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## Differences of the way of drying nori from raw seaweed *Gracilaria* sp. based on the level of preference

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### ABSTRACT

The purpose of this research is to utilize *Gracilaria* sp. Seaweed in making nori and knowing the effect of the drying process on the level of preference of panelists on nori products. This research was conducted at the Fisheries Technology Laboratory of the Faculty of Fisheries and Marine Sciences and Food Chemistry Laboratory Processing, Food Processing Technology Department, Faculty of Agricultural Technology, Bogor Agricultural University in January 2019. The research method used was the experimental method, with 20 semi-trained panelists and three treatments using oven drying, direct sunlight, and sunlight with modification of plastic housing. The test observed in the research is the hedonic test with characteristic organoleptic parameters including appearance, aroma, texture, taste and nori state. In addition, physical and chemical tests were carried out on the best treatment. Chemical tests covered both protein content and water content. Physical tests are hardness and thickness tests. The results of the research show that all the drying treatments on the nori are still favored by the panelists, but the drying treatment using an oven is preferred by the panelists as evidenced by the average value of the appearance characteristics of 6.40; aroma 6.30; 5.90 texture and taste 6.50. The chemical characteristics were as follows: water content 16.85%, the protein content 11.88%, fiber content 5.8%, and the physical characteristics related to hardness of 150 gf, with nori thickness of 0.25 mm.

**Keywords:** Nori, Seaweed, *Gracilaria*, Drying, Level of Preference, Chemical test

## 1. INTRODUCTION

Nori is the seaweed sheets which are dried or baked (Korringa 1976). This is one of the products processed from natural red seaweeds which is dried and processed to get ready products (*Rhodophyta*). High-quality nori sheet is generally greenish-black, whereas the lower quality is the nori green to light-green.

*Gracilaria* sp. is one of the economically important species of seaweed in Indonesia that has not been optimal treated. According to Lachrech *et al.* (2005), *Gracilaria* sp. also included one type of seaweed-producing agar-agar (agarofit) that grows in Indonesia. *Gracilaria* sp. is widely cultivated in Indonesia because of easy maintenance. The use of seaweed is applied not only as industrial raw material, but also can be developed into food products such as nori. In addition to the raw material for agar-agar, *Gracilaria* sp. can also be used as an alternative raw material for the manufacture of nori.

The drying process is something that must be considered in making nori. The drying process of good seaweed nori can affect the product, such as the appearance and texture that will result in the level of preference of the nori. The drying process is generally done by using sunlight and oven. Drying is a stage of making nori. The drying process relies on the evaporation of water. This process is done to reduce the humidity by passing hot air around the material, so the material water vapor pressure is greater than the pressure of the water vapor in the air. Hot air is generally used to utilize wind/air that has been heated by the sun (the drying process), and use the airflow that has been heated by the fire (e.g. in oven) or utilizing a special dryer (mechanical dryer). This pressure difference causes the vapor flow of material into the air. The basic principle is evaporative drying of liquid raw materials and gelling nori (gelatinization process). The purpose of this research is to determine how to perform drying to produce raw material nori *Gracilaria* sp. based on preference level.

## 2. MATERIALS AND METHOD

### 2. 1. Time and Place of Research

The research was conducted from January 2019 on. Preparation of nori and testing the level of preference (hedonic test) was conducted in the Laboratory of Fishery Products Processing Faculty of Fisheries and Marine Sciences, University of Padjadjaran. The chemical and physical tests were conducted at the Laboratory of Food Chemistry Processing, Food Processing Technology Department, Faculty of Agriculture, IPB.

### 2. 2. Tools and Materials

Equipment used to make nori were: basins, blender, trays, sieves, scales, ovens, pans, snack shelves, and plastic. Equipment to test the level of preference, namely the assessment sheet, and plate styrofoam were used. The ingredients to make nori seaweed *Gracilaria* sp. were: freshwater, rice, salt, sugar, pepper, flavor, olive oil, sesame oil and fish sauce.

### 2. 3. Research methods

The method used in this research is an experimental method which consists of 5 treatments and 20 semi-trained panelists as replication. The panelists in this study were students from the Department of Fisheries Faculty of Fisheries and Marine Sciences,

University of Padjadjaran who have experience in the organoleptic assessment. The experimental method was applied by measuring the level of preference panel that includes appearance, aroma, texture, and flavor.

#### 2. 4. The treatment done by different ways of drying the nori

The following ways of treatment were performed: (1) treatment A was done in drying oven, (2) treatment B, by drying using direct sunlight, and (3) treatment C, by drying using sunlight to the modification of the plastic housing.

The parameters observed in hedonic test were to determine the level of preference panelists based on the organoleptic characteristics which included appearance, aroma, texture and taste of nori produced. Chemical test (moisture and protein content) and physical tests (hardness and thickness) relied on the treatment of the most favoured products.

#### 2. 5. Data analysis

The hedonic test data (level A), which is a non-parametric analysis, was carried out by using a two-way analysis of variance Friedman test with a Chi-square test.

Decision-making assessment of the panelists preferred product criteria nori was performed by pairwise comparisons (Pairwise Comparison), then to determine the best treatment to use Bayesian methods. Bayes methods were used to compare different criteria and choose one of the criteria that are prioritized or preferably by using numbers to describe the relative importance of an element.

Comparative descriptive analysis was used to analyze the results of the calculation of the yield and chemical test data (test levels of protein and moisture content test) and physical testing (hardness and thickness).

### 3. RESULT

#### 3. 1. The hedonic test (Level passions)

##### a) Appearance

Based on the research results, the average value obtained hedonic test results to the appearance of nori *Gracilaria* sp. is presented in Table 1.

**Table 1.** Average Appearance Nori *Gracilaria* sp. drying method based on treatment difference.

Drying Method	Median	Average
Oven	7	6.40 b
Sunlight	5	5.00 a
Plastic house	7	6.50 ab

**Description:** The figure showing the same letter is not significantly different according to the Multiple Comparison test at 5% level.

Based on the assessment of the appearance of nori panellists, *Gracilaria* sp. has an average range of 5.00 to 6.50. The average value of the highest preference level panelists against the appearance of nori *Gracilaria* sp. relies on the way of drying oven with the appearance of reddish brown color and shapes that flatter and does not shrink, while the lowest average is when the drying was done using solar light with the appearance of yellowish brown color and form uneven to many shrinkages. Research showed that due to the effect of the concentration of sodium metabisulfite and drying method, it could be stated on the organoleptic way that the method of drying gives effect to the sale of bananas produced color. The higher the temperature used during the drying, then the resulting color is getting brighter. It is caused by the evaporation of water content which can trigger a reaction so that the browning reaction is inhibited.

Statistical approach using Friedman test showed that drying by using plastic home is not significantly different from other treatments while drying oven and sunlight make a real difference, meaning the difference by drying nori which influences the appearance of *Gracilaria* sp. Seeing the value of the median, drying oven and the plastic housing were preferred by the panelists with a value of 7, while drying using direct sunlight valued 5. It means that different ways of drying at nori *Gracilaria* sp. with the drying oven and the plastic housing is preferred by the panelists compared to the drying with the sun directly.

**b) Aroma**

The average values of the hedonic test on the aroma of *Gracilaria* sp. nori are presented in Table 2.

**Table 2.** Average Aroma Nori *Gracilaria* sp. based on differences in treatment of drying method.

Drying Method	Median	Average
Oven	7	6.30 a
Sunlight	5	5.80 a
Plastic house	5	5.00 a

**Description:** The figure followed by the same letter indicates significantly different average according to the Multiple Comparison test at 5%.

Rate panelists evaluated average aroma nori *Gracilaria* sp. with different ways of drying to be in the range of 5.00 to 6.30. The average value of the highest aroma depends on how the drying was done, oven with a typical aroma with a hint of seaweed seasoning, while the lowest average value depended on the way of drying, the plastic housing with a very neutral aroma and flavor drying.

The different ways of drying of nori *Gracilaria* sp. does not affect the aroma of this product. Aroma spices in the process of making is a little more dominant than the typical aroma of seaweed. An increase in temperature results in a reaction in which all the organic matter produces volatile compounds responsible for the aroma and flavor. The formation of new volatility occurs in the heating process due to the thermal oxidation (Liu *et al.*, 2009).

The test results obtained from Friedman statistical tests show that there are real differences among all treatments, which means different ways of drying does not give effect to the aroma of nori *Gracilaria* sp. These results are consistent with the results on the effect of steaming temperature on nutrient content and organoleptic shredded catfish (*Ophiocephalus striatus*) and they were not significantly different but fluctuating. The different ways of drying do not affect the aroma due to the use of a drying temperature that is not to produce a difference of volatile compounds. The different ways of drying the nori *Gracilaria* sp. with all manners of neutral treatment result in a distinct aroma.

**c) Texture**

The test results for the average hedonic nori texture *Gracilaria* sp. are presented in Table 3.

**Table 3.** Average Texture Nori *Gracilaria* sp. based on differences in treatment method.

Drying Method	Median	Average
Oven	5	5.90 b
Sunlight	5	4.60 a
Plastic house	5	4.70 a

**Information:** Figures followed by the same letter indicate significant difference, according to the Multiple Comparison test at 5%.

Panelists rate against *Gracilaria* sp. nori texture has an average value of texture ranging from 4.60 to 5.90, meaning that the texture of the whole treatment of *Gracilaria* sp. nori is neutral or still acceptable by panelists. The average value of *Gracilaria* sp. nori texture by drying with sunlight and plastic houses is the same, while the nori under drying using the oven is relatively higher. The average value of *Gracilaria* sp. nori texture is 5.90 (the highest when drying in oven) 5.90, with a median of 5 (regular/neutral) which has a supple texture and is quite crisp, while the average, at different ways of using sunlight drying and the plastic housing, has a value of 4.60 and 4.70, with the median of 5 (regular / neutral) which has a supple texture but tough and somewhat loud.

The different ways of drying nori *Gracilaria* sp. gives a real difference to the texture, namely the treatment by drying in an oven. Puree or nori is still shaped material such as pulp/fluid containing high amount of water. According to Edwards (1995), the largest component of food is water (55-85%) so that these components are the main factors that will affect the structure and texture of the treated food material. Nori sheet formation occurs when

the water content in nori is reduced so that the moisture content does not dominate the gel content and fiber in nori.

It was stated that the air humidity affects the moisture removal process. When the humidity is high, the water vapor pressure difference inside and outside the material is small thereby inhibiting removal of moisture from the material to the outside. Humidity drying using sunlight and plastic housings is less or the same. Drying in oven cannot be measured by relative humidity which is higher due to the lack of air circulation. The existing air in the oven continues to expand because of a high enough temperature.

Friedman statistical test results showed that the differences in drying oven are significantly different from other treatments. Treatment in drying oven has shown an average value of 5.90, while the use of sunlight and drying plastic housing results in an average value of 4.60 and 4.70, with all the median value of 5 (neutral). *Gracilaria* sp. nori texture with different ways of drying is still acceptable.

**d) Flavor**

The average value of the hedonic test of the sense of nori *Gracilaria* sp is presented in Table 4.

**Table 4.** Average Rasa Nori *Gracilaria* sp. based on differences in treatment method.

Drying Method	Median	Average
Oven	7	6.50 b
Sunlight	5	5.00 a
Plastic house	5	5.00 ab

**Information:** Figures followed by the same letter indicate significant difference, according to the Multiple Comparison test at 5%.

Results of the assessment of the taste panellists on *Gracilaria* sp. nori has an average taste ranging from 5.00 to 6.50. It means the flavor of the whole treatment of *Gracilaria* sp. nori is still acceptable or preferred by panelists. The average value is the highest after drying in oven, with an average value of 6.50, with a median of 7 (preferred) savory taste, typical of seaweed and no sense of fiber in the aftertaste, while the lowest average value appeared in treatment by drying in sunlight and plastic house, with a median value of 5 (neutral/normal) neutral taste, less savory. The different ways of drying at nori *Gracilaria* sp. provide a real difference when drying in oven. The taste of *Gracilaria* sp. nori, while drying using solar light, is not significantly different from other treatments. Research showed the same results as the drying at the temperature difference really affected the organoleptic assessment of jumbo catfish jerky flavor. It can be stated that the drying temperature and amount of moisture can affect the panelist preference level of the product produced. Lowering water levels affect the level of preference of panelists due to the reduced water content so that the constituents of flavor appear. Friedman statistical test results show that the differences in drying give real

effect to the level of acceptance of the panelists on the taste of nori *Gracilaria* sp. produced. The different ways of using the drying oven with the sun shining and the plastic housing result in a different median value of nori *Gracilaria* sp. by using a drying oven favored over other drying methods by the panelists.

### **3. 2. Chemical test**

Chemical characteristics were tested in nori proximate result of the research. The aim of this chemical testing was to determine the best treatment on the contents in nori *Gracilaria* sp. Parameters proximate observed were the water content and protein content.

#### **a) Water content**

Test carried out on samples was to reveal the water content in nori *Gracilaria* sp. after oven drying treatment. The result of the analysis of water content in nori *Gracilaria* sp. after drying in oven exhibited 16.85%. The water content of the test results still meets the requirements of the nori product. Commercial nori on the market derived from seaweed *Porphyra* sp. greenish-black showed a water content of 16.09%. Reduced water content in the drying process occurs during the oven treatment at 70 °C.

#### **b) Protein levels**

Tests on the nori in the treatment using a drying oven showed levels of protein at 11.88%. Quite a high value of protein content in nori *Gracilaria* sp. was observed compared to the value of nori in general. The protein contents of nori made from *Porphyra* sp. is 6.15%. This is because the content of the water in nori after oven drying is relatively low, so the ratio of protein content to water content is high, because the protein does not evaporate when heated.

#### **c) Crude Fiber Content**

Crude fiber content test was conducted on a sample of nori *Gracilaria* sp. with oven drying treatment. Tests on the nori showed the crude fiber content was 5.8% when using the oven drying treatment.

### **3. 3. Physical test**

#### **a) Hardness**

The water content contained in the product affects the hardness of the texture of the product. Increased levels of water result in increase of hardness in food products. Nori dried products using the oven has a hardness value of 150 gf. This value is quite low compared with commercial nori (408 gf). The level of hardness in nori was determined by the water content in the product. Nori *Gracilaria* sp. by drying treatment in the oven has a crunchy texture. Roasting resulted in most of the water out of the food in the form of water vapor.

#### **b) Thickness**

The test done on nori *Gracilaria* sp. after drying in an oven shows the product thickness is 0.25 mm. The thicker the product nori, the level of crispness is diminished. Nori tested in the study has a thickness that is not much different from other studies, making nori imitation

of flour to the extraction of red seaweed species *Gelidium* sp. thickness ( $0.215 \pm 0.01$  cm / 120 cm<sup>2</sup>). As many as 20% still meets the quality requirements nugget by BSN.

### 3. 4. Bayes Decision Methods

Decision-making by looking at the value of the relative weights as the criteria of appearance, aroma, texture, and taste of nori *Gracilaria* sp. was done by pairwise comparisons (Pairwise Comparison) by changing the ratio paired with a set of numbers that represents the relative priority of criteria and alternatives (treatment).

**Table 5.** Weight Value Criteria Nori

Criteria	Weights Criteria
appearance	0.21
aroma	0.10
texture	0.21
flavor	<b>0.49</b>

Based on the above table data, the calculation criteria weights, ranging from appearance to taste of nori *Gracilaria* sp, the value that taste is the most important criterium that determines the final decision of the panelists in selecting products equals 0.486. According to the panellists assessment, the appearance and texture are also important, namely the criteria weights are 0.214 and 0.206, followed by a weight value 0.094 of aroma criterium. This shows that although there is good rating, but if the taste of nori *Gracilaria* sp. is disliked by panelists then the product will be rejected.

**Table 6.** Nori Rate Decision matrices with Bayes Method.

Treatment	Criteria				Alternative value	Priority values
	Appearance	Aroma	Texture	Flavor		
Oven	7	7	5	7	<b>6.59</b>	<b>0.39</b>
Sunlight	5	5	5	5	5.00	0.29
Plastichouse	7	5	5	5	5.43	0.32
<b>Weights criteria</b>	0.21	0.10	0.21	<b>0.49</b>		

Bayes method is the one used to perform the analysis in the decision making the best of a number of alternatives or treatments by considering criteria. The result of the calculation in determining the best treatment by considering the criteria of appearance, aroma, texture, and taste of nori *Gracilaria* sp. is presented in Table 6.

Calculation with Bayesian methods indicates that the way in nori *Gracilaria* sp. drying oven obtains the highest alternative value of 6.59 followed by nori *Gracilaria* sp.-treated by drying the plastic housing that has an alternative value of 5.43, and the value of 5.00 is the lowest alternative by drying with sunlight. In the test based on the parameters that have been observed, in the different ways in nori *Gracilaria* sp. drying, oven is chosen for the best treatment and preferred by panelists.

#### **4. CONCLUSIONS**

According to the research done, the effect of different ways of drying nori, the treatment using the oven drying is preferred by the panelists. Nori *Gracilaria* sp. with the appearance of reddish brown and forming a flat, neutral aroma, typical of seaweed with a crunchy texture and supple, as well as the distinctive flavors of seaweed and seasonings was preferred. Calculations of weighted criteria decision making using Bayesian methods produce values that taste is the most important criterium that determines the final decision in selecting *Gracilaria* sp. nori products by panelists, with the criteria weight value of 0.486. Chemical characteristics of the water content equalled to the amount of 16.85%, the protein content of 11.88%, and the crude fiber content equalling 5.

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