Production process technology and characteristics of cassava nori

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Abstract. Nori is a snack product made from seaweed. The development of nori products from cassava leaves is done to produce snack products from highly nutritious cassava leaves. Cassava leaves have protein and vitamin C quite high content. One of the opportunities to increase the added value of cassava leaf products is by making a snack nori process. This study aims to characterize the effect of processes and formulas on the cassava products produced. The research was designed through preliminary stages and advanced research stages based on the results obtained from previous studies. In the next stage, the research was compiled using a complete randomized design, which was the optimal process combination and previous formula. Based on the results of the study, nori without using GMS has lower water content compared to other formulas. Nori without the addition of emulsifiers also had higher protein and fat content compared to other treatments which were 11.51% and 16.22%. The XRD results show that there are 2θ peaks at 20 and 35. The microstructure structure of SEM results shows sheets of film containing several granules.

1. Introduction
The potential for cassava production in Indonesia is quite high. One part of the cassava plant that is potential enough to be processed and further developed is the leaves. Cassava leaves contain 90 calorie composition, 77 g of water, 6.8 g of protein, 1.2 g of fat, carbohydrate 13 g, calcium 165 mg, phosphorus 54 mg, iron 2 mg, retinol 3300 μg, thiamin 0.12 μg, and thiamin 0.12 μg, and Ascorbic acid 275 μg per 100 grams of material [1]. Cassava leaves contain a high component vitamins A and C which in every 100 g of 3,300 RE vitamins A and vitamin C of 275 μg [2]. According to Adi [3], cassava leaves also contain high levels of calcium to help prevent gout and rheumatic disease in the bones.

One alternative processing technology to increase the added value of cassava leaf products is by processing them into nori products. Nori is food consumed after being dried and baked [4,5]. The name nori in China is hattai, in Korea nori is known as kim or game. Besides that, Nori also has another term, edible seaweed. Nori is a sheet of dried or baked seaweed [6], whereas according to Giury [7], nori is one of the dried processed seaweed products and is a processed product of red seaweed (Rhodophyta). Nori is an edible sheet from seaweed that has the potential to contain protein, vitamins and minerals [8]. The principle of technology for making nori can be used as an alternative by using raw materials in the form of cassava leaves.
In its use, nori can be used directly as a snack food that can be consumed directly. However, nori can also be used as a wrapper for sushi (makisuzhi) and rice balls (onigiri) and other Japanese specialties. Nori forms in the form of sheets also vary in size according to their use. Nori can be processed using raw materials in the form of Glacilaria seaweed which has the characteristics of light brownish-green, rough texture and tensile strength of 24.6% [9]. Whereas nori which is processed using the raw material of gotu kola leaves and seaweed has the characteristics of green, the texture is rather compact, slightly scented with gotu kola [10]. The purpose of this research to produce and characterize cassava nori products with several treatments.

2. Materials and methods
The materials used in this research activity are cassava leaves, tapioca, GMS (Glycerol Monostearate), HK (Hydrocolloid), salt, citric acid, flavoring and cooking oil. While the equipment used includes: knives, scales, blenders, sheeter, hallway dryers, ovens, soxhlet, destruction tools, distillators, SEM (Scanning Electron Microscope), Texture Analyzer and chromameter.

The stages of the process of making cassava leaves are young cassava leaves washed first and then blended for 5 minutes after that filtered using a filter cloth and then weighed. The next stage is the process of mixing with food additives. Then cook for 10 minutes. Then milled using a wooden roll mill and printed according to the size of the pan. Then it is dried in a cabinet dryer for 4 hours at 60ºC. After drying nori cassava leaves are left in room temperature for 15 minutes then smeared with sesame oil and then oven for 10 minutes at a temperature of 100ºC. After stoving, the cassava nori is then cut to size and then packed using plastic mica. Based on the results of the formulation, obtained three types of A samples (30% tapioca, 1% salt, GMS 1%, 1% oil, HK 1%, 1% citric acid, 1% flavoring); B (30% tapioca, 1% salt, GMS 1%, 1% oil, 1% HK, 1% flavoring) and C (30% tapioca, 1% salt, 1% oil, HK 1%, 1% flavoring) and control (without salt, citric acid and Royco).

Analysis carried out included: color analysis, texture, proximate and organoleptic. The best formulation results and products were analyzed for microstructure profiles using SEM (Scanning Electron Microscope) tool.

3. Results and discussions
One of the physical quality parameters that can be observed from cassava leaves is the color produced. The analysis is done using Minolta chromameter. Based on the results of the color analysis of cassava nori samples the results are as shown in table 1.

| Sample Code | L     | a     | b     | Hue    |
|-------------|-------|-------|-------|--------|
| A           | 28.867 | -2.483 | 6.350 | 111.417 |
| B           | 29.087 | -4.380 | 7.280 | 111.417 |
| C           | 24.917 | -3.227 | 6.507 | 120.867 |
| Control     | 30.230 | -3.800 | 8.797 | 113.377 |

Note: numbers followed by the same letter in the same column show significantly different levels of 95% confidence interval.

Sample A containing the most complete composition with the addition of citric acid produced the highest Hue value compared to other treatments. In addition to the color that can be analyzed using the chromameter tool, texture analysis is also carried out, namely the level of hardness of the product produced. Based on the results of the texture analysis of the nori produced as shown in table 2.
Table 2. Texture analysis results of cassava nori.

| Code       | Hardness (N) |
|------------|--------------|
| Sample A   | 3.177<sup>b</sup> |
| Sample B   | 2.497<sup>ab</sup> |
| Sample C   | 1.383<sup>b</sup> |
| Control    | 2.207<sup>ab</sup> |

Note: numbers followed by the same letter in the same column show significantly different levels of 95% confidence interval.

Sample A which contains the most complete formula composition has the highest level of hardness, compared to other formulas. This is possible because the results of the interaction of several ingredients added to affect the level of hardness of the cassava nori produced. To find out the level of acceptance of cassava products produced, the organoleptic quality analysis was carried out which included parameters: color, aroma, taste, texture, and acceptance in general from organoleptic test panelists. The roasting process can increase the level of crispness in nori products, so it is preferred [11]. Based on the results of the organoleptic quality analysis of cassava nori produced as shown in table 3.

Table 3. Results of cassava nori organoleptic analysis.

| Code       | Colour     | Flavour     | Taste       | Texture     | General Acceptance |
|------------|------------|-------------|-------------|-------------|--------------------|
| Sample A   | 3.27<sup></sup>(neutral-like) | 3.37<sup></sup>(neutral-like) | 3.07<sup></sup>(neutral-like) | 3.33<sup></sup>(neutral-like) | 3.17<sup></sup>(neutral-like) |
| Sample B   | 3.80<sup></sup>(neutral-like) | 3.10<sup></sup>(neutral-like) | 3.13<sup></sup>(neutral-like) | 3.27<sup></sup>(neutral-like) | 3.13<sup></sup>(neutral-like) |
| Sample C   | 3.77<sup></sup>(neutral-like) | 3.37<sup></sup>(neutral-like) | 2.87<sup></sup>(rather like-neutral) | 2.67<sup></sup>(neutral-like) | 2.77<sup></sup>(rather like-neutral) |
| Control    | 3.70<sup></sup>(neutral-like) | 3.20<sup></sup>(neutral-like) | 2.70<sup></sup>(rather like-neutral) | 2.10<sup></sup>(neutral-like) | 3.13<sup></sup>(neutral-like) |

Note: 1 = not like; 2 = rather like; 3 = neutral; 4 = like; 5 = very like

In general, sample A which contains a fairly complete formula produces the highest value with neutral-like qualifications. This shows that the product of formula A can be generally accepted by the panelists well. Whereas formula C generally shows a rather like-neutral qualification. This is possible because the absence of the addition of GMS (Glycerol Monostearate) produces a texture that is less crisp so that at the time of general acceptance it affects the results obtained. The interaction of several components affects the quality of the texture produced. Noda et al stated that the typical taste of nori from Japan was derived from the presence of amino acids alanine, glutamic acid, aspartic acid and glycine [12]. Nori also contains a relatively high level of Taurine. To find out the nutritional value contained in the nori produced, proximate analysis of cassava nori was obtained and the results are shown in table 4.
Table 4. Proximate analysis results of cassava nori.

| Parameter                | Sample A  | Sample B  | Sample C  |
|--------------------------|-----------|-----------|-----------|
| Moisture Content (%)     | 7.46^c    | 6.83^b    | 6.41^a    |
| Ash Content (%)          | 4.11^c    | 3.22^a    | 3.74^b    |
| Fat Content (%)          | 14.51^a   | 16.16^b   | 16.22^b   |
| Protein Content (%)      | 9.46^a    | 10.81^b   | 11.51^c   |
| Carbohydrate Content (%) | 64.48^c   | 63.00^b   | 62.14^a   |
| Energy (Kilo calory)     | 426.31^a  | 440.64^b  | 440.52^b  |

Note: numbers followed by the same letter in the same line show significantly different levels of 95% confidence interval.

Cassava nori has high levels of fat and protein. The carbohydrate content found in cassava is the largest component. This is possible because the main raw material used is cassava leaves which have a high fiber composition. Cassava nori also contains tapioca in the form of 30% starch and 1% hydrocolloid. The starch and hydrocolloid also have carbohydrate compositions which can cause nori to have high carbohydrate levels. Seaweed fat levels of 2-3% bk and seaweed are rich in unsaturated fatty acids [12]. Furthermore, Noda [12] states that the levels of seaweed protein in the amount of 25-50% and contain vitamins and minerals that are quite varied. Raw materials greatly determine the proximate levels of nori products produced. Nori is rich in amino acids alanine, aspartic acid, glutamic acid and glycine, although some of them are bound to amino acids that are quite diverse [12]. Some organoleptic test parameters are carried out to approach the parameters that become a reference for consumer acceptance before marketing. Based on consumer preferences, food products are more towards products that have a salty and savory taste [13]. In formulations, salt and flavoring are added in order to meet the possibility of consumer acceptance. The formulation and addition of fillers also affect the sensory quality produced. Based on the results of research by Agusta et al [14], artificial nori products with spinach raw material with the addition of tapioca flour were chosen as treatment with a percentage of panelist acceptance of 88.3% with some sensory characteristics which were brightly colored, crisp and salty taste.

Cassava nori has the form of a snack sheet that is ready for consumption. To determine the quality of the microstructure of the products produced, one of them is by observing the SEM (Scanning Electron Microscope) analysis. The material formulations and process methods used will affect the quality of the microstructure produced. The results of the cassava pulp structure analysis as shown in figure 1. Based on the microstructure profile shows the presence of starch granules distributed between thin sheets such as film layers. The film layer of the three formulas showed a slight difference, where there was an uneven distribution of granular granules. This is possible because of the addition of several additional BTP (Food Additives) ingredients and added ingredients. The use of formula materials affects the 2θ angle profile of the XRD analysis of the cassava nori produced. Based on the results of XRD analysis on cassava nori, the results of 2θ angle are obtained as shown in figure 2.
Figure 1. Results of SEM Analysis of Cassava Nori (from top to bottom: magnification of 50; 100 and 500 times; left to right: sample A, B, C).
Figure 2. XRD results of Cassava Nori (samples A, B, C)

X-Ray Diffraction (XRD) is one instrument that is very important for analyzing the content of a material [15]. Peak angle $2\theta$ generated based on XRD analysis shows that the formula affects the peak for which the XRD profile is produced. The XRD fraction pattern of semicrystalline structure of chitosan dispersed with added tapioca gelatinized and improved amorphous phase [16]. Based on the levels of amorphous phase and crystalline cassava nori as shown in table 5 below.

| Code   | Amorh Phase | Cristaline Phase |
|--------|-------------|-----------------|
| Sample A | 72,6%       | 27,4%           |
| Sample B | 39,9%       | 60,1%           |
| Sample C | 81,2%       | 18,8%           |

The composition formulations used to make nori affect the levels of amorphous and crystalline phase produced. In samples A and C the concentration of the amorphous phase is higher than the crystalline phase. This is the opposite of what happened in sample B, where the crystalline phase is higher than the amorphous phase produced.
4. Conclusion
Nori cassava leaves have physicochemical properties with varying moisture content, namely 5.34% - 6.09%. While the ash content of cassava leaves has a value range of 1.83% - 3.66%. Based on the results of the organoleptic test, the color, aroma, and texture have neutral results up to likes. The organoleptic test parameters for taste have neutral results up to like for samples A and B. In general, cassava leaf nori has a neutral panelist rating up to like except for sample C which is rather like to be neutral. The microstructure profile of cassava showed that starch granules were distributed between thin sheets such as film layer. The film layer of the three formulas showed a slight difference, where there was an uneven distribution of granular granules. For further product development, it requires a feasibility analysis so that the product is prospective enough to be commercialized and has better competitiveness.

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