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# The Formulation of Artificial Nori with the Base Mixture Ingredients of *Gracilaria* sp. and *Arenga pinnata* (Wurmb) Merr. using the Natural Colorant from *Pleomele angustifolia* (Medik.) N.E. Br.

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# The Formulation of Artificial Nori with the Base Mixture Ingredients of *Gracilaria* sp. and *Arenga pinnata* (Wurmb) Merr. using the Natural Colorant from *Pleomele angustifolia* (Medik.) N.E. Br.

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**Abstract**. Alongside the growth of public interest in Japanese cuisine, the consumption of nori in Indonesia increases significantly. The production of artificial nori from a slightly different base material that is a high-quality local alga needs to be executed to fulfill the demand of nori in the national market. This study aimed to determine the most optimum formula in the artificial nori manufacture by utilizing *Gracilaria* sp. and *kolang-kaling* [*Arenga pinnata* (Wurmb) Merr.]. As the base ingredients. This study investigated the quality of artificial nori from seven different formulas. The quality of artificial nori was studied based on three parameters, namely proximate composition, physical character, and the results of the organoleptic test the artificial nori produced. As a result, the formula of 70% *Gracilaria* : 30% *kolang-kaling* has carbohydrate (9.70%), the highest protein (4.42%), thickness (0.58 mm), greenness (2.77), and the highest organoleptic value, the formula of 80% *Gracilaria*: 20% displayed ash content (31.45%), the highest fiber (7.34%)), whereas the formula of 80% *Gracilaria*: 20% *kolang-kaling* pinpointed the highest tensile strength (0.16 N/mm$^2$). In general, the addition of *kolang-kaling* [*Arenga pinnata* (Wurmb) Merr.] improves the quality of the manufactured artificial nori.

**Keywords:** Artificial nori, *Gracilaria* sp., *Arenga catechu* L, *Pleomele angustifolia*

## 1. Introduction

Nori is a typical Japanese food in the form of thin sheets with dark green to dark purple color [1]. This food is commonly used as a supplement to other Japanese specialties, such as sushi [2, 3]. The primary ingredient of nori is macroalgae from the Porphyra genus [1, 2]. These foods contain various nutrients, such as dietary fiber, crude proteins, lipids, carbohydrates, and various minerals (Na, K, Ca, Mg, Fe, Zn, Mn, and Cu) [4–6]. Regarding its nutritional contents, Porphyra belongs to the seaweed group with the highest nutritional content [1]. The nutritional content of Porphyra is sometimes higher than that of plants on land [1, 7]. Besides, nori also has a delicious taste so that the level of food consumption is increasing [8, 9].

Nori consumers not only come from Japanese society [10]. In Indonesia, nori consumption is indicated to continue to increase along with the emergence of Japanese food restaurants [11] and the increasing attractiveness of the public for Japanese cuisine [10, 12, 13]. In response to these conditions, Indonesia should be able to produce its nori to reduce dependence on import nori in fulfilling domestic needs. Unfortunately, the presence of algae from the Porphyra genus is reported to be rarely found in the Indonesian sea [14–16]. Therefore, efforts to look for alternative nori ingredients to replace Porphyra need to be done. This substitute has to be processed into high-quality nori, in terms of physical, proximate, and organoleptic characteristics. Porphyra substitute material should also be in the form of algae which is easily found or easily bred in Indonesian waters.

*Gracilaria* is one of the macroalgae that can be found in various regions of Indonesian waters [14]. Numerous references indicate that Indonesia is one of the countries that have the largest *Gracilaria* population [17–19]. *Gracilaria* can be found in various habitats, for example in the mangrove area or cage culture [20] and is usually cultivated by floating raft method [21, 22]. This macroalga contains various vital nutrients needed by humans, such as proteins [23], important minerals [24], vitamins [23], high in antioxidants [25, 26], and several metabolites such as phenols, flavonoids, and terpenoids [27, 28]. Besides, various bioactive compounds in *Gracilaria* can potentially cure various diseases, such as diabetes mellitus [29], cancer [30], overcoming obesity [29], showing anti-inflammatory activity [31] and antibacterial character [30, 31]. In Indonesia, this macroalga is often used as raw material for *agar* production [32] and abalone feeding ingredient [19].

Previous studies have attempted to assess the potential use of *Gracilaria* as the basic ingredient for artificial nori [33]. However, the quality of the produced nori was still considered less than optimal. Therefore, exploration of complementary materials that can be combined with *Gracilaria* and improve the quality of artificial nori needs to be done. One of the complementary ingredients that have the potential to increase the quality of food products is *kolang-kaling* [34–36]. *Kolang-kaling* is a typical Indonesian snack made from the fruit seeds of palm trees [*Arenga pinnata* (Wurmb) Merr.] [37]. This tree is widely spread and grown in various regions in Indonesia [38]. Up to now, Indonesians often use it as a mixture of drinks [39]. Also, *kolang-kaling* contains a variety of nutrients that have the potential to complement and enrich nori nutrients made from *Gracilaria* [40–42].

Besides having outstanding nutritional quality, artificial nori should also have an appearance similar to the original nori. Therefore, artificial nori should have a green color like *Porphyra*-based nori. In this regard, the use of a natural dye that is safe for health is recommended in the process of making artificial nori. Suji leaf [*Pleomele angustifolia* (Medik.) N.E. Br.] is one of the natural-artificial dye ingredients that has been recommended by several former studies [33, 43, 44], as suji leaves have several advantages, such as safe for health and able to affect the level of consumer acceptance.

As explained earlier, various studies have been conducted to find substitute materials for nori production. Some research has attempted to explore the potential of *Porphyra* found in Indonesia as the basic ingredient of making nori [15], some other studies have tried to focus their research using basic ingredients from other macroalgae genuses that are easier to find in Indonesia such as, *Ulva lactuca* and *Euchema cottonii* [45], *Saidana Hypnea* [46, 47], and *Gracilaria sp*. [33]. However, from those conducted studies, none has been attempted to improve the quality of nori by combining macroalgae with terrestrial plants. Therefore, the purpose of this study was to obtain the best quality nori by varying the composition of *Gracilaria* and *kolang-kaling* in producing artificial nori.

## 2. Methods

### *2.1. Research design*

The research design used in this study was True Experimental Research to determine the differences in the concentration ratio of *Gracilaria sp.* and *kolang-kaling* towards the quality of nori. Concentration variations of material positioned as the level of treatment in this study are presented in Table 1. The nori qualities observed in this study are from physical, proximate, and organoleptic parameters. Artificial nori making is done at the Center for Agricultural Training located on Jl. Ketindan, No. 01 Lawang, Malang. Proximate analysis was carried out at the Chemistry Laboratory, FMIPA, Universitas Negeri Malang. Physical testing was conducted at the Laboratory of Food Science and Technology, FPP, University of Muhammadiyah Malang. Organoleptic tests were carried out in the University of Muhammadiyah Malang's environment.

**Table 1.** Concentration Comparison List of Artificial Nori Base Ingredients

| Treatment Codes* | Ingredient Concentration (%) | |
|---|---|---|
| | ***Gracilaria* sp.** | ***Kolang-kaling*** |
| A1K1 | 100 | 0 |
| A2K2 | 95 | 5 |
| A3K3 | 90 | 10 |
| A4K4 | 85 | 15 |
| A5K5 | 80 | 20 |
| A6K6 | 75 | 25 |
| A7K7 | 70 | 30 |

**code used to summarize the details of the concentration of each treatment. A = Algae (Gracilaria sp.), K = Kolang-kaling (A. pinnata)*

### *2.2. Materials*
The main ingredients utilized in this study were *Gracilaria* sp. and *kolang-kaling* (*Arenga pinnata)* as artificial nori base materials and suji leaf *(Pleomele angustifolia)* as a natural coloring material. *Gracilaria* sp. used in the treatment was obtained from Madura Island (Indonesia) and was collected in the period March to April 2018. The reason for choosing Madura was because this area is one of the cultivating areas of Gracilaria sp. in Indonesia. The *Kolang-kaling* was obtained from Babat market (Babat District, Lamongan, Indonesia) in May. Suji leaves were obtained from the garden located in Tasikmadu (Malang, Indonesia). *Kolang-kaling* and suji leaves can be found anywhere, so there was no specific reason for choosing the location for taking these two materials. The choice of location was only becuase the locations were close to the research location.

### *2.3. Production of artificial nori*
Artificial nori production began with the manufacture of *Gracilaria* sp. and *kolang-kaling* porridge as well as the making of suji leaf solution. Initially, dry *Gracilaria* sp. was cleaned from the remaining dirt. Then, the seaweed was dried again until the water content decreased. After being completely dry, it was crushed in a blender until smooth and became flour. *Kolang-kaling* porriage making was started by washing the material until clean to eliminate all mucus. It was then cut into smaller size to ease the blending process. The cuts were put in a blender and were added by water in a ratio of 1: 1 and then crushed to form a friable porridge. Suji leaf solution was made by using a traditional method that began with washing the suji leaves using running water until it was clean from the dirt. Suji leaves were cut into smaller pieces, and then put into a blender; the water was added later by the ratio of 1: 7 then filtered.

Nori making started from the mixing of *Gracilaria* sp. with *kolang-kaling* porridge following the predetermined concentration ratio of the treatment. Furthermore, the mixing process was carried out on the stove with the addition of 150 mL of water, 2 mL of glycerin, suji leaves as a natural dye of 2 mL, mashed onion and salt. The mintage was done on a 20 × 20 cm glass plate. The next step was the drying of the nori dough formulation using a cabinet dryer with a temperature of 50 °C for 16 hours. After the heating stage, the formulated nori was then released from the mold.

### *2.4. Proximate analysis*
The testing of water content, ash content, and fiber content were done using gravimetric testing. Protein content testing was conducted using spectrophotometry (testing using Folin's Lowry Method). Furthermore, the testing of carbohydrate (reduced sugar) levels was done by using spectrophotometry (testing using the Nelson-Somogyi method).

### *2.5. Physical analysis*
The tensile strength of nori was measured using a tensile strength tool. Nori thickness was measured using a micrometer. This tool has up to 0.001 mm accuracy. Measurements were made on one of the nori parts so that the average nori thickness values were obtained in mm. The color intensity that was observed was the level of greenness determined by using a digital color meter (*Color Reader*).

### *2.6. Organoleptic test*
Organoleptic test in this study was carried out using hedonic test method. The hedonic test is an assessment based on a person's preference level on a sample that is presented based on a hedonic scale determined by thirty assessors.

### *2.7. Data analysis techniques*
Data from proximate and physical analyses were derived using the one-way multivariate analysis of variance (MANOVA) test, followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level. The data from the organoleptic test were analyzed using the Kruskal-Wallis H test and continued with pairwise comparisons through the Kruskal-Wallis H test that has been adjusted by the Bonferroni Correction.

## 3. Results and Discussion
In this study, artificial nori variants made from *Gracilaria* sp. and *kolang-kaling*, naturally colored by suji leaves were produced. Artificial nori produced from each treatment is presented in Figure 1. Based on Figure 1, all nori variants were green. The green color is caused by the addition of natural dyes using suji leaves.

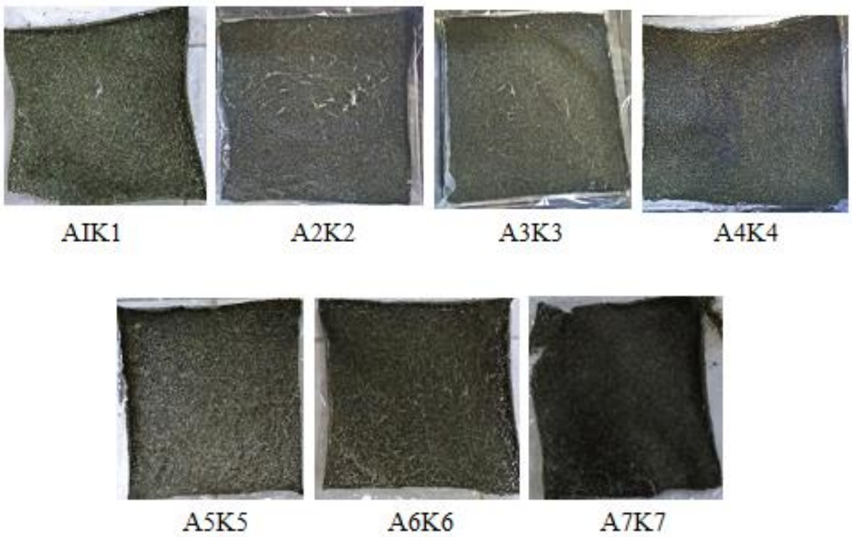


**Figure 1.** Artificial nori samples produced from each treatment. A = Algae, K = *Kolang-kaling*; details of treatment can be seen in Table 1

### *3.1. Proximate composition*
Proximate analysis was employed to measure the relative amount of various substances existed in a sample, including food samples [48]. In this study, there was no difference in proximate levels of artificial nori with variations in the percentage of the analyzed *Gracilaria* sp. and *kolang-kaling*. Based on the results of the multivariate test, the difference in the material percentage has a significant effect on the proximate composition of the artificial nori produced [$F(24.40) = 32.328$, $p < 0.05$]. From the results of the univariate test, the proximate percentage difference occurs in carbohydrate parameters [$F(6.14) = 94.549$, $p < 0.05$], protein [$F(6.14) = 7.135$, $p < 0.05$], ash [$F(6.14) = 5.046$,

p <0.05], or fiber [F (6.14) = 73.095, p <0.05]. The proximate composition of the seven artificial nori combinations produced in this study and the results of the DMRT test on the data are summarized in Table 2.

Based on Table 2, in each formulation of the used material, artificial nori always contained carbohydrates, proteins, ash, and fiber. The existence of these four substances was also found in A1K1 formula. In A1K1 formula, the nori base material was *Gracilaria* sp. without the addition of *kolang-kaling*. Besides, ash content had a much greater percentage than the levels of the other three components. Although it did not have the same percentage, the presence of these four components and the high ash content when compared to other components are in line with the assertions of several other studies examining the proximate process of *Gracilaria* sp.; although they were not produced into nori [19, 24]. Thus, from these findings and the incorporated findings from some of the previous studies, it can be suggested that *Gracilaria* sp. contains carbohydrates, proteins, ash, and fiber and the process of making seaweed into nori maintains some of these components.

**Table 2.** The DMRT Results of Proximate Compositions of Seven Artificial Nori Types

| Treatment Codes | Mean ± SD Proximate Parameters | | | |
|---|---|---|---|---|
| | Carbohydrate (%) | Protein (%) | Ash (%) | Fiber (%) |
| A1K1 | $0.88 \pm 0.20^{a}$ | $2.83 \pm 1.31^{ab}$ | $30.75 \pm 0.52^{c}$ | $1.31 \pm 0.21^{b}$ |
| A2K2 | $1.18 \pm 0.08^{a}$ | $1.93 \pm 0.73^{a}$ | $29.86 \pm 1.60^{bc}$ | $0.30 \pm 0.08^{a}$ |
| A3K3 | $1.16 \pm 0.11^{a}$ | $1.20 \pm 0.05^{a}$ | $26.87 \pm 1.43^{a}$ | $2.88 \pm 0.15^{c}$ |
| A4K4 | $0.97 \pm 0.13^{a}$ | $1.10 \pm 0.09^{a}$ | $27.35 \pm 1.72^{ab}$ | $4.48 \pm 0.34^{d}$ |
| A5K5 | $1.50 \pm 0.28^{a}$ | $1.70 \pm 0.92^{a}$ | $31.45 \pm 1.28^{c}$ | $7.34 \pm 0.58^{e}$ |
| A6K6 | $5.67 \pm 0.29^{b}$ | $4.34 \pm 1.56^{b}$ | $29.26 \pm 2.14^{abc}$ | $3.29 \pm 0.93^{c}$ |
| A7K7 | $9.70 \pm 1.53^{c}$ | $4.42 \pm 0.49^{b}$ | $27.00 \pm 0.76^{a}$ | $2.90 \pm 0.31^{c}$ |

*Note: The values in the same column with different superscript is interpreted in different significancy (p<0.05). A = Algae, K = Kolang-kaling; details of treatment can be seen in Table 1*

In Table 2, the data portrayed that the more *kolang-kaling* portions used in the formulation of nori, the higher the carbohydrate content produced. The tendency is related to the high carbohydrate content in *kolang-kaling* (38-56%) [33, 41, 42, 49]. One of the carbohydrates found in *kolang-kaling* was galactomannan [50, 51]. Galactomannan is a water-soluble polysaccharide composed of repeating units of mannose and galactose [52]. However, in contrast to carbohydrates, the protein content in *kolang-kaling* was only around 0.32 to 2.34% [42, 49]. Therefore, the increasing of *kolang-kaling* proportion as an artificial material in terms of protein content does not have the same tendency as its carbohydrate levels. However, the protein content existed in the artificial nori produced from this study was higher than the levels of *Gracilaria*'s protein reported by Ate et al. [53]. Artificial nori protein levels from this study were also higher than the levels of nori protein with *Hypnea saidana* base ingredient that was observed by Lalopua [47].

On the aspect of ash content, *Gracilaria* has high ash content [19, 24]. On the contrary, *kolang-kaling* only possesses ash content of approximately 0.20 to 0.30% [38, 49]. As a result, the artificial nori formula with the highest *kolang-kaling* mixture (A7K7) had the lowest ash content level. Ash content in the proximate analysis refers to inorganic residues which main constituents are minerals contained in food samples [54]. That is, the lower the ash content of the sample being tested was, the lower the minerals in the food product. Various minerals have significant roles in the human body. Thus, the A5K5 formula was considered as the best formula if viewed in terms of the ash content produced. However, even though the excessive addition of *kolang-kaling* reduced the ash content, the level of ash formulated by the artificial nori from various treatment formulas was still higher than the artificial nori made from *Gracilaria* based on the study done by Sinaga [33]. The artificial nori ash content produced from this study was also higher than the levels of other algae-based nori ash carried out by other researchers, such as the nori made from *Ulva lactuda* [45], *Hypnea saidana* [46, 47], and *Euchema cottonii* [45].

In terms of the fiber content, A5K5 formula composed the highest content of artificial fibers. Based on Table 2, it can be concluded that the fiber content of *kolang-kaling* would certainly increase the artificial nori fiber content produced. However, if the proportion of the material (*kolang-kaling*) was too much, the fiber content would decrease. Despite this tendency, artificial nori fiber content with the proportion of 10% or more was still higher than the level of nori protein from *Hypnea saidana* studied by Lalopua [46].

### 3.2. Physical characteristics

After analyzing the proximate composition, the physical character of the artificial nori produced in this study was also tested. Based on the results of the multivariate test, the difference in the materials percentage gave a significant effect on the physical character of the artificial nori being yielded [$F(18.34) = 34.426$, $p < 0.05$]. From the results of the univariate test, it was suggested that differences in physical characters occurred in thickness parameters [$F(6.14) = 9.835$, $p < 0.05$], tensile strength [$F(6.14) = 3.789$, $p < 0.05$], and greenness level [$F(6.14) = 60.932$, $p < 0.05$]. The physical characteristics of the seven artificial nori variants and the results of the DMRT test on the data are summarized in Table 3.

**Table 3.** The result of the DMRT test of physical characteristics from seven artificial nori variants

| Treatment Codes | Mean ± SD Physical parameters | | |
|---|---|---|---|
| | Thickness (mm) | Tensil strength (N/mm²) | Greenness level |
| A1K1 | $0.17 \pm 0.05^{a}$ | $0.07 \pm 0.05^{a}$ | $1.70 \pm 0.10^{b}$ |
| A2K2 | $0.28 \pm 0.08^{ab}$ | $0.08 \pm 0.02^{a}$ | $1.30 \pm 0.20^{a}$ |
| A3K3 | $0.32 \pm 0.06^{abc}$ | $0.16 \pm 0.06^{b}$ | $1.13 \pm 0.12^{a}$ |
| A4K4 | $0.36 \pm 0.10^{bc}$ | $0.10 \pm 0.04^{ab}$ | $1.80 \pm 0.10^{b}$ |
| A5K5 | $0.47 \pm 0.08^{cd}$ | $0.03 \pm 0.02^{a}$ | $1.17 \pm 0.15^{a}$ |
| A6K6 | $0.58 \pm 0.13^{d}$ | $0.04 \pm 0.02^{a}$ | $2.30 \pm 0.10^{c}$ |
| A7K7 | $0.58 \pm 0.08^{d}$ | $0.08 \pm 0.03^{a}$ | $2.77 \pm 0.15^{d}$ |

*Note: The value in the same coloumn with different superscript is interpreted in different significance(p<0.05). A = Algae, K = Kolang-kaling; details of treatment can be seen in Table 1*

Thickness is an important parameter in the production of packaged food in the form of sheets such as nori. The differences in nori thickness in various treatments were caused by differences in formulations used in the making process. Besides, different thicknesses could be influenced by the area of the mold, the volume of the solution as well as the number of total solids available [34]. The galactomannan compounds found in the *kolang-kaling* mixture were predicted to contribute to the artificial nori's thickness. Therefore, the denser the *kolang-kaling* material used in the mixture, the thicker the artificial nori would be. Artificial nori with 10% or higher formula reached 0.32 mm thickness. This figure exceeded the artificial nori's thickness made from *Eucheuma cottonii* reviewed by Ihsan [34].

In addition to the thickness, tensile strength also determines the quality of the resulting nori. Tensile strength is the maximum tensile force that can be held by the sample during the measurement until the sample starts to break. In this regard, *Gracilaria* sp. contained *agar* in the form of galactants composed of β-D-galactopyranose and 3.6-anhydro-α-L-galactopyranose which were bound by glycoside bonds [55, 56]. The *agar* concentration of *Gracilaria* sp. reportedly increases the tensile strength of the material [57]. Therefore, a decrease in the proportion of *Gracilaria* sp. at a certain point would decrease the tensile strength of the resulting nori.

### *3.3. Organoleptic results*

In addition to the proximate composition analysis and physical character, the artificial nori produced in this study was also tested from the organoleptic aspect. Based on the results of the analysis using Kruskal-Wallis H test, the difference in the percentage of constituent materials had a significant effect on the results of the artificial nori's organoleptic test on aroma parameters [$\chi^2$ (6) = 79.565, $p$ <0.05], taste [$\chi^2$ (6) = 65.943, $p$ <0.05], texture [$\chi^2$ (6) = 50.375, $p$ <0.05], and color [$\chi^2$ (6) = 60.942, $p$ <0.05]. The results of the organoleptic test of the seven artificial nori variants produced in this study and the results of further tests on the data are summarized in Table 4.

**Table 4.** The summary of pairwise comparison through Kruskal-Wallis test adjusted with Bonferroni Correction of the seven artificial nori variants

| **Treatment Codes** | **Mean Rank of Organoleptic Parameter** | | | |
|---|---|---|---|---|
| | **Aroma** | **Taste** | **Texture** | **Color** |
| A1K1 | $51.25^{a}$ | $61.60^{a}$ | $47.55^{a}$ | $47.05^{a}$ |
| A2K2 | $70.65^{a}$ | $71.40^{a}$ | $107.78^{b}$ | $108.02^{bc}$ |
| A3K3 | $81.42^{ab}$ | $79.75^{a}$ | $95.25^{b}$ | $84.20^{ab}$ |
| A4K4 | $133.75^{c}$ | $134.75^{b}$ | $100.40^{b}$ | $105.07^{bc}$ |
| A5K5 | $148.33^{c}$ | $137.70^{b}$ | $125.28^{b}$ | $142.73^{c}$ |
| A6K6 | $120.67^{bc}$ | $130.35^{b}$ | $128.20^{b}$ | $116.87^{bc}$ |
| A7K7 | $132.43^{c}$ | $122.95^{b}$ | $134.03^{b}$ | $134.57^{c}$ |

*Note: The value in the same column with different superscript is interpreted in different significance (p<0.05). A = Algae, K = Kolang-kaling; details of treatment can be seen in Table 1*

From the results of further testing presented in Table 4, although not always showing the highest average value, the treatments containing the most *kolang-kaling* (A7K7) were always included in the treatment group with the highest aroma, taste, texture, and color scores. However, if noted further, the A5K5 formula gave the best results on aroma and taste parameters even though the formula did not give a significant result difference compared to the formula of A4K4, A6K6, and A7K7. On the other hand, although it also did not display significant differences from some other treatments, the formula of A7K7 had the best texture while the A5K5 formula indicated the highest color rating. However, if viewed comprehensively, based on Table 4, the most apparent tendency was that the increase of *kolang-kaling* addition would improve the quality of artificial nori in various organoleptic aspects being examined.

Organoleptic test results provide important information on the level of acceptance of food products by consumers. Aroma parameter is considered as a quick way for people to determine the level of their desire to eat food presented in front of them [58]. Taste parameter denotes a person's level of satisfaction with the food products they consume. Both the aroma and taste of food are influenced by the presence of volatile compounds and the chemical composition of a food product [59]. However, both combine in influencing the sensation of food appetite and subsequent food intake [60]. The presence of glucose, sucrose, fiber, and other substances can increase the aroma and taste of food products [38]. Apart from the aroma captured by the sense of smell and the taste captured by the sense of taste, the color of the food product captured by the sense of sight also determines the level of acceptance by consumers [61]. The greener the nori products produced will generally lead to a better acceptance of the food by consumers [33, 38].

In addition to the three organoleptic parameters that have been conveyed, the texture produced by nori would also affect the level of consumer acceptance. The existence of *kolang-kaling* may improve the texture quality of the manufactured nori. This is due to the presence of galactomannan in *kolang-kaling* [50, 51]. The ability of galactomannan to bind water allows this substance as a good binding agent when combined with various other food ingredients to improve the texture and physical character of the food product [52]. Therefore, in this study, the greater the proportion of *kolang-kaling* used, the better the texture would be resulted (Table 4). Images of each artificial nori sample produced in this study can be seen in Figure 1.

## 4. Conclusion

In this study, artificial nori with the formula of 70% *Gracilaria* sp.: 30% of *kolang-kaling* had the highest carbohydrate, protein, and organoleptic value. The formula of 80% *Gracilaria* sp.: 20% *kolang-kaling* had the highest ash content and fiber. The formula of 80% *Gracilaria* sp.: 20% *kolang-kaling* had the highest tensile strength. The most apparent tendency was that the addition of *kolang-kaling* was proven effective to improve the quality of artificial nori. To fulfill the national nori needs, Indonesia is in the urge to explore various local macroalgae that can alternatively be used as basic ingredients for nori making. In this regard, further research needs to be carried out by using other macroalgae base materials that are easily found in the Indonesian water field. The use of other complementary materials is also recommended as an effort to obtain the best quality of artificial nori.

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