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Seaweed nori *(Kappapycus alvarezi)* physicochemical and organoleptic characteristics with moringa leaf fortification (*Moringa oleifera* LAM)

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ABSTRACT

Nori was a product made from seaweed which contained fiber and bioactive substances even though it had low antioxidants. The solution was needed to increase antioxidants from Nori products was food diversification with the addition of Moringa leaves which contained high antioxidant activity. Identifying the physicochemical and organoleptic properties of the nori seaweed (Kappapycus alvarezi) with the fortification of Moringa (Moringa oleifera Lam) leaves was the aim of this research. The addition of Kappapycus alvarezi seaweed pulp and Moringa leaf pulp was compared in this study's single-factor randomized design (CRD) four treatments: (K0=100%:0% kontrol), (K1=90%:10%), (K2=80%:20), (K3=70%:30%). The data were evaluated using statistical analysis of variance (ANOVA), and the Duncan Multiple Range Test was used if there was a significant result (p<0.05) for each treatment (DMRT). The results showed that Kappapycus alvarezi nori seaweed with fortified Moringa leaves (Moringa oleifera Lam) had an effect on physicochemical and organoleptic characteristics, and could increase the nutritional value of nori, which had an antioxidant activity value of 59.921ppm, total phenol of 252.527%, the water content of 18.030%, Fiber content of 18.637%, thickness test of 0.20 mm, tensile strength/tear strength of 0.541MPa, hydration test of 24.446%. The organoleptic values consist of color at 5.83, aroma at 4.87, taste at 5.03, and texture at 5.53. The impact of this research was to produce products that contained good bioactive substances and antioxidants.

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INTRODUCTION

Due to the rising need for local and export purposes, algae, or seaweed, *Kappapycus alvarezi*, is one of Indonesia's aquaculture industry's significant and excellent products. Indonesia uses seaweed (sea algae) as a source of agar, carrageenan, and alginate, three crucial raw materials for the food and non-food sectors. Seaweed of the *Kappapycus alvarezi* type is frequently found in the coastal waters of Sulawesi, particularly in Gorontalo Province, which is spread over three districts in Gorontalo and has the potential to develop seawater cultivation over an area of 5,000 hectares and the utilization of seaweed cultivation of 2,850 Ha. The seaweed is primarily found in Kwandang District and District North Gorontalo (Department of Marine and Fisheries of Gorontalo Province 2007). Indonesia's output of *Kappapycus alvarezi* seaweed is expected to reach 5 million tons in 2019 (Rosalina et al. 2019)

Kappapycus alvarezi has a total fiber content of 25.05%, including red seaweed (Matanjun et al., 2009). This form of *Kappapycus alvarezi* seaweed, derived from several types of seaweed, includes antioxidant components that have been shown to delay the onset of aging, fight cancer, and boost bodily resistance (Sirat 2012). According to Lantah et al. (2017), Kappapycus alvarezi seaweed extracted with methanol has weak antioxidant activity. Therefore we need a combination of food ingredients that can increase and contain antioxidant activity compounds. In Gorontalo, processing dried seaweed is the only method of production, and it is often exclusively done for export. Based on Hasiru et al. (2010), the processing seaweed carried out by farmers in Gorontalo only comes to drying, so there is a need for food diversification that can produce other products that are rich in high nutritional content so that it is good for the body and can increase product quality in nori products.

Thin sheets of nori, a red seaweed product that has been dried or roasted, are made from the seaweed Phorpyra (Levine and Sahoo, 2010). Nori is typically used as a garnish and flavoring for main courses, sides, and snacks. Additionally, seaweed nori products are good for a balanced diet since they offer health advantages and include fiber and bioactive compounds (Zakaria et al. 2017). The overall phenol content and antioxidant capacity of the finished Nori product in the research of a blend of *Lacuta ulva* seaweed and Euheuma Cottoni decreased, along with Nori's total phenol value and antioxidant capacity. Therefore, adding one element with strong antioxidant activity will help to diversify foods, which will help to overcome this problem. The Moringa leaf is one of them.

The Moringa plant's leaves, which are frequently consumed, contain a variety of antioxidant chemicals. Because of its naturally occurring supply of nutritious nutrients for the body and whose content exceeds that of plants generally, Moringa has been recognized for millennia as a plant that includes advantages and qualities that are excellent for the body. It is also known as The Miracle Tree (Toripah 2014). According to research findings, moringa leaves contain nutrients and molecules that can prevent the formation of free radicals, such as nitrogen compounds (alkaloids, amines, and betalains), and phenolic compounds, such as phenolic acids, flavonoids, quinones, coumarins, lignans, stilbenes, and tannins, as well as some other endogenous metabolites that are highly active antioxidants (Fitriana et al. 2016; Rizkayanti et al. 2017). Moringa leaf extract contains 0.19 percent phenol, according to research by Ojiako (2014). Given that Moringa leaves have a high nutritional value for the body, 8.22% are tannins, and 1.75% are saponins, making them an excellent complement to nori made from *Kappapycus alvarezi seaweed*. The study's title was changed to "Physicochemical and Organoleptic Characteristics of Nori Seaweed *Kappapycus alvarezi* with Fortification of *Moringa Leaves* (Moringa oleifera Lam)" based on the description given above.

METHODS

This research was conducted for 2 months, from March to April 2022, at the Laboratory of the Department of Food Science and Technology, Faculty of Agriculture, State University of Gorontalo.

Equipment and Materials

This study used tooles such as a blender, basin, aluminum mold, knife, stirrer, drying oven, silicon paper, hotplate, analytical balance, drying oven, dropper, measuring pipette, test tube, measuring cup, rubber bulb, erlenmeyer, beaker glass, micropipette, pipette tip, vortex, incubator, centrifugal, spatula, cuvette tube, stopwatch and spectrophotometer, desiccator, porcelain cup, measuring cup, pipette, kjedhal flask, texture analyzer, micrometer.

The materials used include Kappapycus alvarezi seaweed (dried), fresh Moringa leaves, salt, and sugar. The materials used include NaOH, methanol, DPPH (1,1-diphenyl-2-pikrilhydrazil), K_2SO3, H_2SO_4, HgO, HNO_3, HCl, N-Hexane, and Aquades.

Research Steps

Following are the steps in creating seaweed porridge:

The dried Kappapycus alvarezi seaweed was initially cleaned with clean water. The seaweed is then cut into small pieces to simplify the destruction process. After being soaked in NaOH for 12 hours to soften the seaweed tissue and remove the typical sea/coral aroma present in the seaweed, it is washed again with clean water to remove the NaOH residue.

The stages of making fresh Moringa leaf porridge

Initially, fresh Moringa leaves are separated from the stems to facilitate washing, then washed with clean water, which aims to remove dirt from Moringa leaves, then blanching is carried out for 5 minutes, which aims to remove the unpleasant odor in Moringa leaves, then crushed using a blender to get leaf pulp Moringa, after which further processing is carried out.

Stages of making Nori from Kappapycus alvarezi seaweed and Moringa leaves.

The first step in creating nori is to heat seaweed porridge on a hotplate for about 3 minutes, between 60^oC and 80^oC. While the porridge is heating, 50cc of water, 3grams of salt, and 12grams of sugar are added. After thoroughly mixing, the mixture was allowed to cool for about a minute at ambient temperature before forming. The cold nori was then poured into an aluminum mold, dried in an oven at 50^oC for 22 hours, and was then ready for further testing.

Research Design

The comparison between the pulp from the leaves of the Moringa plant and that from the Kappapycus alvarezi seaweed utilized a single factor completely randomized design (CRD), and it included four treatments:

K0 : 100% *Kappapycus alvarezi* seaweed pulp and 0% *Moringa* leaf pulp
K1 : 90% *Kappapycus alvarezi* seaweed pulp and 10% *Moringa* leaf pulp
K2 : 80% *Kappapycus alvarezi* seaweed pulp and 20% *Moringa* leaf pulp
K3 : *Kappapycus alvarezi* seaweed pulp 70% and *Moringa* leaf pulp 30%) (Indriyani and Subeki 2018).

Each treatment was repeated 3 times using analysis of variance data. Analysis of the data that significantly affects the observational variables will be continued with the Duncan Multiple Range tests (DMRT) At the 95% confidence level = 0.05, which is processed using SPSS version 20 software.

Test Parameters

The test parameters consist of Antioxidant Activity (Pratiwi et al. 2010), Total Phenol Chatatikun et al. (2013), Moisture Content (AOAC 2005), Fiber Content (Sudarmaji et al. 1989), Thickness Test (Akesowan 2010), Tensile Strength/Tear Strength, Hydration, and Organoleptic (Soekarto 2002).

RESULTS AND DISCUSSION

Antioxidant Activity

Based on the graph of the results of the antioxidant activity test on *Kappapycus alvarezi* seaweed nori with Moringa leaf fortification can be seen in Figure 1.

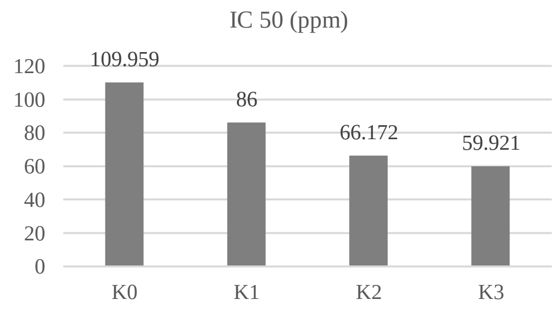

Figure 1 Antioxidant activity

Based on the graph in Figure 1, the investigation of nori's antioxidant activity produced values between 59.921 and 109.959 ppm. The highest antioxidant activity was obtained in treating 70% Kappapycus alvarezi seaweed pulp and 30% Moringa leaf pulp with a value of 59.921ppm with strong antioxidant activity properties. In contrast, the lowest in the control treatment without adding Moringa leaves, with a value of 109.959 ppm, had moderate antioxidant properties. Therefore, the results indicate that the more additions of Moringa leaves, the more antioxidant activity will increase.

Including additional Moringa leaves to boost the antioxidant activity of nori resulted in the maximum antioxidant activity value in treating 70% Kappapycus alvarezi seaweed pulp and 30% Moringa leaf pulp when compared to the control treatment.

Moringa leaves exhibit extremely strong antioxidant activity, with an IC50 value of 4.289, according to (Susanty et al. 2019). The presence of this molecule aids in neutralizing and stabilizing free radicals so that they may no longer harm healthy cells and tissues. Additionally, Kappapycus alvarezi seaweed has very low antioxidant activity, measured by Lantah et al. (2017), with a value of 163,819 ppm, likely due to the impact of seaweed that was already in a dry condition.

Analysis of Total Phenol

Based on the graph of the results of the total phenol test in *Kappapycus alvarezi* seaweed nori with Moringa leaf fortification can be seen in Figure 2.

Based on the graph in Figure 2, the analysis of total phenol in nori obtained values ranging from 52.159 -252.527 mg GAE/g. With a value of 252.527 percent, total phenol was extracted from pulp made of 30% Moringa leaf and 70% Kappapycus alvarezi seaweed. In contrast, the lowest was in the control treatment without adding Moringa leaves, with a value of 52.159 mg GAE/g. Accordingly, the data collected indicates that the total phenol would rise when more Moringa leaves are added. Antioxidant activity and total phenol are correlated, meaning that the stronger the antioxidant activity, the higher the total phenol level. This happens because the phenolic compounds in the form of flavonoids will affect antioxidants.

Due to adding more Moringa leaves than the control with a 100 percent seaweed slurry treatment, the total phenol attained high values in the treatment of 70 % Kappapycus alvarezi seaweed pulp and 30 percent Moringa leaf pulp as compared to no control treatment. Because moringa leaves are known to have higher total phenol than seaweed, adding moringa leaves to seaweed result in a greater overall concentration of phenol. According to (Goretti 2017), Kappaphycus alvarezii seaweed extract contains a total phenol of 385.06 mg/100gr GAE bw. Likewise, according to (Sagala and Juniasti 2021), Moringa leaves contain 745,1735mg of phenol. So adding Moringa leaves can increase the total phenol content in the ingredients. According to (Ardila 2020), leaves can produce high levels of phenol due to the biosynthesis of phenolic compounds, which are usually located in the cytoplasm of the leaf.

Kappapycus alvarezi seaweed nori with *Moringa* leaf fortification impacted the overall amount of nori phenol generated, according to the analysis of variance (ANOVA) results. This is evident from Duncan's further test, which revealed a substantial difference between treatments for the therapy utilizing Kappaphycus alvarezii and Moringa leaves.

Moisture Content Analysis

The percentage of water in food is known as the moisture content. The significant amount of water that a substance contains. The moisture content may be expressed based on the weight of the dry material and the wet material. Typically, water content and water activity are used to describe the role of water in food.(Verdiana et al. 2018). The results of the water content test can be seen in the Figure 3

The maximum moisture content was obtained in treatment K0, which is the ratio of 100% Kappapycus alvarezi seaweed slurry, with an average value of 18.030%, according to the graph of the results of testing the water content of nori seaweed *Kappapycus alvarezi* fortified with *Moringa leaves* above. The K3 treatment, which contained 70% *Kappapycus alvarezi* seaweed pulp and 30% Moringa leaf pulp and had a value of 15.381%, had the least moisture content. The known value of commercial nori is 8.44% (Riyanto et al. 2015). Commercial nori is less valuable than the outcomes of the study, which are more valuable..

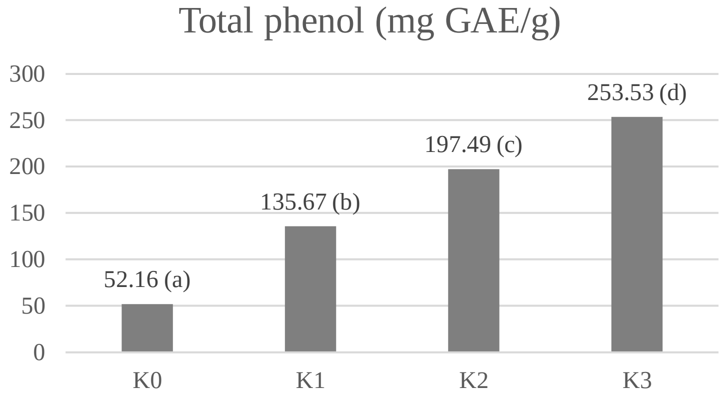

Figure 2 Average of total phenol

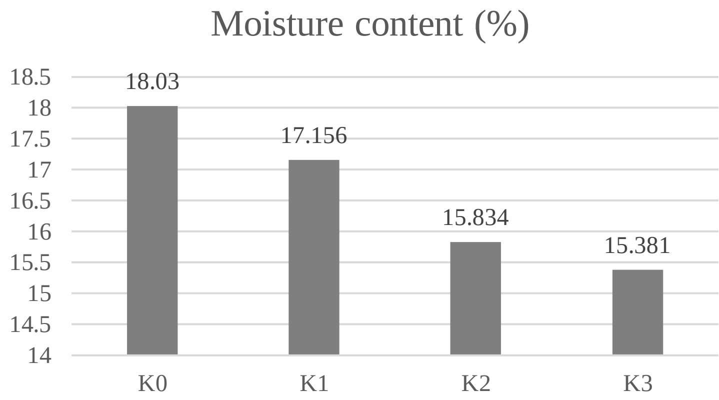

Figure 3 Average of moisture content

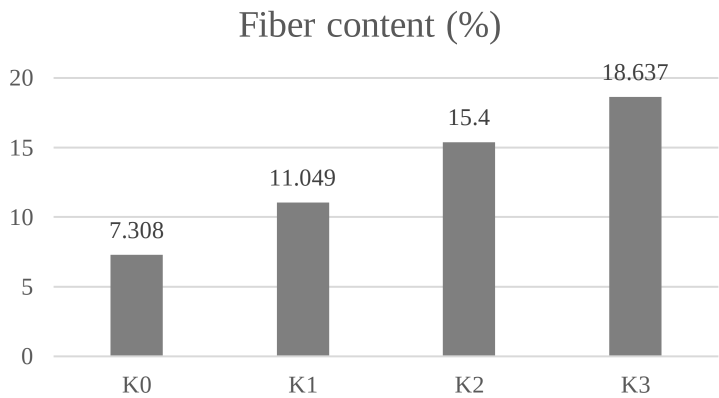

Figure 4 Average of Fiber Content

According to the analysis of variance, there was no need for Duncan's additional test since the moisture content of nori seaweed *Kappapycus alvarezi* with the fortification of *Moringa leaves* had no significant influence where (sig>0.05) on the moisture content of nori. The seaweed *Kappapycus alvarezi* contains carrageenan, which can increase the ability to bind water, causing the resulting nori product to readily bind water and causing the nori to have a high moisture content. Higher hydrocolloid addition enhance the gel matrix's compactness, according to Widyaningtyas and Wahono (2015). During this period, the gel produced strengthens and more tightly bonded to the water. According to Andarwulan et al. (2011), the moisture content in food is a factor in determining organoleptic quality, particularly flavor, and crispness.

Fiber Content

Crude fiber, or substances that cannot be hydrolyzed by acids or alkalis, is a type of substance that is typically examined in labs. Lignin, pentose, and cellulose make up crude fiber (Hermayanti 2006). The graph below shows the outcomes of evaluating the *Kappapycus alvarezi* seaweed's nori fiber content with Moringa leaf fortification in Figure 4.

The seaweed nori product *Kappapycus alvarezi* with the fortification of *Moringa* leaves has risen, as seen by the graph of the findings above. The comparative treatment of 30% *Moringa* leaf pulp and 70% *Kappapycus alvarezi* seaweed pulp produced 18.637%, the greatest fiber content. The *Kappapycus alvarezi* seaweed porridge with a 100% comparison treatment without *Moringa* leaves had the lowest fiber content, with a value of 7.308%.

The significance of nori's fiber composition Kappapycus alvarezi seaweed has a fiber content of 31.67%, practically identical to commercial nori. The fiber percentage of a product may be estimated from the raw materials utilized. According to Matanjun et al. (2009), the fiber content of Moringa leaves is 19.2%, while that of Kappapycus alvarezi is 25.05% (Aminah et al. 2015). Insoluble fractions include cellulose, mannan, and xylan, whereas soluble fractions include agar, alginic acid, laminarin, and porphyrin. An anionic polysaccharide that is soluble, less degraded, or not fermented by the microbiota in large human intestines makes up the fiber of edible seaweed (Lalopua 2017).

Analysis of variance (ANOVA) findings revealed that the fiber content of nori seaweed *Kappapycus alvarezi* with *Moringa* leaves fortification had a significant impact ($p< 0.05$) on the fiber content generated. Based on the findings of Duncan's additional test, it can be shown that K1 differed considerably from K3 but not significantly from K0, and K2, whereas K2 differed significantly from K0 but not significantly from K1 or K3.

Thickness Analysis

Thickness is one of the important parameters for packaging material in sheets or films (Fera and Nurkholik 2018). Based on the research results, the *Kappapycus alvarezi* seaweed nori product with the fortification of *Moringa* leaves can be seen in the Figure 5.

According to the graph of the analysis of the Kappapycus alvarezi nori seaweed thickness with the fortification of Moringa leaves, the ratio of 70% Kappapycus alvarezi seaweed pulp and 30% Moringa leaf pulp has the highest thickness value, with an average value of 0.20 mm, where the value is equivalent to the thickness value. Nori used in Japanese food is 0.2 mm thick. The lowest treatment, 0.12 mm, was produced with a 100% Kappapycus alvarezi seaweed pulp ratio without adding Moringa leaf pulp.

The thickness of a product is influenced by several things, one of which is the use of molds, the volume of the solution, and the amount of dough used. Keeping with the study by Ihsan (2016) found that the mold's area, the volume of the solution, and the overall amount of solids all impacted the thickness. When more total solids are present in a solution, a thicker film is produced (Gunarti Supeni 2012). Due to the presence of hydrocolloid substances, specifically, the carrageenan found in seaweed, nori becomes thicker (Anggadiredja et al., 2006). Carrageenan is a component of the galactose polysaccharide family derived from seaweed. The sulfate ester groups of galactose and copolymers of 3,6-anhydrous-galactose can be linked to the sodium, magnesium, and calcium found in most carrageenans.

The nori seaweed product Kappapycus alvarezi with Moringa leaf fortification had a substantial significant influence ($\alpha=0.05$) on the value of nori thickness generated, according to the analysis of variance (ANOVA) results. This can be seen based on the results of Duncan's test, which the F count (12.491) is higher than the F table (0.002), demonstrating that K0 while being in the same table as K1, K2, and K3, has a considerable impact on the thickness of the nori

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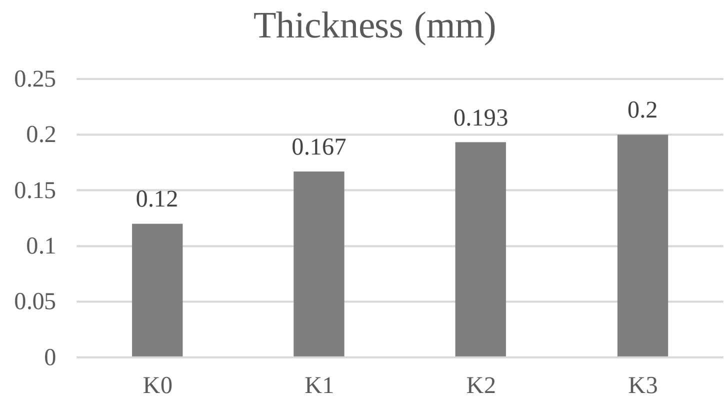

Figure 5 Thickness Test

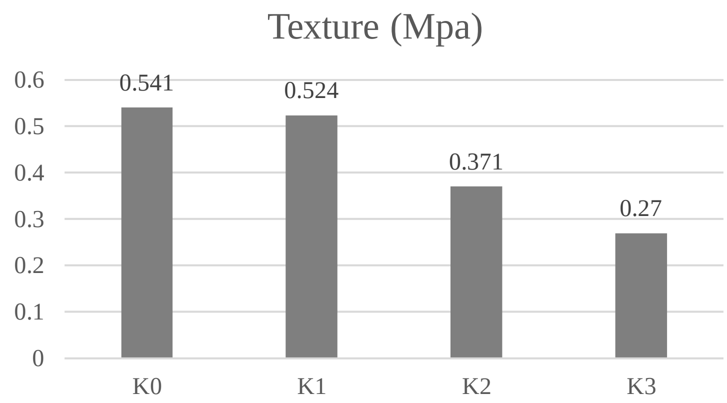

Figure 6 Average of texture value

Tensile/Tear Strength

Tensile strength is the maximum strain the sample can accept before breaking. Based on the research results of Kappapycus alvarezi nori seaweed with Moringa leaf fortification, it can be seen in the Figure 6.

According to the graph of the analysis of tensile strength/tear strength on nori seaweed Kappapycus alvarezi with Moringa leaves fortification, the value of tensile strength/tear strength is 0.541MPa, and the highest tensile strength/tear strength is found in the 100% treatment of Kappapycus alvarezi seaweed slurry without Moringa leaves. The treatment of 70% Kappapycus alvarezi seaweed pulp and 30% Moringa leaf pulp had the lowest value, measuring 0.270MPa.

The value of the tensile strength of a film product is influenced by the formulation of the material used. The stronger the gel is formed, the higher the tensile strength value (Fera and Nurkholik, 2018). The hydrocolloid substances like carrageenan in seaweed cause the resultant nori to gel. Carrageenan can gel when the hot solution cools; the carrageenan polymer becomes randomly arranged when heated above the gelling temperature. The polymer solution will form a double helix when the temperature is dropped, and if the temperature is lowered further, the polymer will create a three-dimensional structure. (Herawati 2018). Carrageenan produced by *Kappapycus alvarezi* seaweed is a type of kappa carrageenan that has a strong and rigid gelling level. The tensile strength value obtained is very different from the tensile strength value in commercial nori, which is 653.35 Kgf/cm2 (Riyanto et al., 2014). However, it is not much different from the elongation value obtained in nori made from red seaweed (*Gracilaria gigas*) by adding kenkir leaves, which is 0.2-0.7%.

The analysis of variance (ANOVA) showed that nori seaweed *Kappapycus alvarezi* with *Moringa* leaves fortification had a significant effect (α=0.05) on the tensile strength/tear strength value produced. Where F count (10.172) > F table (.004) in Duncan's further test K1 and K2 have no significant effect because they are in the same table with not much difference. While K0 and K3 significantly affect K1 and K2.

Hydration Analysis

A material's capacity to absorb water is referred to as hydration. Figure 7 displays the graph of the results of the hydration test on the nori seaweed Kappapycus alvarezi fortified with Moringa leaves.

The highest treatment is in the ratio of 100% Kappapycus alvarezi seaweed slurry without the addition of Moringa leaves with a value of 24.446 percent, and the lowest is in the 70% treatment of slurry, according to the analysis results of the hydration test of Kappapycus alvarezi seaweed nori with the fortification of Moringa leaves in Figure 7. Kappapycus alvarezi seaweed and 30% of the 20,5%-valued pulp from Moringa leaves. The length of time that nori is kept in the open air without appropriate packaging impacts its capacity to absorb water in food items.

The results of the analysis of variance (ANOVA) revealed that there was no need for Duncan's additional test since the hydration test of the nori seaweed *Kappapycus alvarezi* with the fortification of *Moringa* leaves had no significant impact where (sig>0.05). Due to the nori's high concentration of total solids, the value differential between the treatments was not significantly different, making it unlikely that the product's capacity to absorb water would differ significantly. Nori contains a significant proportion of total solids. RH, temperature, film thickness, hydrocolloid type, and material characteristics significantly impact water vapor transfer. Because the substance is a polar polymer with many hydrogen bonds, which causes water absorption, it has a high value for transmitting water vapor. The disruption of intramolecular chain connections caused by water absorption causes an increase in diffusivity, which enables the ability to absorb water vapor from the atmosphere (Lalopua 2017). The presence of carrageenan in a product affects the overall quantity of solids. Carrageenan is a component of the galactose polysaccharide family derived from seaweed. Carrageenan is a hydrocolloid that benefits from having the requisite mechanical qualities and a good capacity to protect goods from oxygen, carbon dioxide, and lipids (Lalopua 2017).

Organoleptic Test

Color

Color is one of the important parameters in a food product. Determining a food product is attractive when viewed from its appearance. Based on the results of panelists' scores on the color of *Kappapycus alvarezi* nori seaweed products with *Moringa* leaves fortification can be seen in the Figure 8.

The K3 treatment, which compares a porridge made of 70% *Kappapycus alverzi* seaweed and 30% *Moringa* leaf pulp, has the highest score, with a value of (5.83), indicating that the panelists enjoy the porridge's dark green hue. In contrast, the K2 treatment compares a slurry made of *Kappapycus alvarezi* seaweed with an average hedonic value of 5.30, the pulp from 80 and 30 percent of *Moringa* leaves is similar and barely distinguishable from the K3 treatment. Without including *Moringa* leaf pulp, it has the lowest average value in the K0 treatment (3.37), indicating that it is disliked on the hedonic scale since its color does not generally match nori.

The number of uses of *Moringa* leaf pulp influences the color of nori. It showed that the color produced in nori products is light green to dark green. This color comes from the chlorophyll pigment in Moringa leaves, and chlorophyll comes from photosynthetic pigments that are abundant in green plants, especially in the leaves (Setijo, 2008). According to Patriyanti (2016), the color change of the resulting nori is thought to be due to chlorophyll degradation followed by the appearance of lycopene which causes the color to become dark green.

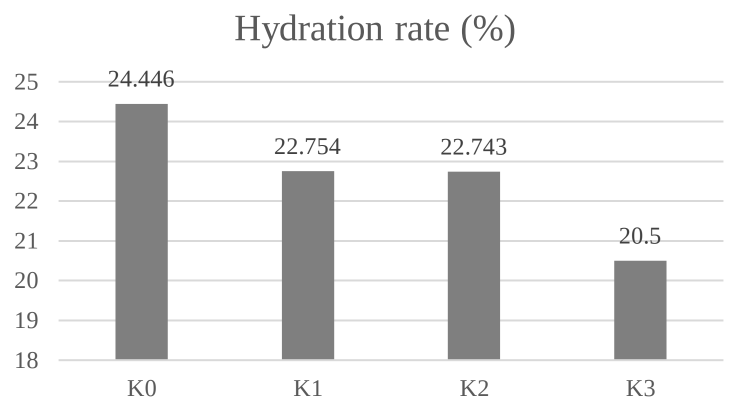

Figure 7 Average Hydration Rate

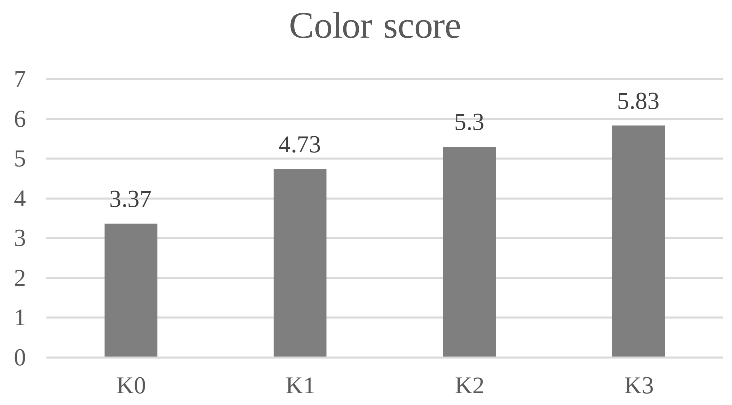

Figure 8 Nori. Color Score

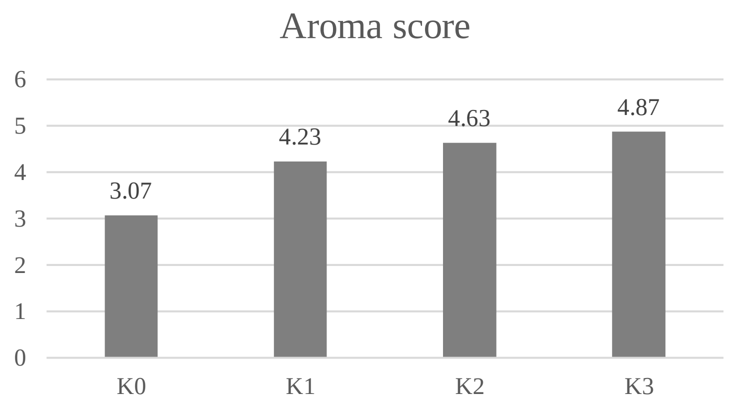

Figure 9 Aroma Score

Analysis of variance (ANOVA) results revealed a significant effect and difference on the color of the Kappapycus alvarezi nori seaweed product fortified with Moringa leaves, with a significant level (0.05 percent) on the color of the resulting nori and where Fcount (37,195) was greater than F significant (.000). The fact that each treatment was in a distinct table and that all treatments significantly altered the color of the nori product was demonstrated by Duncan's further test.

Aroma

One of the criteria used to measure the sensory qualities (organoleptic) by employing the sense of smell is the aroma. An acceptable fragrance is the outcome of a certain scent (Lamusu, 2018). The graphic below shows the findings of the panelists' evaluation of the scent of the *Kappapycus alvarezi* nori seaweed product with the addition of *Moringa* leaves.

The results of the highest panelist assessment were found in the K3 treatment, namely the ratio of Kappapycus alverzi seaweed pulp 70% and 30% Moringa leaf pulp with an average value (4.87), while in K1 and K2 treatments with a comparison of 90% and 10% Kappapycus alverzi seaweed slurry. Moringa leaf porridge, the comparison of 90% Kappapycus alverzi seaweed porridge and 20% Moringa leaf porridge obtained results that were not much different, namely the average value obtained was between (4.23-4.63), on a hedonic scale, indicating that the panelists' assessment was neutral to the aroma of nori products. The lowest rating was found in the K0 treatment, namely without adding Moringa leaf pulp, with an average value of (3.07) on a hedonic scale, which is said to be rather disliked because of the fishy smell typical of the sea.

The comparison treatment of nori seaweed Kappapycus alvarezi with the fortification of Moringa leaves significantly affected the assessment of aroma on the nori. The research results gave a slightly distinctive aroma of Moringa leaves because Moringa leaves have a *langu* aroma. Keeping with a study (Roihanah and Ismawati 2014) claims that Moringa leaves have a recognizable bad odor. In their research journal, (Diantoro et al. 2015) explained that the addition of Moringa leaf extract that affected the aroma of yogurt was due to Moringa leaves containing lipoxide enzymes. These enzymes are found in various green vegetables that hydrolyze or decompose fats into compounds that cause unpleasant odors in Moringa leaves, which are included in the hexanol 7 and 8. Blanching can be used to eliminate the scent (quick dip). (Roihanah and Ismawati 2014), stated that Moringa leaves have a distinctive odor. Diantoro et al. (2015) explained that the addition of Moringa leaf extract, which affects the aroma of yogurt, is caused by Moringa leaves containing lipoxide enzymes. These enzymes are present in various green vegetables and hydrolyze or decompose fats into compounds that produce offensive odors in Moringa leaves, which are included in the hexanol. Blanching can be used to eliminate the scent (quick dip).

The results of analysis of variance (ANOVA) on the aroma of nori seaweed Kappapycus alvarezi with Moringa leaf fortification gave a significant effect where the calculated F (15.703) was greater than the significant F (.000) with a significant level (0.05%). Then continued with Duncan's further test, where K3 was significantly different from K0 but not significantly different from K2 and K1 because the K2 treatment was in the same column as the K3 treatment.

Flavor

Taste is the level of preference in the organoleptic test observed with the human sense of taste. Based on the results of the panelists' scores on the taste of Kappapycus alvarezi nori seaweed products with Moringa leaf fortification can be seen in the Figure 10.

Based on the results of the organoleptic test in the graph above shows that the panelists' highest assessment of the taste of the Kappapycus alvarezi nori seaweed product with Moringa leaf fortification was found in the K3 treatment with a ratio of 70% Kappapycus alvarezi seaweed pulp and 30% Moringa leaf pulp obtained an average value (5.03) on a hedonic scale shows that the panelists like the taste of the resulting nori product. Meanwhile, the panelists assessed the K1 and K2 treatments, namely the comparison of 90% and 10% *Kappapycus alverzi* seaweed pulp and 10% *Moringa* leaf pulp, and the 90% and 20% Kappapycus alverzi seaweed porridge ratio obtained an average value that was not much different, namely between (4.20) and (4.47) where the hedonic scale shows that it is on a neutral scale. The lowest rating was found in the K0 treatment, namely without adding Moringa leaves, with an average value of (3.63), meaning they do not like it.

The taste of the seaweed nori made from Kappapycus alvarezi with the addition of Moringa leaves is salty with a hint of bitterness from the leaves. It is due to tannins found in moringa leaves, which give products a bitter flavor. When eaten, cross-links between tannins and proteins or glycoproteins develop in the oral cavity, resulting in a dry, wrinkled sensation or an astringent flavor (Khasanah and Astuti, 2019). At the same time, the combination of salt and sugar produces the consequent salty flavor. Commercial nori is made to specified seaweed standards and has a salty, savory flavor. Riyanto et al. (2014) claim that free amino acids such as alanine, glutamic acid, taurine, and aspartic acid give nori its mouthwatering flavor (umami). These amino acids contribute to the wonderful flavor of nori (umami).

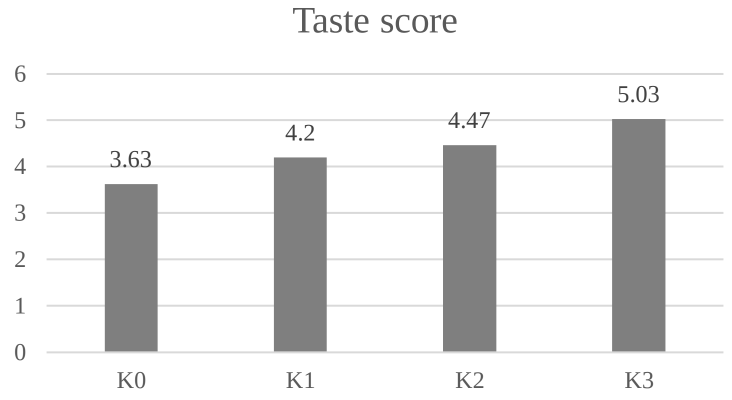

Figure 10 Taste Score

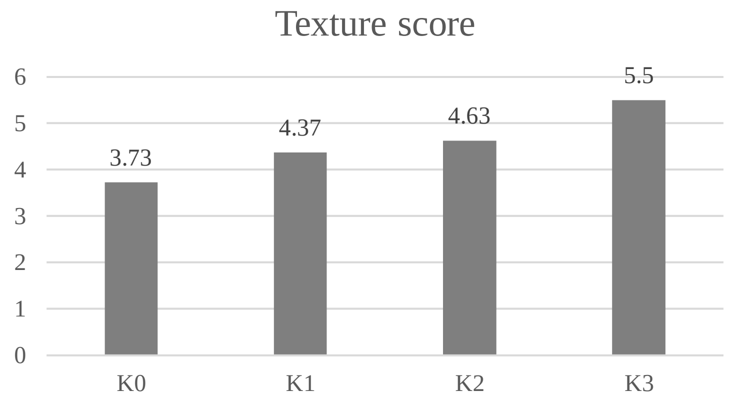

Figure 11 Texture Score

The analysis of variance (ANOVA) showed that the comparison treatment of Kappapycus alvarezi seaweed nori with Moringa leaf fortification gave a significant effect with a significant value (0.05%) with a confidence level of = 0, on the taste of the nori product produced. Following Duncan's further test, which determined that the K3 treatment did not significantly affect the K2 treatment, while the K2 treatment was not significantly different from the K1 treatment. However, the K3 treatment significantly affected the K0 treatment (control).

Texture

One of the factors people consider when selecting a product to use or eat is texture. The image below shows the findings of the panelists' evaluation of the texture of the *Kappapycus alvarezi* nori seaweed product with the addition of *Moringa* leaves.

The highest value was obtained in the 70% treatment of Kappapycus alvarezi seaweed pulp and 30% Moringa leaf pulp with a value of (5.50) on a hedonic scale, which means it likes it because the resulting texture is rather coarse and compact. Based on the graph of the results of the organoleptic texture test on *Kappapycus alvarezi* seaweed nori with *Moringa* leaf fortification. The treatment of 100% seaweed slurry yielded the lowest rating, which, at (3.73), indicates that the material is slightly hated due to its thick texture.

Based on the study's findings, it can be shown that adding Moringa leaf pulp can change the final nori's texture. This experiment revealed that the panelists' preferred ratio of 70% Kappapycus alvarezi seaweed pulp to 30% Moringa leaf pulp had the highest value. Compared to other nori textures, the texture of the obtained nori is a little rough and mixed. This results in a texture that is somewhat fused, tough, and difficult to tear due to the contact between the fibers in the seaweed and the fibers in the Moringa leaves. When using a high carrageenan concentration, nori will be more difficult to digest in the mouth (Aulia et al. 2021). According to (Wenno et al. 2012), Kappapycus alvarezi seaweed has 43.3% kareganan and fiber content of 23.57%.

The results of analysis of variance (ANOVA) showed that nori seaweed Kappapycus alvarezi with Moringa leaf fortification had a significant effect where the calculated F value (11.296) was greater than F significant (.000) with a significant level (p <0.05). Following Duncan's further test, the K3 treatment (70%:30%) was significantly different from the P0 treatment (100%). In comparison, the K2 treatment (80%:30%) was not significantly different from K1 (90%:10%) because it was at the same table with the resulting value difference is not much different.

CONCLUSION

The following conclusions may be drawn from the research described above: 1. Based on antioxidant activity and total phenol, the K3 treatment with a ratio of 70% seaweed pulp and 30% Moringa leaf pulp had the highest levels, with values of 59.121 ppm and 252.527%, respectively. Based on the physicochemical properties, the K3 treatment with a concentration ratio of 70% seaweed pulp and 30% Moringa leaf pulp, consisting of 18.637% fiber, 0.20 mm thickness, and tensile strength 0.541PM, was the best. The 70% seaweed pulp and 30% moringa leaf pulp ratio was determined to be the optimal treatment based on the panelists' approval of nori products.

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