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CHARACTERIZATION OF DRIED NOODLES FROM SEAWEED (*Kappaphycus alvarezii*) AS POTENTIAL SUBSTITUTE FOR WHEAT FLOUR

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ABSTRACT

The main ingredient of dry noodles is wheat flour which made from milling wheat. However, we usually obtain wheat from overseas by import. Therefore, to achieve food resilience in Indonesia, it is necessary to find substitutes for local ingredients with high nutrition that can be used to make dry noodles. This research aims to investigate the characteristics of dry noodles made from Kappaphycus alvarezii seaweed flour. The method used in this study was to substitute K. alvarezii seaweed flour as much as 0, 5, 10, 15, 20, and 25% in the production of dry noodles. Analysis was carried out on its chemical composition, physical properties, and organoleptic characteristics. The results showed the best result of substitution of K. alvarezii in the 5% treatment. The chemical composition in dry noodles of this treatment showed water content of 8.39%; ash content 3.07%; fat content 0.59%; protein content 12.43%; and 0.29% crude fiber content. Meanwhile, the results of the physical test showed7.95% cooking loss;210.5 seconds cooking time; and 89.34% water absorption. The organoleptic values obtained are color 4.60 (like); fragrance 4.80 (like); texture 4.23 (like); and taste 4.20 (like).

Keywords: *Kappaphycus alvarezii*, seaweed flour, dry noodle

INTRODUCTION

Dried noodles are one of the favorite food products in Asia because it has good nutritional content, inexpensive, and practical or easy to consume. In Indonesia, dry noodles have been consumed by all levels of society and become one of staple ingredient other than rice (Juniawati, 2003). Dry noodles are made from wheat flour which comes from milling wheat seeds. Indonesia's climate which is not suitable for the growth of wheat crops makes Indonesia have to import wheat to meet people's demand. In 2019, Indonesia's wheat imports reached 10 million tons. This causes Indonesia to become the largest wheat importing country in the world (FAO, 2020). The high number of wheat imports is also due to the fact that many food products in Indonesia use wheat as their raw material (Saajidah & Sukadana, 2020). The high number of import needs to be a concern because if there is an escalation price of wheat, then dried noodles producers will experience difficulties. Wheat flour substitute material is needed to reduce Indonesia's dependence on imported raw materials and also to create food resiliency.

Seaweed is one of the important commodities in Indonesia. It has a complete nutritional content, including vitamins, essential amino acids, fatty acids, and dietary fibers (Roohinejad et al., 2016). As a good source of nutrition, seaweed have been used

as many food products, such as *nori*, pickles, pasta, or salad dressings. Seaweed can also be processed into seaweed flour, such as *Gracillaria* spp. (Aditia et al., 2021).

Kappaphycus alvarezii is a seaweed that has commercial value and is an Indonesian export commodity. *K. alvarezii* is usually used as a natural preservative because it contains antioxidants and antibacterials (Tjahyaningsih et al., 2013). In addition, *K. alvarezii* also contains carrageenan so that it can be used as a thickener, stabilizer, and thickener (Williams & Philips, 2008). Based on these characteristics, *K. alvarezii* has the potential to be developed into flour for the manufacture of dry noodles. Carrageenan from *K. alvarezii* (Ulfah, 2009) and also combination between *K. alvarezii* and *Elops hawaiensis*'s fish meat (Setiawati, 2019) has been previously used to enhance the elasticity of dried noodles. However, the proper formulation of *K. alvarezii* to produce good noodles have no't been found. Therefore, it is necessary to conduct research on the formulation of seaweed flour from *K. alvarezii* and the characteristics of the dry noodles produced from the substitution.

MATERIALS AND METHODS

Tools and Materials

The tools used in this study were dry noodle cast, analytical scale (Boeco BBI-32), drum dryer, disk mill (model FFC 15), oven (Cosmos CO-958), 100 mesh filter, Soxhlet extractor, whiteness meter, and *Kjeltec* machine.

The main ingredient in this study was 30-days-old dry seaweed *Kappaphycus alvarezii* obtained from Lontar, Serang Regency, Banten. Other materials used in this study were wheat flour, salt, water, eggs, carboxyl methyl cellulose (CMC), baking soda ($NaHCO_3$), 5% calcium oxide (CaO), and distilled water.

Methods

Seaweed Flour Production

The method of making seaweed flour was modified from Agusman et al. (2013). Dried seaweed *K. alvarezii* was soaked in fresh water for 24 hours, then drained. *K. alvarezii* was then immersed in 5% CaO solution for 5 hours, then rinsed and drained. After that, it was milled using a blender and dried using a drum dryer. Finally, *K. alvarezii* seaweed flour was sieved using a 100-mesh sieve. After that, chemical characteristics of dried seaweed flour was analyzed. It consists of water, ash, fat, crude fiber, and protein content.

Dried Noodle Production

The initial stage of making dry noodles is making a dough consisting of *K. alvarezii* flour, wheat flour and other ingredients. In this study, 5 different seaweed flour formulatios were made, namely 0% (control), 5%, 10%, 15%, and 20%. The formulation of dry noodle dough with the substitution of *K.*

Table 1. Dried noodles formulation with substitute of *Kappaphycus alvarezii* flour

Composition	Treatment					
	Control (0%)	5%	10%	15%	20%	25%
Kappaphycus alvarezii flour (g)	0	5	10	15	20	25
Wheat flour (g)	100	95	90	85	80	75
Water (ml)	58	58	58	58	58	58
Salt	1	1	1	1	1	1
CMC (g)	1	1	1	1	1	1
Egg (g)	5	5	5	5	5	5
Baking soda (g)	1	1	1	1	1	1

alvarezii flour is presented in table 1. Next, the dough is milled and molded into noodles. The noodles that have been printed are then steamed at 100^{o}C for 10 minutes and then drained. After that, noodles were dried using an oven at 100^{o}C for 1 hour.

Data Analysis

Dry noodles analysis consisted of chemical composition, physical properties, and organoleptic tests. Chemical composition analysis carried out on dried noodles were its content of water, ash, protein, fat (BSN 2006), and crude fiber (BSN 1992). Physical properties analysis that carried out includes cooking time, cooking loss (Oh et al., 1985), whiteness degree, and water absorption power (Rasper & de Man, 1980). Last, organoleptic test adopted from Setyaningsih et al. (2010) was conducted with hedonic test for its color, texture, aroma, and flavor.

This research was conducted using a completely randomized design (CRD) method with two repetitions / duplo. Data were analyzed using one-way ANOVA and Duncan's test. Meanwhile, the data from the organoleptic test were analyzed using the Kruskal Wallis test and Duncan's test.

RESULTS AND DISCUSSION

Chemical Characteristics of Seaweed Flour

Chemical characteristics of dried seaweed flour are shown in Table 2. It was composed of whiteness, crude fiber, water, ash, fat, and protein content. The results showed that *K. alvarezii* flour had a higher water content than BSN standard. This was due to the short drying time. It also had higher ash content than BSN standard. According to Mayer et al (2011), ash content in seaweed is much higher than in terrestrial plants, such as wheat.

Chemical Composition

Chemical composition analysis results for dried noodles are shown in Table 3. It consists of water, ash, protein, fat, and crude fiber content.

Table 2. Chemical characteristics of dried seaweed flour

Characteristics	BSN standard	*K. alvarezii* flour
Whiteness (%)	White	Yellowish-white
Crude fiber (%)	-	5,43 ± 0,47
Water (%)	≤ 14,50	17,56 ± 0,15
Ash (%)	≤ 0,70	16,90 ± 0,11
Fat (%)	-	0,13 ± 0,01
Protein (%)	≥ 7,0	4,07 ± 0,12

a. Water Content

The results showed that all treatments had a higher water content than control. The lowest water content was found in the 5% treatment, which was 8.39%. The higher the concentration of *K. alvarezii* flour used, the higher the water content. This is presumably because seaweed has a high water insoluble fiber content, hence water will be bound and trapped in the matrix (Nafiah, 2011). Even so, BSN (2015) applies a good standard of moisture content in dry noodles is ≤ 10%. So, the dry noodles with *K. alvarezii* flour at concentrations of 5 and 10% still meet the standards. The water content of a food product will affect its durability, quality, and texture.

b. Ash Content

Ash content shows the mineral contained in a food product, such as calcium, potassium, phosphorus, iron, and others. In this study, all treatments had higher ash content than controls. According to Santoso et al. (2013), seaweed *K. alvarezii* has high mineral and salt content which will be left after the dry ashing process. The higher the concentration of *K. alvarezii* flour used, the greater the ash content. The lowest ash content was found in the 5% treatment, which was 3.07%. However, this value does not

meet the BSN standard (2015) which stipulates that a good ash content in dry noodles is 3%.

control. The highest fiber content was found in the 25% treatment, which was 1.41%. This is because seaweed is a high source of dietary

Table 3. Chemical composition of dried noodles

Composition	Treatment						
	Control	5%	10%	15%	20%	25%	BSN standard
Water (%)	5.64[a]	8.39[b]	9.26[c]	11.4[d]	14.79[e]	17.69[f]	≤ 10%
Ash (%)	2.11[a]	3.07[b]	3.97[c]	4.65[d]	5.88[e]	6.15[e]	3%
Protein (%)	12.57[c]	12.43[c]	11.81[b]	11.59[b]	11.39[b]	10.84[a]	≥ 8%
Fat (%)	0.62	0.59	0.52	0.50	0.42	0.39	-
Crude fiber (%)	0.16[a]	0.29[a]	0.38[a]	0.81[b]	1.32[c]	1.41[c]	-

Note: Value with different notation in the same column has a significant differences at 5% (Duncan's test)

c. Fat and Protein Content

Dried noodles with *K. alvarezii* flour substitution had lower fat content than the control. This is because in general, seaweed has a lower fat content compared to terrestrial plants, which is <4% (Ortiz et al., 2012). In this study, the highest fat content was found in the 5% treatment, which was 0.59%. Similar to fat content, dry noodles with *K. alvarezii* flour substitute also had lower protein content than control. The highest protein content was found in the 5% treatment, which was 12.43%. According to BSN (2015), a good protein content in dry noodles is 10%. Therefore, although the protein content in the treatment was lower than the control, the protein content in all treatments had met the standards set by BSN.

fiber, which is 78.94% (Astawan et al., 2004). This is also shown by the higher concentration of *K. alvarezii* flour used, the higher the crude fiber content. Crude fiber can help the digestive process in humans. The higher the fiber content, the shorter the time required for the digestive process (Dhingra et al., 2012).

Physical Properties

Physical properties analysis results are shown in Table 4. It consists of cooking time, cooking loss, and water absorption power.

a. Cooking time

The calculation of cooking time refers to the time it takes for dry noodles to rehydrate so that the texture becomes supple and elastic as before it was dried. Short cooking time

Table 4. Physical properties of dried noodles

Physical Properties	Treatment					
	Control	5%	10%	15%	20%	25%
Cooking time (s)	199.50[a]	210.50[b]	216.00[c]	219.50[d]	223.00[e]	227.50[f]
Cooking loss (%)	7.14[a]	7.95[b]	9.04[c]	9.88[d]	10.82[e]	11.13[e]
Water absorption (%)	95.29[f]	89.34[e]	88.23[d]	86.3[c]	83.20[b]	80.48[a]

Note: Value with different notation in the same column has a significant differences at 5% (Duncan's test)

d. Crude Fiber Content

The results showed that the fiber content in all treatments had a higher value than

will be preferred by consumers because it is more practical. In this study, dry noodles substituted with *K. alvarezii* seaweed flour

with a concentration of 5% had the shortest cooking time, which was 210.5 seconds. Even so, the value of this cooking time is still lower than the control, which is 199.5 seconds. The length of cooking time in the treatment is due to the fact that seaweed has a high fiber content so that it can inhibit the gelatinization process and slow down the cooking time (Irviani & Nisa, 2015). This is also shown by the higher the concentration of seaweed flour, the longer the cooking time.

drying process which is indicated by the level of swelling of noodles (Safriani et al., 2013). If the value of water absorption is high, then the ability of noodles to absorb water is also high indicated by a swelling noodles. The results showed that all treatments had a lower water absorption value than the control. The highest water absorption value was found in the 5% treatment, which was 89.34%. According to Sugiyono et al. (2011), one of the factors that affect water absorption in noodles is gluten. The low gluten value in dry noodles made from seaweed flour causes the noodle mass to become less dense so that the water absorption value also become low.

Table 5. Organoleptic test results of dried noodles

Sensory Test	Treatment					
	Control	5%	10%	15%	20%	25%
Color	4.07	4.60	4.77	4.57	4.57	4.43
Aroma	4.90^{c}	4.80^{c}	4.50^{bc}	4.07^{ab}	4.23^{b}	3.73^{a}
Texture	4.53^{b}	4.23^{b}	4.43^{b}	4.03^{b}	4.17^{b}	2.80^{a}
Flavor	4.37^{bc}	4.20^{ab}	4.17^{ab}	4.37^{bc}	4.87^{c}	3.77^{a}

Note: Value with different notation in the same column has a significant differences at 5% (Duncan's test)

b. Cooking loss

Cooking loss refers to the lost amounts of solids (starch) during the cooking process. A high cooking loss value indicates that the intermolecular bonds in the noodles are getting weaker so that the noodles become more easily broken (Widiatmoko & Estiasih, 2015). In this study, the smallest value of cooking loss was found in the treatment with a concentration of 5%, which was 7.95%. The higher concentration of *K. alvarezii* flour used, the higher the cooking loss value. The value of cooking loss in all treatments was higher than the control, which was 7.14%. This is because wheat flour has the ability to form gluten which is formed from gliadin and glutenin complexes (Widianto et al., 2002) while seaweed flour does not have the ability to do so.

c. Water absorption power

Water absorption is the ability of dry noodles to reabsorb water after undergoing a

Organoleptic Test

The most preferred dried noodles for panelists is the treatment of 5% *K. alvarezii* flour. The results of organoleptic test is shown in Table 5.

a. Color

The initial characteristic seen by consumers in choosing a food product is color. The results of organoleptic testing on the panelists showed that the 10% treatment had the highest level of preference, which was 4.77 (like). The higher the concentration of *K. alvarezii* flour used, the lower the panelists' preference level. However, all samples of dried noodles with *K. alvarezii* flour substitution had a higher level of preference than the control, which was 4.07 (like). The color of dried noodles from *K.*

alvarezii seaweed flour is yellowish-white with a whiteness level of 80.50% (Figure 1). This is in accordance with the characteristics of BSN (2015) which states that good dry noodles have a yellowish-white color.

b. Aroma

Aroma is a factor that is also important for consumers to choose a product. The results showed that the most preferred aroma of dried noodles with *K. alvarezii* flour substitution was in the 5% treatment with a value of 4.80 and was not significantly different from the control. The higher the concentration of seaweed flour used, the lower the value of the level of preference for aroma. The 25% treatment had the lowest level of preference, namely 3.73 (rather like). This is because seaweed has a distinctive fishy odor from sea water. The distinctive odor can be disguised through better processing, such as soaking, heating, or adding other substances (Ulfah, 2009).

Figure 1. The color of *K. alvarezii* flour and dry noodle

c. Texture

Texture is a characteristic that can affect the image of a food. The dry noodle texture assessment showed that the most preferred substitution of *K. alvarezii* flour was at a concentration of 10% with a value of 4.43 (like) and not significantly different from the control, which was 4.53 (like). Dried noodles with 25% seaweed concentration had the lowest preference value, which was 2.80 (rather dislike). This is presumably because seaweed flour has a high fiber content, causing the dry noodle structure to become brittle and break easily (Supriadi, 2004).

d. Flavor

The most important characteristic of a food product is taste. The results showed that the most preferred concentration of *K. alvarezii* flour substitution by the panelists was at a concentration of 20% with a value of 4.87 (like). This value is higher than the control, which is 4.37 (like) but not significantly different. This is because seaweed has a bland taste so it does not affect the taste of dried noodles (Hudaya, 2008). However, the addition of a concentration that is too high can cause a fishy odor which can also affect the taste. This is indicated by the low level of preference for the 25% treatment, which is 3.77 (rather like).

CONCLUSION

In accordance with the objectives of the study, which is to investigate the chemical characteristics, physical properties, and panelists' preference of dried noodles made from *K. alvarezii* flour formulations, the best formulation is 5% substitution of *K. alvarezii* flour. As for chemical composition, *K. alvaarezii* dried noodles in this treatment showed 8,39% water; 3,07% ash; 0,59% fat; 12,43% protein; and 0,29% crude fiber content. Physical properties test shown 7.95% cooking loss; 210.5 seconds cooking time; and 89.34% water absorption. Moreover, the organoleptic values obtained are color 4.60 (like); fragrance 4.80 (like); texture 4.23 (like); and taste 4.20 (like).

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