IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

Physicochemical, nutritional, and color characteristic of Nori Snack from Snakehead Fish *(Ophiocephalus striatus), Eucheuma cottonii*, and *Gracilaria sp*

To cite this article: Muhammad Yusuf *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **819** 012012

Physicochemical, nutritional, and color characteristic of Nori Snack from Snakehead Fish *(Ophiocephalus striatus)*, *Eucheuma cottonii,* and *Gracilaria sp*

Muhammad Yusuf[1*], Nur Fitriani UA[2], Syahriati[2]

[1]Department of Chemical Engineering, Politeknik Negeri Ujung Pandang, 90245, Indonesia.
[2]Department of Agroindustry, Politeknik Pertanian Negeri Pangkep, 90655, Indonesia.

[*]yusufitri@poliupg.ac.id

Abstract. Seaweeds thrive in Indonesia. Most Indonesians reject seaweed-based products on the market due to their unappealing taste. This research aims to create a nori snack (seaweed snack) that appeals to the Indonesian community's taste using *Eucheuma cottonii* and *Gracilaria sp* in order to popularize seaweed consumption in Indonesia. Addition of snakehead fish to increase the nutritional value of protein in nori snacks. Traditional nori making techniques developed to obtain nori snacks that has added value in terms of nutritional value, taste, flavor and texture. Nori snack samples showed increases in carbohydrate and protein, but low in fat contents. The addition of snakehead fish, *Eucheuma cottonii,* and *Gracilaria sp* can increase the nutritional value of nori snacks so that they become a reference as functional food for the community.

1. Introduction

Chemical composition of seaweed varies with environmental conditions, habitat, and maturity [1,2]. Although seaweed polysaccharides are an excellent source of dietary fiber, human intestinal enzymes do not entirely digest them [3]. Green seaweed polysaccharides have more in common with the physical properties of land plant leaves than with those of other seaweed classes [2]. Enteromorpha as a chlorophyte (green seaweed) contains minerals found in the chlorophyll band, including calcium, iron, and magnesium. Edible Chlorophyta species have between 12.4-18.7% ash, 43.4-60.2% carbohydrate, and 16-22.1% protein on a dry basis (db). Seaweed composition is showed to impair the bioavailability of dietary components [3]. While edible seaweeds contain various minerals, they also have other nutrients such as resistant protein and dietary fiber, which can pass through the intestine without being absorbed while retaining dietary mineral components.

Eucheuma cottonii is a carragenophyte found in red seaweed. This seaweed is high in nutrients, dietary fiber, and minerals. This alga has been used to supplement and fortify instant noodles, doughnuts, and bread. The addition of this alga to these products is intended to increase their nutritional and functional value [4]. Some seaweeds contain 10-100 times more vitamins and minerals per unit of dry basis than terrestrial plants or animal foods. Vitamins (A, D, E, K, C, B1, B2, B9, B12) and essential minerals (zinc, copper, manganese, selenium, fluoride, calcium, magnesium, iron, iodine, phosphorus, potassium) are among them [5,6]. *Gracilaria sp* is an economically important species of seaweed in Indonesia that has not been appropriately treated. *Gracilaria sp* also included one type of seaweed-producing agar-agar (agarofit) that grows in Indonesia. Because of its ease of care, *Gracilaria sp* is widely cultivated in Indonesia. Seaweed is an industrial raw material and can also be developed into food products such as Nori. *Gracilaria sp,* a raw material for agar-agar, can also be used as an alternative raw material for Nori production [7]. Fish is a healthy food high in proteins, micronutrients as polyunsaturated fatty acids, particularly docosahexaenoic acid (ω)-3 eicosapentaenoic acid. Other regions and countries have studied cork fish or snakehead fish for their effect on wound healing and chemical composition. The protein content of snakehead fish *(Ophiocephalus striatus)* was 23% (dry basis), crude ash 1.0-1.8%, and total lipid content was generally high 5.7-11.9%, according to the proximate analysis. The major amino acids 9.7-21.7%, with lysine, glutamic acid, and aspartic acid accounting for the majority. The DHA levels in these fish have been used to reduce inflammation, pain and promote wound healing in Malaysia for centuries [8,9].

Due to their nutrient deficiency and high energy density, most market snacks are made from rice starch or corn and have a nutritional deficiency. As a result, snakehead fish and seaweed ingredients appear to be ideal candidates for creating healthier snacks with high fiber content and a diverse nutrient profile [10,11]. A healthy vegetarian diet requires a adequate micronutrients such as vitamin B12, iodine, selenium, and zinc and balanced amino acid composition [12,13].

In this regard, the combination of fiber, protein, and cereals is crucial. Healthy snacks from green grass tree leaves Nori *(Premna Oblongifolia Merr)* examines the effect of different seasonings (spraying, dyeing, greasing) on the organoleptic properties (color, texture, and flavor) and antioxidant capacity on snack nori. Develop a snack made of green grass tree leaves as a healthy snack, and conduct additional research to determine the nutritional value of a beneficial snack its associated water content [14]. Studies on the use of *Enteromorpha compressa (Linnaeus),* green seaweed *(Chlorophyta)*, are rich in dietary fiber, minerals, and vitamins. Enteromorpha is used to manufacture healthy snacks, *"Pakoda"* which is a typical food from India. In increasing Enteromorpha levels, Pakoda samples showed increases in dietary fiber, protein, and ash content but reduced polyphenols and free radical-scavenging activity in the sample [15].

Various seaweeds are used in food preparation in Far-Eastern countries, such as Nori, making thin sheets of crushed *Porphyra* species, and *Kombu* made of dried *Laminaria*. *Undaria seaweed* is dried or boiled and salted to make *Wakame.* Utilization of Snakehead Fish*, Eucheuma cottonii,* and *Gracilaria sp* in healthy snacks (Nori) identified to increase nutritional value. However, the use of snakehead, *Eucheuma cottonii,* and *Gracilaria s* as food and snack in Indonesia extremely limited. This study evaluated the physicochemical and nutritional characteristics (moisture, ash, protein, carbohydrates, and lipid contents) and physical parameters (color and texture) of nori snacks produced from Snakehead fish *(Ophiocephalus striatus), Eucheuma cottonii,* and *Gracilaria sp.*

2. Methodology

2.1. Materials

Snakehead fish *(Ophiocephalus striatus)* supplied by Lotte Mart Wholesale (Makassar, South Sulawesi). E*ucheuma cottonii* and *Gracilaria sp* was received from seaweed farmers in Takalar Regency, South Sulawesi (Figure 1). The texture was determined using a TA express Stable Micro Systems texture analyzer (United Kingdom). Control samples used are commercial snack nori products.

2.2. Preparation of surimi from snakehead fish

Fish meat is separated from the bones, fillets, and ground using a grinder. Meat that has washed 2 times using cold water temperature 5°C and salt solution 0.3% (w/v), then meat and water are separated in cleaning to produce raw surimi.

2.3. Preparation of nori snack

The nori snack made using a modified method from a previous study [16]. Before soaking in water, *Eucheuma cottonii* and *Gracilaria sp* were cleaned and sorted (seaweed: water = 1:2). The water contained 0.01% NaOH. Soaked seaweed for 12 h was washed and drained. Water added in seaweed crushed (seaweed: water = 2:1 w/v). Seaweed is mashed and added *Pandanus amaryllifolius* leaf extract, then seaweed porridge is boiled for 5 min at a temperature 100°C. A filter of the mixture used 80 mesh.

The filtered mixture was then poured into the square mold (19x13 cm). It was dried in an oven for 7 h at 50ºC. Table 1 shows the preparation of a nori snack.

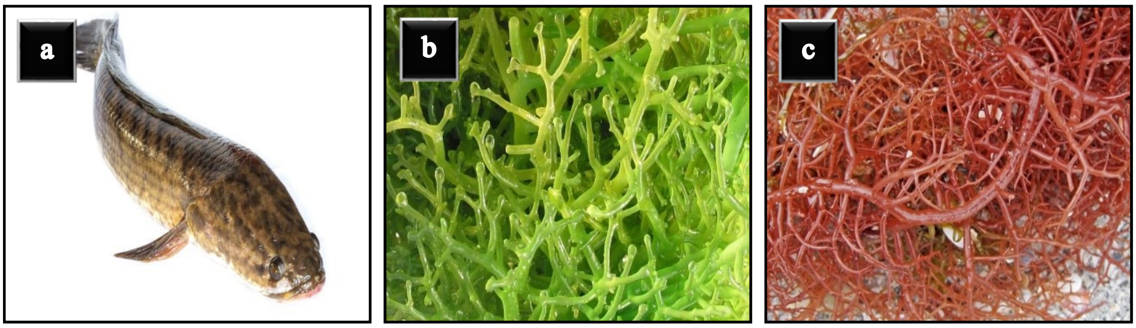

Figure 1. Main ingredient nori snack. a) Snakehead, b) *Eucheuma cottonii*; and c) *Gracilaria sp.*

Table 1. Formulations of nori snacks

Samples	**Surimi Snakehead fish (g)**	***Eucheuma cottonii* (g)**	***Gracilaria sp* (g)**
SE1	100	10	0
SE2	100	15	0
SE3	100	20	0
SE4	100	25	0
SE5	100	30	0
SG1	100	0	10
SG2	100	0	15
SG3	100	0	20
SG4	100	0	25
SG5	100	0	30

2.4. Color measurements using chromameter
Minolta Chroma CR-400 (Minolta Co, Osaka, Japan) was used to analyze the samples' colors using the Hunter method (L, a, and b). Parameter of the value L, a, b sample will be visible, where the value of the nori snack's luminosity (L), hue angle (°Hue), and chromaticity (C). Value (+) a represents red, the value (-) a represents green, the value (+) b represents yellow, and the value (-) b represents blue [17].

2.5. Texture analyzer properties
TA-HD plus texture analyzer with a 5 kg load cell used to conduct the force-deformation test (Stable Micro Systems, Surrey, United Kingdom). Samples were obtained directly from the package and punctured with a 5 mm diameter cylindrical flat probe (P/2). Deformation tests were performed at a constant rate of 1 $mm^{.s-1}$ to ensure that the probe penetrated the nori snack completely; carefully selected the deformation level. The upper and lower nori snacks were fractured using Exponent software, which

used to record force versus deformation data and calculate mechanical parameters such as force (N) and distance (mm) at fracture.

2.6. Tensile strength and thickness properties
Thickness was measured with a 0.01 mm digital micrometer with 10 samples and 3 duplicated. A tensile stress analyzer was used to determine tensile strength and elongation [18].

2.7. Proximate analysis
Ash and moisture content is determined using gravimetric methods, Lipids use soxhlet extraction methods, and Lowry-folin methods for analyzing proteins. Carbohydrate levels were analyzed using spectrophotometry (Nelson-Somogyi).

3. Results and Discussion

3.1. Characterization of nori snack
The proximate values snacks enriched with Snakehead fish, *Gracilaria sp,* and *Eucheuma cottonii* are presented in Table 2. Nori snacks for each addition in 30 g showed significantly higher moisture and ash content values, lipids, carbohydrate, and protein content than control (P>0.05). Table 2 shows average water content values of samples between 9.77-14.14%. The water content of nori snacks produced from the research in Table 2 still does not meet the quality standards required in the Indonesian National Standard (SNI 01-2886-2000), which is a maximum of 4%. The low water content needed due to the high water content will result in a smaller extruded development index. Heat and pressure drop when the extruder is processed, causing the water trapped inside the extruded. The gelatinization and protein denaturation process will form a film layer to trap air vapor in the material. The material will expand to create an air cavity, and extrusion will float [19].

Protein levels are still not listed to Indonesian National Standard (SNI 01-2886-2000). Protein levels are significant for quality attributes into SNI because generally, those who consume food mild extrusion is a child's age growth. Children of growing age desperately need enough protein, and formulation of raw materials strongly influence levels of proteins. Attributes of quality protein levels in nori snacks have a relatively high-value range of 30.88-42.04%. High levels of protein in nori snack due to the composition of Snakehead fish, *Eucheuma cottonii* and *Gracilaria sp* in the mixture of extrudate formula.

Table 2. Nutritional value and physical characteristic of nori snacks

Sample	Chemical composition					Physical characteristic			
	Carbohydrate (%)	Protein (%)	Lipid (%)	Moisture content (%)	Ash content (%)	Tensile strength (Kgf/cm^2)	Thickness (mm)	Texture (gf)	Colour (°Hue)
Control	1.83	19.19	1.49	75.85	0.75	807.68	0.13	521.61	149.95
SE1	27.29	42.04	4.69	14.14	2.83	343.72	0.19	215.94	146.41
SE2	29.49	38.10	3.97	13.34	3.61	350.48	0.19	241.12	146.41
SE3	32.59	34.45	3.45	12.86	4.56	421.05	0.19	269.78	146.41
SE4	34.56	31.55	2.95	12.43	4.99	469.84	0.20	314.79	150.84
SE5	36.92	29.60	2.45	11.72	5.34	571.43	0.20	324.60	150.84
SG1	25.27	43.55	3.98	12.74	4.61	329.41	0.20	110.96	146.41
SG2	27.72	39.78	3.45	12.28	5.07	422.22	0.20	127.38	146.41
SG3	30.12	34.97	2.99	11.30	5.25	495.24	0.20	236.18	146.41
SG4	31.83	32.49	2.48	10.52	5.86	523.84	0.20	246.96	150.84
SG5	33.58	30.88	1.98	9.77	6.68	637.45	0.20	340.95	150.84

The Carbohydrate content of snacks ranges from 27.29-33.58%. Parameters carbohydrates are important to be used as a requirement because this parameter will be seen how many calories there are per 100 g of extrudate snacks produced. Carbohydrates provide calories for almost the entire world's population and are critical in determining foods' taste, appearance, and texture. Lipids content in this study ranged from 1.98-4.69%. The lipids content of nori snacks produced is below 30%, following

Indonesian National Standard (SNI 01-2886-2000). Nori snack has low-fat content, and this is very important because they need for fat in the body is minimal. Nori snacks can be a reference for foods that are low in fat but rich in nutrients.

3.2. The physical characteristic of nori snack

Nori snack tensile strength increased as the *Eucheuma cottoni,* and *Gracilaria sp* concentration increased. The highest and lowest tensile strength was found in a nori snack containing 30 g of *Gracilaria sp* (SG5), and 10 g of *Gracilaria sp* (SG1) (Table 2). The maximum stress a material can withstand before breaking is defined as its tensile strength. Divide the tensile force by the thickness and width of the material to get the tensile force. Tensile strength is affected by fiber strength, fiber length, and bonding [16]. The thickness of the nori snack made of Snakehead Fish, *Eucheuma cottonii,* and *Gracilaria sp* was 0.19-0.20 mm. The thickness of nori snacks and commercial Nori did not differ significantly. It could be because the amounts of Snakehead Fish, *Eucheuma cottonii*, and *Gracilaria sp* mixture used in each group were the same. Figure 2 illustrates the nori snack. Hardness ranged from 110.96-340.95 gf based on the texture profile analysis of the nori snack. The polysaccharide content of Eucheuma cottonii and Gracilaria sp. contributes to the crunchy texture of nori snacks.

3.3. Colour measurement of nori snack

The color intensity of the nori snack addition showed relatively similar results for each treatment. Formulation of seaweed addition *Euchema cottonii* and *Glacilaria sp* at 10, 15 and 20 g, indicating a °Hue value of 146. Formulations of 25 and 30 g indicate °Hue value of 151. Results plotted to the table (Hunter Method) area of the color range chromaticity and obtained *Yellow Green* color with °Hue value of 126-162.

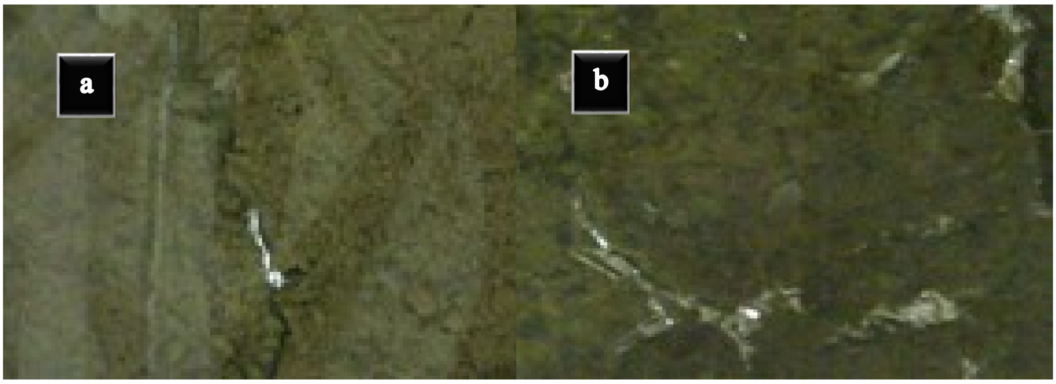

Figure 2. Nori snack from snakehead fish, *Eucheuma cottonii,* and *Gracilaria sp.* a) sample code SE1, b) sample code SG1.

4. Conclusion

Healthy snack made from a mixture of high-protein snakehead fish, *Eucheuma cottonii,* and *Gracilaria sp* fiber-rich fractions were successfully produced and studied. The snacks processed under ideal conditions also showed positive proximate analysis, which was highly correlated with the parallel parameters determined by tensile strength, thickness, and texture analysis. The nutritional value of these products qualifies them for the nutrition claims "high in protein" and "low in fat."

REFERENCES

[1] Abdallah M A M 2014 Seaweed uses: Human health and agriculture *Seaweeds: Agricultural Uses, Biological and Antioxidant Agents*
[2] Ito K and Hori K 1989 Seaweed: chemical composition and potential food uses *Food Rev. Int.* **5** 101–44
[3] Urbano M G and Goi I 2002 Bioavailability of nutrients in rats fed on edible seaweeds, Nori

(Porphyra tenera) and Wakame (Undaria pinnatifida), as a source of dietary fibre *Food Chem.* **76** 281–6
[4] Firdaus M, Yahya, Nugraha G R H and Utari D D 2017 Fortification of seaweed (Eucheuma cottonii) flour on nutrition, iodine, and glycemic index of pasta *IOP Conference Series: Earth and Environmental Science* vol 89 pp 1–7
[5] Qin Y 2018 Applications of bioactive seaweed substances in functional food products *Bioactive Seaweeds for Food Applications: Natural Ingredients for Healthy Diets* pp 111–34
[6] Shannon E and Abu-Ghannam N 2019 Seaweeds as nutraceuticals for health and nutrition *Phycologia* **58** 563–77
[7] Ramadhan Y A, Afrianto E, Dhahiyat Y and Liviawaty E 2019 Differences of the way of drying Nori from raw seaweed Gracilaria sp . based on the level of preference *Sci. News Pacific Reg.* **133** 12–22
[8] Zuraini A, Somchit M N, Solihah M H, Goh Y M, Arifah A K, Zakaria M S, Somchit N, Rajion M A, Zakaria Z A and Mat Jais A M 2006 Fatty acid and amino acid composition of three local Malaysian Channa spp. fish *Food Chem.* **97** 674–8
[9] Pasaribu Y P, Buyang Y, Suryaningsih N L S, Dirpan A and Djalal M 2020 Effect of steaming and pressurized boiling process to the nutrient profile of Papuan cork fish Channa striata as potential protein-rich food to prevent stunting *Med. Clin. Pract.* **3** 100120
[10] Alam M S, Kaur J, Khaira H and Gupta K 2016 Extrusion and Extruded Products: Changes in Quality Attributes as Affected by Extrusion Process Parameters: A Review *Crit. Rev. Food Sci. Nutr.* **56** 445–7
[11] Susan Arntfield H M 2015 Extrusion Processing and Evaluation of an Expanded, Puffed Pea Snack Product *J. Nutr. Food Sci.* **5** 4–9
[12] Sobiecki J G, Appleby P N, Bradbury K E and Key T J 2016 High compliance with dietary recommendations in a cohort of meat eaters, fish eaters, vegetarians, and vegans: Results from the European Prospective Investigation into Cancer and Nutrition-Oxford study *Nutr. Res.* **36** 464–77
[13] Saldanha do Carmo C, Varela P, Poudroux C, Dessev T, Myhrer K, Rieder A, Zobel H, Sahlstrøm S and Knutsen S H 2019 The impact of extrusion parameters on physicochemical, nutritional and sensorial properties of expanded snacks from pea and oat fractions *LWT* **112** 1–12
[14] Wibowotomo B, Hidayati L and Hariyani S D 2020 Antioxidant Capacity Assay and Sensory Evaluation of Flavored Healthy Snack Composed from Nori of Green Grass Tree Leaves (Premna Oblongifolia Merr.) *Applied Science, and Technology in Home Economics (ICONHOMECS 2019) Copyright © 2020 The Authors.* (Atlantis Press) pp 57–64
[15] Mamatha B S, Namitha K K, Senthil A, Smitha J and Ravishankar G A 2007 Studies on use of Enteromorpha in snack food *Food Chem.* **101** 1707–13
[16] Andriani R, Wulansari A, Dewi E K and Husen A H 2020 Physical characteristics of artificial Nori made from Ptilophora pinnatifida and Moringa oleifera leaves *IOP Conference Series: Earth and Environmental Science* vol 584 pp 1–6
[17] Fitriani Nur U A, Yusuf M, Pirman, Syahriati and Rahmiah S 2020 Physicochemical, antioxidant and sensory properties of chocolate spread fortified with jackfruit (Artocarpus heterophyllus) flour *Food Res.* **4** 2147–55
[18] del Olmo A, López-Pérez O, Picon A, Gaya P and Nuñez M 2019 Cheese supplementation with five species of edible seaweeds: Effect on proteolysis, lipolysis and volatile compounds *Int. Dairy J.* **90** 104–13
[19] Howe J C 1996 Fish nutrition in aquaculture *Fish. Res.* **26** 387–90