 24 h as much as 1 L, seaweed rinsed with clean water, then soaked with clean water 1.5 L for 48 h, water is replaced every 24 h. The ingredients were prepared namely *Kappaphycus alvarezii* seaweed which had been soaked and seasoning ingredients namely 0.2 g salt, 1 g sugar, 0.2 pepper, 0.3 g flavoring, 1 mL fish sauce, 2 mL olive oil, and oil 2 mL sesame. Soaked *Kappaphycus alvarezii* is weighed as much as 100 g and added to 200 ml of water, then blended for 2 min. Blended seaweed is put into a boiling pan and seasoning is added, then cooked for 5 min to produce a gel product. Cooked seaweed puree is measured 80 ml with a measuring cup and poured into a baking sheet measuring 17 × 23 cm and baked using an oven at 70ºC for 180 min.

2.6 Data Analysis

2.6.1 Hedonic Test

Hedonic tests were used to determine the level of panelists preference for the products which included appearance, aroma, texture, and flavor, the results were statistically analyzed using Friedman Test and Bayes Test.

2.6.2 Physical Test

The physical test on the Nori were the measurements of thickness and hardness. Physical tests were carried out for the most preferred products.

2.6.2.1 Thickness (LPPM IPB)
Nori is measured using a micrometer tricle brand with several replications in mm. The measurement results are averaged so that the average thickness value of the Nori is obtained.

$$\text{Average value} = \frac{\text{number of values}}{(\text{lots of data})}$$

2.6.2.2 Hardness (LPPM IPB)
Nori is measured using the TA-XT2i Stable micro system. Measurements are made by giving a compressive force to the sample to produce a curve that shows the sample texture profile. Hardness is expressed from the maximum force (peak value) to pressure or first compression with units of gram force (gf) [4]. The style value obtained shows that the greater the value, the smaller the crispness of the texture. The data obtained is then visualized in graphical form using a program in a computer [6].

2.6.3 Chemical Test
Chemical tests are carried out for the most preferred products. Chemical tests on the Nori are moisture content (AOAC 1980) and crude fiber content (AOAC 1980).

2.6.3.1 Moisture Content (AOAC 1980)
One gram of sample was weighed in a cup. Put it in the oven at a temperature of 105 ^{0} C, for 8 hours, then work out the water content calculated by the formula:

$$\text{Moisture content} = \frac{\text{sample weight (fresh-dried)}}{\text{Fresh sample weight}} \times 100\%$$

2.6.3.2 Crude Fiber Content (AOAC 1980)
A total of 1 g of sample was dissolved in 100 mL of 1.25% H_2SO_4, heated to boiling and then continued with destruction for 30 min. then filter with filter paper and with Buchner curing bundles. The filter residue is rinsed with 20-30 mL of boiling water and with 25 mL of water 3 times. The residue is reconstructed with 1.25% NaOH for 30 min. Then filter in the manner above and rinse successively with 25 mL of H_2SO_4 1.25% boil, 25 mL of water three times and 25 mL of alcohol residue and filter paper is transferred to the porcelain cup and dried in the oven at 130ºC for 2 h, after the residue cools along with a porcelain cup weighed (A), then put in a furnace of 600ºC for 30 min., cooled and weighed again (B).

$$\text{Crude fiber weight} = W - W^{0}$$

Information:
W = residual weight before being burned in the kiln
= A- (weight of cup filter paper): A: residual weight + filter paper + cup
W^{0} = weight of residue after being burned in the kiln
= B - (cup weight): B: residual weight + cup

$$\text{Crude fiber content} = \frac{\text{crude fiber weight}}{\text{sample weight}} x\ 100\%$$

3. RESULTS AND DISCUSSION

3.1 Hedonic Test

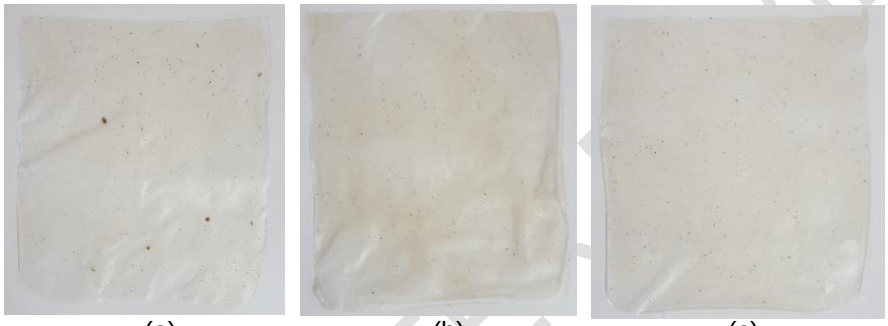
3.1.1 Appearance
Appearance is the first parameter seen in a product [23]. Observations of the appearance of Nori from *Kappaphycus alvarezii* seaweed are presented in Table 1.

Table 1. Average Appearance of Nori Based on Differences in Condition of *Kappaphycus alvarezii* Seaweed Raw Materials

Condition of Nori Raw Material	Median	Average
Dried	9	7.70 b
Semi-dried	5	6.10 a
Dried 50% : Semi-dried 50%	7	7.20 ab

Description: The average number of treatments followed by the same letter shows that there is no significant difference according to the multiple comparison test at 5%.

Statistical tests showed the appearance of Nori from seaweed *Kappaphycus alvarezii* dried raw material was significantly different from the appearance of Nori from *Kappaphycus alvarezii* seaweed from semi-dried raw materials. All treatments included in the neutral, preferred, and very preferred category with median values 5, 7, and 9. The appearance of Nori from *Kappaphycus alvarezii* seaweed conditions of dry raw materials had the highest average value of 7.70 producing Nori with a white appearance rather than transparent. Nori from *Kappaphycus alvarezii* seaweed, the condition of semi-dried raw materials has a slightly brownish color appearance and is rather transparent. Nori from *Kappaphycus alvarezii* seaweed condition of dry raw material 50%: 50% semi-dry has a slightly brownish white color and is rather transparent.



(a) (b) (c)

Figure 2. Nori Results: (a) Nori *Kappaphycus alvarezii* condition of dry raw material, (b) Nori *Kappaphycus alvarezii* condition of semi-dry raw material, (c) Nori *Kappaphycus alvarezii* condition of 50% dry raw material: 50% semi dry.

Different Nori colors are caused by different conditions of the raw material of *Kappaphycus alvarezii* seaweed which produces a different color of seaweed product. The condition of dried seaweed raw materials is white because in the process of drying seaweed there is a soaking process of calcium oxide (CaO) solution which serves to remove fishy odor, whiten and kill microbes [2], while the raw material for seaweed is not treated by immersion of calcium oxide (CaO) in the process of drying seaweed, so that there is still the original color of the *Kappaphycus alvarezii* seaweed which is slightly brownish in color. The color is slightly brownish in the Nori from semi-dry raw material because the seaweed *Kappaphycus alvarezii* has a slightly brownish red color derived from the pigment content of phycoerythrin, the red pigment [26].

3.1.2 Aroma

The aroma assessment aims to determine the delicacy of the product based on the sense of smell. The observation of nori aroma from *Kappaphycus alvarezii* seaweed is presented in Table 2.

Table 2. Average Aroma of Nori Based on Differences Condition of *Kappaphycus alvarezii* Raw Materials

Condition of Nori Raw Material	Median	Average
Dried	7	7.00 a
Semi-dried	7	6.80 a
Dried 50% : Semi-dried 50%	7	6.40 a

Description: The average number of treatments followed by the same letter shows that there is no significant difference according to the multiple comparison test at 5%.

The aroma is one of the factors that influence the panelists on a product. Based on the panelists 'assessment of the Nori aroma of *Kappaphycus alvarezii* seaweed, the panelists' average values ranged from 6.40 to 7.00. The results of the statistical tests show that all treatments did not provide significantly different results and included the preferred category of panelists. The resulting aroma of Nori smells of aroma and typical seaweed. The highest average value of Nori aroma was found in the Nori treatment with the condition of dry raw materials with a value of 7.00, with a slightly fishy aroma on the Nori and flavored spice. The less fishy aroma on dry raw material conditions is because the drying process of dried seaweed undergoes a process of immersing it in calcium oxide (CaO) solution which has the function of removing fishy odor, whitening and killing microbes [2]. The cause of the fishy odor is the amine content found in seaweed [28]. The lowest average value of the aroma of Nori was found in the treatment of Nori with the condition of 50% dry raw material: 50% semi-dry at 6.40. The aromas produced by the treatments was still acceptable to the panelists.

3.1.3 Texture

The texture is one of the quality attributes of food ingredients [12]. Texture assessment is done by feeling and folding the Nori. The observation of the Nori texture of *Kappaphycus alvarezii* seaweed is presented in Table 3.

Table 3. Average Nori Texture Based on Different Conditions of *Kappaphycus alvarezii* Raw Materials

Condition of Nori Raw Material	Median	Average
Dried	7	7.50 a
Semi-dried	7	6.20 a
Dried 50% : Semi-dried 50%	7	6.80 a

Description: The average number of treatments followed by the same letter shows that there is no significant difference according to the multiple comparison test at 5%.

Based on the panelists 'assessment of the texture of Nori from *Kappaphycus alvarezii* seaweed, the panelists' average values ranged from 6.20 to 7.50. The results of the statistical tests showed that all treatments did not give significantly different results from other treatments. Nori in the treatment of the condition of dry raw materials has the highest average value with a value of 7.50, the texture of the Nori produced is thick, flexible and somewhat crunchy. This is because the raw materials of *Kappaphycus alvarezii* seaweed dry conditions have lower moisture content than *Kappaphycus alvarezii* seaweed in semi-dry conditions. The moisture content of dried seaweed is 13.39% -15.13% [2] and the moisture content of semi-dried seaweed is 32% [24]. The moisture content of dried seaweed is lower because the process of drying seaweed is carried out for 3 days [2], while the drying of semi-dried seaweed is carried out for 2 days [24]. The preference for the texture produced in the Nori was still acceptable to the panelists.

3.1.4 Flavor

The taste assessment is done using the Nori being cut into a small size of ± 2 cm and then given to the panelists for sampling and assessment. The results of observations of the Nori flavor from *Kappaphycus alvarezii* seaweed are presented in Table 4.

Table 4. Average Flavor of Nori Based on Differences Conditions of *Kappaphycus alvarezii* Seaweed Raw Material

Condition of Nori Raw Material	Median	Average
Dried	9	7.90 b
Semi-dried	7	6.60 ab
Dried 50% : Semi-dried 50%	5	6.10 a

Description: The average number of treatments followed by the same letter shows that there is no significant difference according to the multiple comparison test at 5%.

Based on the panelists' assessment of the Nori taste of *Kappaphycus alvarezii* seaweed it is known that all treatments can still be accepted by the panelists. The statistical test showed that the Nori taste of *Kappaphycus alvarezii* seaweed was significantly different from the Nori flavor of seaweed *Kappaphycus alvarezii* 50% dry matter: 50% semi-dry.

The nori taste of *Kappaphycus alvarezii* seaweed, the condition of dry raw materials has the highest average value of 7.90 producing nori with savory flavors, after taste feels rather bitter, slightly feels typical of seaweed. Nori from *Kappaphycus alvarezii* seaweed, the condition of semi-dried raw materials has a savory taste, after taste feels chewy and somewhat bitter, very noticeably typical of seaweed. Nori from *Kappaphycus alvarezii* seaweed condition of 50% dry raw material: 50% semi-dry has a savory taste, rather bitter after taste, quite feels typical of seaweed. The taste formed in the Nori of *Kappaphycus alvarezii* seaweed can be derived from the amino acid contained in *Kappaphycus alvarezii* seaweed namely glutamic acid, glycine and alanine [14] other than because of the addition of spices. Commercial nori taste that is salted and smells of seaweed, the taste produced in Nori comes from three amino acids found in *Porphyra/Pyropia* seaweed namely alanine, glutamic acid, and glycine [25].

The condition of different raw materials can affect the taste because the *Kappaphycus alvarezii* seaweed conditions of dry raw materials during the drying process of seaweed undergo the immersion stage of calcium oxide (CaO) solution which serves to eliminate fishy odor on seaweed [2], so that the Nori is produced from dried seaweed raw materials have a little fishy seaweed. Whereas, in semi-dried seaweed, during the drying process there is no immersion with a solution of calcium oxide (CaO) so that the distinctive fishy smell of seaweed is still felt and the Nori taste produced is very fishy seaweed. Mixing the two conditions of the raw material produces a taste of Nori that is quite fishy seaweed product.

3.2 Bayes Decision Methods

Decision making on alternative weight values of the appearance criteria, aroma, texture, and Nori taste of *Kappaphycus alvarezii* seaweed was carried out by multiple comparison tests (Pairwise Comparison). The results of calculations on the weighted scores of the appearance criteria, aroma, texture, and Nori flavor of seaweed *Kappaphycus alvarezii* are presented in Table 5.

Table 5. Weight Value Criteria Nori

Criteria	Weighted criteria
Appearance	0.20
Aroma	0.12
Texture	0.11
Flavor	**0.58**

Based on the calculation of the weight of the appearance criteria, aroma, texture, and Nori taste of *Kappaphycus alvarezii* seaweed, it was found that the taste criteria had the highest value compared to other criteria. This shows that the taste criteria most influence the assessment of Nori from *Kappaphycus alvarezii* seaweed. Flavor is the most considered criteria because the good taste will be an important point in a product [1]. This is because food made with modern technology and high nutritional value is not a guarantee that consumers will like it in terms of taste [12]. The calculation results on the weight of criteria and in determining the best treatment taking into the appearance, aroma, texture, and Flavor of nori from *Kappaphycus alvarezii* seaweed is presented in Table 6.

Table 6. Nori Rate Decision Matrices by Bayes Method

The Condition of Nori Raw Materials	Criteria				Alternative Value	Priority Value
	Appearance	Aroma	Texture	Flavor		
Dried	9	7	7	9	**8,54**	**0,41**
Semi-dried	5	7	7	7	6,61	0,31
Dried 50% : Semi-dried 50%	7	7	7	5	5,85	0,28
Weight Criteria	0,2	0,12	0,11	**0,58**		

Based on the calculation by the Bayes method, the highest Nori value of *Kappaphycus alvarezii* seaweed was obtained with the condition of dry raw material with a value of 8.54. Nori from *Kappaphycus alvarezii* seaweed with dry raw material conditions is the most preferred Nori by the panelists compared to other treatments, because it has a savory taste, after taste feels a bit bitter, slightly feels fishy typical of seaweed.

3.3 Physical Test

3.3.1 Thickness

Based on the results of thickness tests that were carried out on Nori from *Kappaphycus alvarezii* seaweed with the condition of dry raw materials had a thickness 0.108 mm. The carrageenan content in *Kappaphycus alvarezii* seaweed can form a gel so that it can maintain the shape of the Nori sheet so that it is not easily damaged and torn [7]. Thickness is affected by the area of the mold, the volume of solution, and the amount of total solids [16]. Nori thickness affects the crispness of the product and the drying time. The more amount of dough used can produce Nori which is thicker, heavier, and not crispy [21].

3.3.2 Hardness

Based on the tests carried out, the Nori from *Kappaphycus alvarezii* seaweed dry matter has a value of 1916.16 gf. The unit of gram force (gf) comes from the hardness which is expressed from the maximum force (peak value) at the first pressure or compression [4]. The value of the force obtained shows that the greater the value, the smaller the level of crisp texture [6]. The high value of nori from *Kappaphycus alvarezii* dry matter seaweed can be influenced by carrageenan content in *Kappaphycus alvarezii* seaweed which during heating forms a gel. [10] In research that stated that the tensile strength of Nori *Calliblepharis saidana* (formerly *Hypnea saidana*) was influenced by carrageenan extracted during heating and the cooling process, the hydrogen atoms in the carrageenan molecule would help to form a twist, the interaction of this twist would form a gel, then forming aggregation of these cross points and form a three-dimensional structure. This results in the gel getting stronger and not easily broken.

3.4 Chemical Test

3.4.1 Moisture Content

Based on the results of the Nori test from *Kappaphycus alvarezii* seaweed with the condition of dry raw materials having a moisture content of 17.23%. Based on the standards [5], the quality requirements for dry products have a maximum moisture content of 10%. The higher the water content, the lower the nori crispness and conversely the lower the moisture content, the higher the crispy Nori [11]. Nori sheets easily absorb water, so even though they are packaged, many Nori uses silica gel and other materials as moisture absorbers [10]. The higher water content in the Nori from *Kappaphycus alvarezii* seaweed can also be caused by the carrageenan content of the *Kappaphycus alvarezii* seaweed. [19] In research stated that the increase in water content due to water molecules binds to carrageenan molecules and the drying process does not evaporate to the maximum. [8] The carrageenan content of *Kappaphycus alvarezii* seaweed dry conditions amounted to 61.52%.

3.4.2 Crude Fiber Content

The test results of crude fiber on Nori from *Kappaphycus alvarezii* seaweed with dry raw material conditions had a value of 10.10%. Crude fiber content found in Nori was influenced by carrageenan contained in seaweed *Kappaphycus alvarezii*. [13] In research stated that fiber content which is relatively high in dodol was caused by the use of ingredients from dodol, namely seaweed *Kappaphycus alvarezii* as a producer of carrageenan having high fiber content. Levels of dietary fiber from *Kappaphycus alvarezii* seaweed reached 67.5% consisting of water-insoluble dietary fiber 39.47% and water-soluble dietary fiber 26.03% [9]. The total level of commercial Nori dietary fiber as much as 31.67% consisted of 8.37% dissolved feeding fiber and 23.3% non-dissolved dietary fiber [20]. Levels of crude fiber are lower than dietary fiber because strong acids (sulfuric acid) and strong bases (sodium hydroxide) have a greater ability to break (hydrolyze) food components compared to digestive enzymes [3].

4. CONCLUSION

Based on the results of the research conducted on Nori products from *Eucheuma cottonii* seaweed, the panelists preferred the Nori with dried raw material condition of *Eucheuma cottonii* seaweed. Nori thickness of *Kappaphycus alvarezii* seaweed with dry raw material conditions of 0.108 mm and hardness of 1916.16 gf was the most preferred. Meanwhile, the moisture content of 17.23% and the crude fiber content of 10.22% was contained in this product.

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