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Effect of additional carrageenan concentration on the characteristics of wet noodles based on mangrove fruit flour variation

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Abstract

In general, wet noodles are made from tapioca flour, but the weakness of noodles made from tapioca flour is the lack of nutrients, high carbohydrate content, low protein content, low vitamin content and high gluten content. Making wet noodles with the fortification of mangrove fruits flour and carrageenan is expected to produce wet noodles with physical, chemical, and nutritional characteristics. The method used in this study was an experiment with a factorial randomized block design (RBD). The test was carried out with three replications (triple) with two test parameters, the concentration of carrageenan flour (8%, 12%, 15%) and three mangrove fruit species, namely, *Avicennia marina*, *Bruguierra gymnorrhiza*, and *Sonneratia caseolaris*. Based on the results, the addition of various concentrations of carrageenan flour in wet noodles and using different types of mangrove fruit flour gave significantly different effects ($P<0.05$) on several test parameters, namely proximate test, crude fibre content, antioxidant activity, water absorption, cooking time, power dropping of noodles, cooking loss, and sensory testing. The addition of carrageenan flour affected the physical and sensory properties of mangrove flour noodles. In addition, different types of mangrove fruit flour affect the increasing nutritional characteristics and antioxidant activity of wet noodles.

1. Introduction

Noodle is a source of carbohydrate that is widely liked and consumed by the public. In general, wet noodles are made from tapioca flour, but the weakness of noodles made from tapioca flour is the lack of nutrients, high carbohydrate content, low protein content, low vitamin content and high gluten content. Making wet noodles with the fortification of mangrove fruits flour and carrageenan is expected to produce wet noodles with physical, chemical, and nutritional characteristics. Therefore, several studies researched producing wet noodles with non-gluten raw materials and adding some fortification to the composition of ingredients that were high in nutrients. The fortification of sweet potatoes for making wet noodles can improve the nutritional value, particularly antioxidants obtained from anthocyanin pigments (Mahmudatussa'adah *et al*., 2021), and using red seaweed as raw material for gluten-free pasta (Sholichah *et al*., 2021).

Mangrove fruits have quite complete nutrition, *Sonneratia caseolaris* contains vitamin A 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg, and vitamin C 56.74 mg (Putri *et al*., 2015). In addition, besides having high vitamin content, it contains other nutrients such as carbohydrates (76.56 g), fat/glycerol (0.9 g/fruit), protein (4.83 g) and mineral substances (Rahman *et al.,* 2016). *Sonneratia caseolaris* has been a food ingredient in a variety of products, such as brownies (Sumartini *et al*., 2020; Harahap *et al*., 2020), fruit leather (Rahman *et al*.,2016), jam, food bars (Basuki *et al*., 2017), chocolate (Wintah *et al*., 2018), syrup (Rajis *et al*., 2017), biscuits (Jariyah *et al*., 2020) and a chocolate bar (Ratrinia and Sumartini, 2021). Several studies using edible mangrove fruit as an ingredient aim to maximize the potential for nutritional content such as fibre, carbohydrates, vitamins, minerals, and antioxidants. In addition, *A. marina, B. gymnorrhiza, and S. caseolaris* are edible mangrove fruits used as raw materials for mangrove fruit flour (Rout *et al*., 2015). They are usually used with ingredients that contain starch to be used for various food preparations. Therefore, it is possible to mix starch-containing ingredients with mangrove fruit flour for a wide variety of products with the added functional benefit of mangrove fruit properties (Jariyah *et al*., 2014).

Compared with dry noodles, wet noodles are one of

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the foods that are lack nutrients but stronger in gluten. In terms of sensory quality, preferred wet noodles are those with a chewy texture. One of the factors that affect the chewiness of the noodles is the gluten content found in wheat flour protein, on the other hand, gluten has a worse health impact when consumed exaggeratedly. The production of noodles made from mangrove fruit flour with carrageenan flour fortification is expected to produce wet noodles with physical, chemical, and nutritional characteristics as well as a better source of chewing agent compared to commercial instant noodles on the market.

2. Materials and methods

2.1 Research method

The method used in this study was an experiment with a factorial randomized block design (RBD). This research is carried out with three replications (triple) with two test parameters. The parameters are the concentration of carrageenan flour (8%, 12%, 15%) and the difference addition of three mangrove fruit species, namely, *A. marina, B. gymnorrhiza,* and *S. caseolaris*. According to the regulation of the National Food and Drug Agency of Indonesia (2019), there is no maximum limit for adding carrageenan to pasta and noodle products and similar products.

2.2 Sample preparation

The fruit of *Avicennia marina* is peeled, and then sorting and removing the pistil is carried out. Then boil it in 800 mL of distilled water at 90°C for 60 mins Subsequently, *A. marina* fruit was soaked in ash water suspension for 24 hrs. According to Perdana *et al.* (2012), boiling treatment with several levels of rubbing ash and long water immersion had a significant effect on the decrease in fruit tannin levels. The next step was drying in a drying oven for 10 hrs (70°C). The fruit flour of A. *marina* is done by blending it for 3 mins. The fruit flour of the *A. marina* is soft and light green. Sifting is done to get a soft texture using a sieve (filter size 60-80 mesh). Furthermore, the proximate test of *A. marina* fruit flour was carried out.

Bruguierra gymnorrhiza fruit flour is produced according to the method of Sulistyawati *et al.* (2012) with slight modifications. The fruit is boiled at a temperature of 80 - 90°C for 60 mins, and then the fruit is peeled and sliced using an aluminium knife then soaked in 10% (w/v) ash water suspension until the fruit is completely immersed for 24 hrs. The fruit is dried in the sun until it is completely dry. The dried fruit is then milled and sieved with a 100-mesh filter (Amin *et al.,* 2018). Furthermore, the proximate test of *B. gymnorrhiza* fruit flour was carried out.

Sonneratia caseolaris fruits were collected and randomLy selected from various parts of the mangrove tree. *Sonneratia caseolaris* was transferred to the laboratory, then peeled and blended with distilled water (1:3). The resulting dispersion was sieved with a 50 mesh sieve to remove the seeds, then dried in an oven/ drying cabinet for 15-18 hrs at 50-60°C, and sieved with an 80 mesh sieve (Jariyah *et al*., 2014).

2.3 Wet noodle production

The research was conducted by making control treatment wet noodles with a 100% wheat flour recipe (Table 1). The process of making wet noodles consists of mixing, resting, milling/printing the noodles, and cutting. The mixing process takes about 15-25 mins. This time is needed to form the dough matrix and homogenize the ingredients. The resting purpose is for water dispersion and gluten formation in the dough. Resting the dough for a long time will result in softer noodles and dough that can be stretched. The break time is usually 30-60 mins. The moulding of the noodles is carried out by mechanical means, and the thickness of the ends of the noodles is 1.2-2 mm.

In this process, the soft gluten fibre can be expanded while it is being formed. The proper temperature for this process is 25°C or higher so that the dough does not turn coarse, harden and spoil. The noodles are then cut to 0.5-1 m long.

Control wet noodles compared to some noodle formulations. Using the formulas in Table 1, the study consisted of three main variations in the types of mangrove flour and three types of variations in the concentration of carrageenan. The variations of the ingredients consist of variations of basic flour (mangrove fruit flour, wheat flour); variations in the amount of carrageenan flour (8%, 12%, and 15%), 1 egg, and salt.

Table 1. The formula of making wet noodles based on carrageenan and mangrove fruit flour

Formula	*A. marina* fruit flour (A)	*B. gymnorrhiza* fruit flour (B)	*S. caseolaris* fruit flour (S)
Carrageenan 8%	A8	B8	S8
Carrageenan 12%	A12	B12	S12
Carrageenan 15%	A15	B15	S15
Control		100% wheat flour	

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2.4 Statistical analysis

The research used a factorial randomized block design (RBD) experimental design method with a 5% test level. The variables used in this study were differences in the concentration of carrageenan flour (8%, 12%, and 15%) and the types of mangrove fruit species (*B. gymnorrhiza*, *S. caseolaris*, and *A. marina*). The parameters tested were the proximate value (AOAC, 2005), crude fibre content (AOAC, 2005), antioxidant activity (Tristantini *et al*., 2016), development power of noodles, as well as water absorption capacity (Kohn *et al.,* 2015), cooking time (Wandee *et al*., 2015), cooking loss (Tan *et al.,* 2009), and sensory testing (Litaay *et al*., 2022).

2.5 Moisture analysis

The water content measurement was carried out using the thermogravimetric method (AOAC, 2005) with slight modifications. First, the cup used in the measurement was dried in an oven (Memmert UN30) at a temperature of 100-105ºC until a constant weight was obtained, then cooled in a desiccator (Duran DN200) and weighed. Next, the sample was weighed 5 g in the cup and dried in an oven (Memmert UN30) at a temperature of 100-105ºC until a constant weight was obtained. Finally, the sample is cooled in a desiccator and then weighed. The principle of the water content analysis method is based on the evaporation of water contained in the sample. Therefore, weight reduction occurs due to the evaporation of water contained in the sample.

2.6 Fat content

Fat content analysis was carried out using the Soxhlet method (AOAC, 2005) with slight modifications. The principle of this analysis is to extract fat using hexane solvent. When heated, the hexane solvent will evaporate to calculate the fat content. Measurement of fat content begins with drying the fat flask (Pyrex) using an oven (Memmert UN30) at 105ºC for 30 mins, then cooled in a desiccator (Duran DN200) for 15 mins and weighed. A total of 5 g of the sample was wrapped in filter paper, put into a fat sleeve, covered with fat-free cotton, and doused with hexane solvent. The following procedure is distillation until the hexane solvent evaporates. The extracted flask was then heated in an oven (Memmert UN30) at 105ºC until the weight was constant. Finally, the dried sample was cooled in a desiccator (Duran DN200) and weighed.

2.7 Protein content

The method of measuring protein content was carried out using the Kjeldahl (AOAC, 2005) with slight modifications. The principle of analysis of this method includes destruction, distillation, and titration. Protein content analysis uses the Kjeldahl method to determine protein from carbon-containing materials and convert nitrogen into ammonia. Ammonia reacts with an acid to form ammonium sulfate; then ammonia is absorbed in boric acid solution (Merck). The HCl titration step can determine the amount of nitrogen in the sample using a burret (Duran).

2.8 Ash content

Measurement of ash content was carried out according to (AOAC, 2005) with a slight modification and using a furnace (Nabertherm LT 15/14/B410) with a temperature of about 550°C (dry ashing method). The ash content was determined by heating at a temperature of 550°C by oxidizing organic matter and then weighing the remaining substances.

2.9 Carbohydrate content

Calculating carbohydrate content refers to (AOAC, 2005) slightly modified. In the proximate analysis, it is calculated using the by-difference method. Calculation of carbohydrate analysis is 100%-(water content + ash content + fat content + protein content). Carbohydrates are obtained by subtracting the number 100 from the percentage of water content, ash content, fat content, and protein.

2.10 Water absorption analysis

WAC analysis refers to research (Kohn *et al*., 2015). First, a 5 g sample was put into a centrifuge tube (Falcon type plastic tube with a capacity of 50 mL), added 32 mL of distilled water, and agitated manually for 1 min. Then the tube was allowed to stand for 10 mins and centrifuged for 25 mins at 2,900×g. Next, the supernatant was discarded, and the tubes were dried in an air-circulating oven (50ºC for 20 mins in an inclined condition). Finally, the tube was weighed, and the WAC was calculated for each sample as a percentage.

2.11 Sensory evaluation

Sensory evaluation procedures were based on the research method (Litaay *et al.,* 2022). First, all noodle samples were boiled using the optimal cooking time. Then, the sample was evaluated for colour, texture, flavour, taste, and overall acceptability by 30 untrained panellists using a scale where 9 = enormously liked and 1 = intensely disliked.

2.12 Dietary fiber

Analysis of dietary fiber was carried out using the enzymatic method (AOAC, 2005) with slight modifications. This measurement was done by reacting

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the sample with the enzyme alpha-amylase and pepsin. The residue from the enzyme reaction was then washed with ethanol and acetone. The residue is insoluble when washed with ethanol and acetone and then dried. The soluble fiber filtrate is precipitated using ethanol and then filtered and dried. Determination of dietary fiber content is divided into three stages, namely sample preparation, measurement of insoluble dietary fiber, and measurement of soluble dietary fiber.

2.13 Cooking time

The cooking time testing procedure refers to the research method (Wandee *et al*., 2015). A total of 5 g was cut into a length of 4-5 cm and cooked in 200 mL of boiling distilled water in a closed glass. The optimal cooking time was evaluated by observing when the white core disappeared from the noodle strands every 30 s by pressing the cooked noodles between two transparent glass slides.

2.14 Cooking loss

The cooking loss test was carried out using the research method (Tan *et al.,* 2009). The noodles were weighed as much as 5 g (W0) and then cut into 5 cm lengths. Noodles are cooked in 200 mL of boiling distilled water in a beaker with a lid for 1 min or the optimal cooking time. The cooked noodles are then rinsed with cold water and dried using filter paper. Cooking loss (CL) was determined by evaporating the water used for cooking and washing at a temperature of 110ºC. The residue (W1) obtained was then weighed and determined as a percentage of cooking loss (CL).

$$CL\ (\%) = W1/W0 \times 100\%$$

2.15 Antioxidant activity

Prepare a sample of wet noodles. Then make a mother liquor of each sample of 100 ppm by dissolving 10 mg of extract in 100 mL of methanol PA. Furthermore, dilution using methanol PA solvent by varying the concentration of 5 ppm, 6 ppm, 7 ppm, 8 ppm and 9 ppm for each sample. Prepare 50 ppm DPPH stock solution. DPPH stock solution is prepared by dissolving 5 mg of DPPH solids into 100 mL of methanol PA. Then a comparison solution was designed, namely a control solution containing 2 mL of methanol PA and 1 mL of 50 ppm DPPH solution. Every 2 mL of sample solution and 2 mL of DPPH solution were prepared for the test sample. Then, they were incubated for 30 mins at a temperature of 27°C until a color change from DPPH activity occurred. All samples were made triple. All samples, namely extract samples that have been incubated, are tested for absorbance values using a UV-vis spectrophotometer at a wavelength of 517 nm (Tristantini *et al*., 2016).

3. Results and discussion

3.1 Characteristics of mangrove noodles during cooking

Based on the experiments of a factorial randomized block with a test level of 5%, the results of processing mangrove noodle data during cooking, namely the parameters of cooking time, cooking loss, and power dropping showed that there were significant differences ($P<0.05$) on the addition of carrageenan treatment. The effect of different types of mangrove fruit flour did not show significant differences (Table 2).

The addition of carrageenan flour affects the cooking time. The higher the carrageenan flour concentration, the longer the cooking time will be. This result is possible because of the high water and fibre content contained by the noodles with the addition of carrageenan flour compared to the control because of its ability to bind water. According to Rahmi *et al*. (2018), cooking time is influenced by differences in the concentration of seaweed pulp. According to Husna *et al*. (2017), the more the addition of seaweed pulp, the longer the cooking time for the noodles. The seaweed pulp still contains fibre, which hinders the cooking process of the noodles. Cooking loss is one of the parameters to determine the quality of the noodles after cooking. Cooking loss is a test to find out how many raw noodles are lost due to the cooking process. Carrageenan has a high water binding ability or is a gelling agent because of its hydrophilic nature. Based on the results (Table 2), the higher the concentration of carrageenan will reduce the cooking loss value. Based on these results, it means that the addition of carrageenan flour can improve the quality of wet noodles by reducing the yield produced. According to Salma *et al*. (2018), the higher the addition of carrageenan, the lower the cooking loss value of the wet noodles. The possibility of low cooking loss is due to the high viscosity of carrageenan and its high gel strength, it takes a longer time to break down the starch molecules contained in the resulting wet noodles. The lower the cooking loss value, the better quality of the wet noodles (Ratnawati and Afifah, 2018). According to Setyani *et al*. (2017), the differences in the value of cooking loss are due to the amylose content of mangrove fruit flour as raw material. The higher the amylose level, the stronger the gel structure is formed. Table 2 shows that the higher the carrageenan concentration added, the higher the power dropping of the noodles. The results showed that commercial noodles made from wheat flour had the lowest power dropping. This is due to the presence of gluten which is owned by a protein that is not owned by wet noodles with raw materials of mangrove fruit flour and carrageenan. Irsalina *et al*.

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Table 2. Characteristics of mangrove noodles during cooking

Parameter	Formula									
	K0	B8	B12	B15	S8	S12	S15	A8	A12	A15
Cook Time (min)	8.8±1.56^{a}	5.5±1.60^{b}	7.6±0.80^{c}	9.5±0.10^{d}	6.5±1.70^{be}	7±0.20^{cf}	9±0.35^{g}	4.8±0.67^{be}	6.8±0.77^{gh}	8.9±0.59
Cooking loss (%)	12.67±1.42^{a}	13.67±1.42^{b}	11.67±1.42^{c}	10.78±1.56^{d}	13.89±1.22^{b}	12.7±1.42^{a}	8.60±2.51e	13.60±2.51^{b}	11.60±2.73^{c}	8.52±1.96^{e}
Power Dropping Noodles (%)	10.56±1.34^{a}	14.56±1.42^{b}	21.56±1.77^{c}	31.67±0.89^{d}	13.96±1.64^{be}	23.56±0.79^{f}	30.56±1.32^{g}	13.56±1.38^{be}	24.58±1.25^{fh}	29.56±1.34^{gi}
Water absorption (%)	0.87±0.005^{a}	0.91±0.01^{a}	1.14±0.01^{c}	1.43±0.03^{d}	0.96±0.02^{c}	1.16±0.01^{c}	1.26±0.01^{d}	0.92±0.01^{ab}	1.13±0.02^{c}	1.44±0.04^{e}

Values are presented as mean±SD. Values with different superscripts with within the same row are significantly different (p<0.05).

Table 3. The sensory analysis results of mangrove noodles

Parameter	Formula									
	K0	B8	B12	B15	S8	S12	S15	A8	A12	A15
Texture	4.25±0.06^{a}	4.5±0.60^{b}	5.6±0.80^{c}	3.56±0.10^{d}	4.60±0.88b^{e}	5.59±0.08^{c}	4.5±0.35^{b}	4.9±0.67^{be}	5.8±0.77^{g}	3.8±0.19^{h}
Colour	4.77±1.00^{a}	4.67±1.42^{ab}	4.87±0.42^{a}	3.78±0.06^{c}	4.81±0.32^{a}	4.78±0.42^{a}	4.60±0.5^{ab}	3.60±0.51^{d}	5.60±0.07^{e}	3.52±0.01^{f}
Taste	4.56±1.34^{a}	4.86±0.42^{b}	4.56±0.77^{a}	3.67±0.89^{c}	4.16±0.60^{d}	5.64±0.79^{e}	3.56±0.3^{cf}	3.57±0.8^{cf}	4.38±0.20^{g}	3.51±0.13^{cf}
Aroma	3.36±1.34^{a}	3.98±0.89^{b}	4.96±0.52^{c}	3.17±0.89^{d}	4.98±0.98^{c}	4.21±0.12^{d}	3.89±0.78^{be}	3.39±0.08^{a}	5.67±0.03^{f}	4.16±0.07^{g}

Values are presented as mean±SD. Values with different superscripts with within the same row are significantly different (p<0.05).

Table 4. Proximate analysis, fiber content, and antioxidant activity of wet noodles

Parameter	Formula									
	K0	B8	B12	B15	S8	S12	S15	A8	A12	A15
Water Content (%)	38±0.011^{a}	31.54±0.04^{c}	34.57±0.07^{d}	37.28±0.41^{a}	31.72±0.05^{c}	33.52±0.03^{e}	36.86±0.35^{g}	30.74±0.45^{b}	34.67±0.23^{d}	37.23±0.16^{a}
Fat Content (%)	1.58±0.01^{g}	1.37±0.02^{f}	1.27±0.02c^{d}	1.16±0.03^{b}	1.3±0.02^{de}	1.26±0.01^{c}	1.19±0.005^{b}	1.31±0.01^{e}	1.29±0.01^{cde}	1.12±0.03^{a}
Protein Content (%)	5.14±0.04^{a}	4.26±0.05^{bc}	4.35±0.01^{d}	4.28±0.01^{bc}	5.14±0.04^{a}	5.22±0.03^{b}	5.27±0.02^{bc}	5.05±0.04^{bc}	4.29±0.02^{cd}	5.00±0.01^{bc}
Ash Content (%)	5.73±0.04^{a}	5.9±0.01^{b}	6.88±0.02^{e}	7±0.01^{e}	5.84±0.02^{d}	6.72±0.02^{c}	6.85±0.04^{e}	5.83±0.04^{d}	6.69±0.09^{c}	6.83±0.03^{e}
Carbohydrate Content (%)	30.1±0.04^{f}	34.48±0.05^{a}	31.58±0.10^{b}	30.18±0.08e	33.95±0.05^{a}	32.03±0.85^{bc}	31.53±0.41^{de}	33.56±0.01^{a}	32.51±0.40^{c}	30.68±0.38^{d}
Fibre Content (%)	10.45±0.11^{a}	15.30±0.22^{c}	17.56±0.11^{e}	18.25±0.05g	15.48±0.18^{c}	16.67±0.11^{f}	17.88±0.30^{b}	14.44±0.30^{b}	16.66±0.09^{d}	18.63±0.03^{h}
Antioxidant Activity (%)	252.66±3.78^{a}	264.33±3.5^{1b}	275.00±4.0^{c}	294.33±4.04^{e}	266±5.5^{b}	284.33±3.51^{d}	296±3.0^{e}	260±0.5^{b}	276.74±1.27^{c}	293.60±3.41^{e}

Values are presented as mean±SD. Values with different superscripts with within the same row are significantly different (p<0.05).

(2016) state that the protein content in the flour is correlated with the texture of the noodles because the processing of dry noodles with heat cause the protein to denature and the protein become rigid. This rigid protein makes the texture of the noodles hard, and the force required to break the noodles is high. In addition, Rahmi *et al.* (2019) reported that the addition of 1% carrageenan to the noodle formula can improve the power dropping of Moringa noodles.

The results showed that the variation of carrageenan concentration gave a significant difference in the absorption power of the resulting mangrove noodles. The absorption power of carrageenan noodles is higher when compared to control noodles. The results of the water absorption test showed that the higher the addition of the carrageenan flour concentration, the higher the absorption capacity of the noodles.

3.2 Sensory analysis

Based on the results (Table 3), shows that the texture value has a significant difference ($P<0.05$) to the addition of carrageenan flour. The different types of mangrove fruit flour did not have a significant effect ($P<0.05$) on the texture value. The relationship between the addition of carrageenan flour and the texture value is that the higher the addition of carrageenan, the chewier the texture is, and the panellists favour it, but to a certain degree, the texture tends to be disliked by the panellists (3.56±0.10). According to Ratnawati and Afifah (2018), Gum/hydrocolloid is widely used in starch-based products to increase stability, modify texture, and facilitate processing. Hydrocolloids used in the formulation of gluten-free food products come from various sources such as seeds, fruit, plant extracts, seaweed, and microorganisms. The hydrocolloid protects the starch granules against stirring during cooking and improves the product's texture. According to Ba'ari *et al*. (2020), one of the factors and mechanisms of texture formation is the heating process and the duration of cooking, where when boiling occurs the starch gelatinization process and protein coagulation make the chewy texture of the wet noodles.

In terms of colour parameters, it shows that the mangrove fruit flour noodles are less preferred by panellists. This may be because the colour of the mangrove noodles tends to be darker than the control. The noodles produced by the control using wheat flour as raw materials tend to give a brighter colour than the control. According to Jaziri *et al*. (2018), the low degree of whiteness in the seaweed flour used causes the colour of the dry *Euchema cottonii* noodles to be a darker colour. Following the opinion of Santoso *et al*. (2006), the decrease in the value of this colour is due to the low value of the degree of whiteness in the seaweed flour so that the colour of the dry noodles becomes darker yellow.

Based on the results (Table 3), the taste has a significant effect on the addition of mangrove fruit flour, panelists prefer mangrove fruit flour noodles with the addition of carrageenan concentration by 12%. The addition of carrageenan flour does not affect the resulting taste because carrageenan has no specific taste. According to Nurhuda *et al*. (2017), the addition of carrageenan flour did not affect the taste of the sea catfish meatballs, presumably because carrageenan flour had a neutral or bland taste it did not affect the taste of the resulting sea catfish meatballs. Based on Table 3 shows that the higher the addition of carrageenan concentration, the taste parameter value will decrease, the results of this study are in line with the research of Atiqoh *et al*. (2021), the more seaweed is added, the tasteless it will be.

The aroma produced by mangrove fruit noodles shows a significant difference ($P<0.05$), the aroma produced by wet noodles tends if more carrageenan flour is added, the noodles will be more preferred, but if too much carrageenan flour is added, aroma tends to be disliked by the panellist. This is probably because the texture is too rigid/stiff, which affects the perception of the taste of wet noodles. According to Kaudin *et al.* (2019), the quality of taste reception is influenced by texture, namely smoothness, thickness, elasticity, and hardness. With the higher concentration of carrageenan, the panellists liked the wet noodle taste, because carrageenan can form a gel in making wet noodles.

3.3 Moisture content

There is a significant difference ($P<0.05$) in the value of water content with the treatment of different carrageenan concentrations (Table 4). The treatment using different types of mangrove fruit flour did not show a significant difference ($P<0.05$) in the water content. The results showed that the higher the concentration of carrageenan affects higher the water content value. Carrageenan flour is a gelling agent that has hydrocolloid properties produced from the ingredients of red seaweed. According to Waqiah *et al*. (2019), the higher the concentration of seaweed addition, the water content also increases, this is because seaweed has properties that can trap (adsorb) water in the wet noodle mixture. Carrageenan is a hydrocolloid compound that can bind water. According to Gomez-Guillen *et al*. (2006), the value of high water binding capacity is due to carrageenan swelling, thereby increasing elasticity by reducing water content and increasing density around the protein matrix. If the water

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holding capacity of carrageenan is high, it will hold water in the formed matrix space.

3.4 Ash content

Table 4 shows that there is a significant difference (P<0.05) in the value of the ash content with the treatment of different carrageenan concentrations. The treatment using different types of mangrove fruit flour did not show a significant difference (P<0.05) in the ash content. The results showed that the higher the concentration of carrageenan, the higher the ash content of the noodles. According to Kaudin *et al*. (2019), the more carrageenan added can increase the mineral content in wet noodles. Santoso *et al*. (2003) reported that the high mineral content in seaweed is due to the adaptation to marine environmental conditions that contain various minerals with high concentrations.

3.5 Protein content

The results showed that the variation in carrageenan concentration gave different protein values to the mangrove noodles. Based on the data (Table 4), the value of protein content with the treatment of variation carrageenan concentrations showed significant results (P<0.05). The protein content of mangrove noodles tends to be lower than the control noodles. The high protein content of noodles in the control was caused by wheat flour-based noodles containing gluten. While the noodles with the basic ingredients of mangrove fruit flour and the addition of carrageenan flour have higher carbohydrate content than protein, this is possible that the content with the basic ingredients of mangrove fruit flour is richer in fibre, carbohydrates, and antioxidants. According to Abubakar (2011), protein content is influenced by the amount and type of flour used as raw material as well as the protein content of the additives used. In this case, carrageenan does not affect protein levels in wet noodles because it is a polysaccharide.

3.6 Fat content

Fat content values treated with different carrageenan concentrations showed significant results (P<0.05). The fat content of mangrove noodles is lower than control noodles. The results of this study are the same as the results of research by Kaudin *et al*. (2019), that carrageenan addition affects the reduced fat content of wet noodles. Added by Nugroho *et al.* (2014) in their research said that the addition of carrageenan shrimp meatballs with a concentration of 8% of 0.22% showed that the addition of carrageenan decreased fat content of shrimp meatballs.

3.7 Carbohydrate content

The results showed that the difference in carrageenan concentrations gave different carbohydrate values to the mangrove noodles (Table 4). The carbohydrate content of mangrove noodles tends to be higher than control noodles. The results of the carbohydrate content test showed that the higher the addition of carrageenan flour concentration, the lower the carbohydrate value. This is in line with the research of Nafiah *et al*. (2012), where fat and carbohydrate levels will decrease with the greater concentration of carrageenan that is added.

3.8 Fibre content

The value of fibre content with the treatment of different carrageenan concentrations showed significant results (P<0.05) (Table 4). The results of the fibre content test showed that the higher the addition of carrageenan flour concentration, the higher the fibre content value. Carrageenan is a commercial hydrocolloid compound from red seaweed (*Rhodophyceae*) which is widely used in food and industrial products such as in the manufacture of chocolate, milk, pudding, instant milk, canned food, and bread. Carrageenan can change the desired functional properties of the product. Some of the roles of carrageenan in food products include emulsifying, stabilizing, gelling, and coagulating. *E. cottonii* is a carrageenan producer that has high fibre content. Usual wet noodles are produced from wheat flour as raw material but lack fibre content (Billina *et al*., 2014). The addition of seaweed in making wet noodles can increase the total food fibre content (Murniyati *et al*. 2010).

3.9 Antioxidant activity

The antioxidant activity of mangrove noodles tends to have a higher value of antioxidant activity compared to control noodles (Table 4). The results of the antioxidant activity test showed that the higher the addition of carrageenan flour concentration would increase the antioxidant value. According to Harsyam *et al.* (2020), carrageenan extracted from red seaweed *E. cottoni* has high antioxidant content. Carrageenan has more hydroxyl groups which can form a double helix structure that is also higher and can protect antioxidant compounds in the three-dimensional matrix of the heat during cooking and of oxygen. In addition, the higher antioxidant activity value was also influenced by the raw materials used, namely mangrove fruit flour, which is rich in antioxidants. According to Nawaly *et al*. (2013), antioxidant compounds derived from seaweed extract are important compounds in protecting cells against free radicals. The application of seaweed extract in human

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and fish food can increase the antioxidant value of these foods which can function to maintain food nutrition and provide health impacts for consuming subjects.

After all, based on the results of the proximate analysis of mangrove fruit flour in (Table 5) shows that the composition of mangrove fruit flour produced by the four species of mangrove fruit is similar to wheat flour. The resulting mangrove fruit flour is richer in fiber and antioxidants than wheat flour. However, it has a lower protein content when compared to mangrove fruit flour. This is because mangrove fruit flour does not have gluten like wheat flour. Based on the characteristics presented in (Table 5), shows that mangrove fruit flour has the potential to be used as a substitute for wheat flour.

4. Conclusion

Based on the results of the study, the addition of variations in the concentration of carrageenan flour in wet noodle products using different types of mangrove fruit flour gave significantly different results ($P<0.05$) on several test parameters, namely testing the proximate value, crude fibre content, antioxidant activity, water absorption, cooking time, breaking strength of noodles, cooking loss, and sensory testing. The best treatment that affected the sensory and nutritional characteristics was wet noodles with the addition of mangrove fruit flour *S. caseolaris* and 12% carrageenan. The addition of carrageenan flour affected the physical and sensory properties of mangrove flour noodles. In addition, the use of mangrove fruit flour has the effect of increasing the nutritional characteristics and antioxidant activity of noodle products.

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Table 5. Nutritional characteristic of mangrove fruits flour

No	Parameter	Sample			
		B. gymnorrhiza Flour	*S. caseolaris* Flour	*A. marina* Flour	Control
1	Water Content (%)	11.88±0.08	10.59±0.10	9.78±0.10	11.67±0.01
2	Fat Content (%)	1.88±0.10	1.56±0.01	0.91±0.22	1.33±0.08
3	Protein Content (%)	6.71±0.20	8.84±0.06	4.78±0.71	9.95±0.56
4	Carbohydrate Content (%)	76.75±2.15	74.67±0.23	73.78±0.67	82.78±0.10
5	Ash Content (%)	5.01±0.13	5.20±0.03	4.48±0.05	0.51±0.05
6	Fibre Content (%)	8.09±0.53	9.23±0.76	7.90±0.08	2.01±0.05
7	Antioxidant Activity (mg/L)	169.25±0.05	177.21±0.10	170.12±0.24	53.1 ±0.03

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