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Application of refined carrageenan (RC) in the non-gluten crispy fish seaweed product processing

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Abstract. Crispy fish seaweed is an innovative fisheries product. The chance to meet such expectation is high because, in crispy fish seaweed, two ingredients namely wheat flour as gluten and almond powder as vegetable protein are replaced by more nutritious component namely cornstarch as non-gluten, catfish meat as fish protein and refined carrageenan as an additive. This research aimed to find the best formula of crispy fish seaweed, through a series of modifications to the ingredient composition, associated with their characteristics and the property of the resulting product using web diagram sensory method. The results showed that the best formula is: 200 g catfish meat, 10 g margarine, 1 egg, 20 g cornstarch, 1 g cake emulsifier, 1 g carrageenan, 0.5 g salt, and 6 g garlic. The formula gives a sensory value of appearance 9, smell 9, taste 9, texture 9, crunchy 9. Other characteristics of the formula are: moisture content of 1.5%, 3.7 % ash, 54% protein, 11.6% fat, 29.6% carbohydrate, TPC 1.8×10^2 , negative yeast, and total energy of 329.1 Kcal. This research also recommends a packaging and label design which is in accordance with the Indonesia Law No 7 of year 1996.

Keywords: crispy, fish, non-gluten, refined carrageenan, seaweed

1. Introduction

Seaweed is one of Indonesia's fishery commodities that is quite potent as a foreign exchange earner. Based on statistical data from the Ministry of Maritime Affairs and Fisheries (MMAF), the total domestic seaweed production reaches 15.6 tons in 2017 [1]. Carrageenan is a compound that belongs to the polysaccharide group extracted from seaweed. Most carrageenan contains sodium, magnesium, and calcium which can be bound to sulfate ester groups from galactose and 3,6-anhydro-galactose copolymers. Carrageenan has an important role as a stabilizer (balance regulator), thickener, gelling agent, emulsifier, and others. This property is widely used in the food industry, medicine, cosmetics, textiles, paint, toothpaste, and other industries [2].

Catfish meat has a high calorie and protein content, the taste of the meat is distinctive, tasty and savory so that it is popular to the public. Catfish is considered safe or health because of low cholesterol levels compared to livestock meat. *Pangasius hypophthalmus* catfish is a freshwater fish that has high economic value to be developed [3]. Nutrient content of catfish is 7.51% protein, 6.57% fat, and 75.21% water [4].

Crispy fish seaweed is an innovative product that was initiated to take advantage of excellence and improve the weaknesses of similar products that have been on the market namely crispy almond cheese.



The advantage in question is a large and broad market including children. The opportunity to meet these expectations is very high because, in the crunchy seaweed, two ingredients, namely wheat flour as gluten and almond powder as vegetable protein are replaced by more nutritious components, namely cornstarch as non-gluten, catfish meat as fish protein and processed carrageenan as an additive.

This study aimed to determine the best formulation of crispy fish seaweed manufacturing process based on sensory web diagram analysis, crispy fish seaweed quality, nutrition adequacy number, and label and packaging design planning.

2. Materials and Methods

2.1. Flow of crispy fish seaweed making process

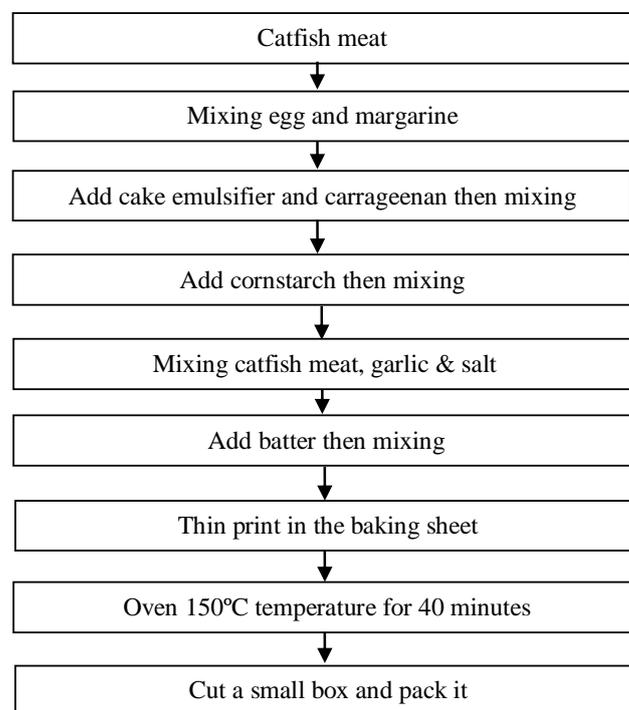


Figure 1. The flow of crispy fish seaweed production process [5].

Processing of crispy fish seaweed was done by preparing the ingredients to be used. Put margarine and eggs in the mixer until it expands. Add cake emulsifier then mix again until the mixture is well mixed. Add carrageenan and cornstarch then mix them for a while. Mix the catfish meat, garlic, salt and mix using a food processor. Add the mixture that has been mixed and stir briefly. Rub the pan with margarine and sprinkle the flour until smooth. Print thin thickness dough. Then do oven at 150°C for 30 minutes. Cut the dough with a pizza cutting knife. Then oven again for 10 minutes. Store in tightly closed packaging.

2.2. Determination of initial formula of crispy fish seaweed

This crispy fish seaweed formula refers to the recipe for crispy almond cheese [5]. The ingredients used for the manufacture of crispy almond cheese were wheat flour 150 g, almond cheese 50 g, margarine 100 g, egg white 4 grains, salt 0.25 g, 100 g of refined sugar, 0.25 g of vanilla extract, almond flake for sprinkling, grated cheese for sprinkling. Based on the recipe then modifications are made with the addition of crushed and carrageenan fish and the reduction of unnecessary ingredients as shown in table 1.

Table 1. Formulation of crispy fish seaweed formulation [5].

Material	Formulation						
	1	2	3	4	5	6	7
Catfish meat (g)	50	50	100	100	200	200	200
Margarine (g)	50	50	50	10	10	10	10
Egg (item)	1	1	2	1	1	1	1
Cornstarch (g)	10	10	20	20	20	20	20
Cake emulsifier (g)	-	0.5	1	1	1	1	1
Carrageenan (g)	0.25	0.25	1	2	4	2	1
Salt (g)	0.25	0.25	0.5	0.5	0.5	0.5	0.5
Garlic (g)	3	3	6	6	6	6	6

2.3. Determine the formula selected by the trial based on the characteristics of the material used

The selected formula is determined by making the product based on the reference to the initial recipe for modified crispy almond cheeses. The initial formula made was then tested by hedonics to the panelists. Based on the values that have been obtained from the panelists, then the prescription is improved based on the characteristics of the ingredients used. Making recipes is done to get the best formula evaluation by panelists.

2.4. Crispy fish seaweed quality testing

2.4.1. Hedonic test. Hedonic testing is an assessment of product preferences tested by panelists. This hedonic test is designed to measure the best products from several products compared through several parameters such as appearance, taste, smell, texture, and crispness. Panelists assess the product using a score sheet as a guide in an assessment. The method of testing the sample is through a hedonic test which is based on the panelist's assessment level. The number of panelists is 6 trained panelists. Assessment based on appearance, taste, smell, texture and crispness. Panelists' assessment results for each parameter are then summed up and divided by the number of panelists to obtain an average value. Then the product results are discussed with descriptive analysis.

2.4.2. Chemical composition measurement.

a) Measurement of moisture content

Water molecules are removed by heating with a non-vacuum oven at 105°C-110°C for 5-24 hours. Determination of the weight of water is calculated gravimetrically (1) based on the difference in weight of the sample before and after the sample is dried [6].

$$\% \text{ moisture content} = \frac{\text{sample} - (C-A)}{(C-A)} \times 100\% \quad (1)$$

b) Measurement of ash content

The sample is oxidized at 650°C in an ignition furnace for 8 hours or until it has white ash. Determination of ash content (2) was calculated gravimetrically [7].

$$\% \text{ ash content} = \frac{B-A}{\text{sample weight (gr)}} \times 100\% \quad (2)$$

c) Determination of protein content

Nitrogen compounds are released from meat tissue through destruction using concentrated sulfuric acid with the help of heat at 410°C for ± 2 hours (until a clear solution is obtained) in which nitrogen-bound compounds by sulfate form ammonium sulfate. Then ammonium sulfate is converted to basic salt NH₄OH with the addition of NaOH. NH₄OH is distilled using steam heat to separate ammonia compounds. Ammonia is captured by boric acid to form ammonium borate and then titrated with hydrochloric acid. Determination of the amount of nitrogen is calculated by stoichiometry and protein content is obtained by multiplying the amount of nitrogen by the conversion factor [8].

d) Measurement of fat content

A sample of 2 g is weighed and wrapped in filter paper and placed on a Soxhlet extraction device mounted above the condenser and the bottom squash. The hexane solvent is poured into a 75 mL fat flask according to the size of the soxhlet used and do it for at least 16 hours until the solvent drops again. The fat flask is then cooled in the desiccator for 5-10 minutes and weighed [9].

e) Measurement of carbohydrate by different

The carbohydrate content of crispy fish seaweed product is calculated by the calculation of difference, by subtracting 100% with the total value of water content, ash content, protein content, and fat content.

2.5. Microbiology testing

Crispy fish seaweed samples were tested for Total Plate Count (TPC) whether the carrageenan produced was feasible or not in terms of the total content of microorganisms contained therein [10]. As well as testing molds in accordance with the standards of dry food products. Mold counted using [11].

2.6. Calculating nutrition adequacy figures

The step of calculating the RDA based on the proximate results is as follows. The first step is to calculate the amount of protein, fat, and carbohydrates in 100 g of ingredients. Water, ash, and there is no AKG standard because it contains almost no calories. The second is to calculate the amount of protein, fat, and carbohydrates in 1 package. In 75 g packaging, the proximate result is multiplied by 75 divided by 100. Then calories were calculated from the third number of macronutrients by confirming 1 g of carbohydrate 4 Kcal, 1 g of protein 4 Kcal, 1 g of fat 9 Kcal. The proximate results are multiplied by the standard of confers then calculated the total number of calories. Look for calorie standards for adults. Average calorie needs for adults 2,000 Kcal to 2,200 Kcal, by division. Protein 10-15% (used for 15% standard), Fat 10-25% (used for standard 17.5%), Carbohydrates 60-75% (used for standard 67.5%). After that, RDA were calculated on the product material with formula (3).

$$\text{Formula} = (\text{Kcal material} / \text{Kcal macronutrient standard, referring to 2,000 Kcal}) \times 100\% \quad (3)$$

2.7. Designing label and packaging designs

On the packaging label, especially for food and beverages, the following are stated at least: Product name, list of ingredients used, net weight or net contents, name and address parties who produce or put food into the territory of Indonesia with information about *halal* date, month and year expiring [12].

3. Results and Discussion

3.1. Determination of the best formulation

Crispy fish seaweed was processed by referring to the modified formula of crispy almond cheese [5]. The ingredients used for the manufacture of crispy almond cheese are wheat flour 150 g, almond powder 50 g, margarine 100 g, egg white 1 grain, salt 0.25 g, refined sugar 100 g, 0.25 g vanilla extract, almond flake for sprinkles, grated cheese for sprinkles. Product modification is done by replacing almond powder with fish flesh and replacing wheat flour with cornstarch in order to eliminate the gluten content of the product, vanilla extract is replaced with garlic to neutralize fishy fish odor and add thickener and carrageenan. The manufacturing process is carried out by making the first formulation that has been determined and then performed a hedonic test by trained panelist Ocean Fresh. From the results of hedonic products based on panelists' assessment, the results of descriptive observations and corrective actions were concluded. Corrective action is carried out by adding or reducing materials used based on the characteristics of the material. The best formula is formula 7 based on table 1.

Hedonic testing is done with the appearance, odor, texture and crispness parameters. Parameter assessment uses numbers 1 through 9. The description of the assessment is 1= very strongly dislikes, 2= very dislikes, 3= dislikes, 4= somewhat dislikes, 5= neutral, 6= somewhat likes, 7= likes, 8= really likes, 9 = very likes. The results of the hedonic assessment are illustrated in the following sensory web diagram:

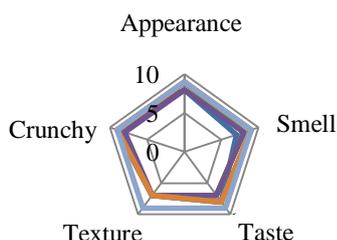


Figure 2. Web sensory diagram of crispy fish seaweed formula (— formula 1; — formula 2; — formula 3; — formula 4; — formula 5; — formula 6; — formula 7).

3.2. Crispy fish seaweed quality test results

Chemical composition measurements of crispy fish seaweed includes water, ash, fat, protein, and carbohydrate content. While microbiological quality testing included TPC and mold. Crispy fish seaweed chemical and microbiological testing results can be seen in table 2.

Table 2. Quality testing for crispy fish seaweed.

Parameter	Results	SNI Fish crackers	SNI Tempe chips
Content moisture	1.5%	Max. 12	Max. 3
Total ash	3.7%	-	Max. 3
Protein	54%	Mix. 12	Max. 20
Fat	11.6 %	-	-
Carbohydrate	29.6 %	-	-
TPC	1.8×10^2 col/g	10^4	Max. 0.5
Mold	Negative	-	-

3.2.1. Moisture. Water content is important on the quality of food so that in the process of processing and storing food, water needs to be removed. Determination of water content aims to determine the maximum or range of the amount of water content in the material [13, 14]. Based on the results of testing the crispy fish seaweed water content of 1.5%. One of the factors that play a role in decreasing water content is the heating process, namely steaming, drying. High temperatures cause fish dough crackers such as the water content will decrease due to some of the existing water will evaporate. Processing with high temperatures will cause the water contained in the product to shrink, the water content in the product will decrease and the use of high temperatures will also affect the appearance of the product after processing [15].

3.2.2. Ash. Ash content or mineral content is the residue left behind if a sample of food ingredients is burned completely in an ignition furnace. This ash content describes the number of minerals that do not burn into substances that cannot evaporate. Ash content also determines the presence or absence of minerals in a food ingredient. Mineral content is needed in small amounts in the work process of the body [16]. Based on the results of testing the ash content, the obtained result is 3.7%. The ash content shows the mineral content of the product. Ash is an organic residue from burning organic matter [17]. Usually, these components consist of calcium, sodium, iron, manganese, and magnesium. In determining ash content, organic matter is burned while inorganic materials are not burned. Most of the food ingredients, which are about 96% consist of organic matter and water. The rest consists of mineral elements.

3.2.3. Protein. Protein is a substance that is very important for the body because this substance besides functioning as fuel in the body also functions as a building agent and regulator. Protein is a source of amino acids that contain elements of C, H, O, and N that are not owned by fat or carbohydrates. Protein molecules also contain phosphorus, sulfur, and there are types of proteins that contain metal elements such as iron and copper [18]. Based on the results of protein testing, the value of 54% was obtained. The high protein levels due to the amount of fish concentration added to the product.

3.2.4. *Fat*. Fat and oil are the densest energy sources, producing 9 kcal for each gram, which is 21/2 times the amount of energy produced by carbohydrates and proteins in the same amount. Fat slows gastric acid secretion and slows gastric emptying, so fat gives a longer feeling of fullness. Besides that, fat gives a preferred texture and gives special delicacy to food [19]. Fat content testing results obtained a value of 11.6%. The effect of adding fish meat to the processing of fish cracker products can add fat to the product [20].

3.2.5. *Carbohydrates*. Carbohydrates are the main energy source in most foods. Forms of carbohydrates that can be digested in foodstuffs are generally starch and various types of sugars such as glucose, sucrose, fructose, and lactose, while cellulose, pectin, and hemicellulose are available in sufficient quantities, but not digested. Starch is a store of carbohydrates in plants and is the main carbohydrate eaten by humans throughout the world. Starch is mainly found in grains, and tubers. Corn rice and wheat contain 70-80% starch; dried beans such as soybeans, red beans, and green beans (30-60)%, while sweet potatoes, taro, potatoes, and cassava (20-30)% [19]. Carbohydrates contained in crispy fish seaweed products by the by difference method is by reducing 100% to the percentage of water, ash, protein and fat content [21]. Carbohydrate testing results obtained a value of 29.5%.

3.3. *Nutritional adequacy of crispy fish seaweed*

The nutritional adequacy rate (NAR) of the product were also measured. The NAR of the crispy fish seaweed product can be seen in table 3.

Table 3. Nutrition adequacy rate.

Serving size 1 package (75 g)		
Amount of servings per package 1		
AMOUNT OF PER PAYMENT		
	Total energy is	
	329.1 kcal	
	Energy from	
	78.3 kcal fat	
		% NAR
Protein	40.5 g	54
Fat	8.7 g	22.3
Carbohydrate	22.2 g	6.5
% NAR is based on the number of energy needs of 2000 kcal		
Your energy needs may be higher or lower		

3.4. *Designing label and packaging designs*

The packaging design shown in figure 3. This Secondary and premium packaging is in the form of a box that adapts to the primary packaging. This package uses ivory packaging material with a thickness of 1 mm so that it can protect its contents from impact and damage that can make the product destroyed. This pouch packaging model can be displayed on the stand so as to facilitate the arrangement on the sales shelf. The paper that is safe to use as a type of food packaging paper. This type of paper has 2 white sides with different textures. One side is smooth textured and the other side is a bit tight like HVS. Usually used for boxes or packaging because they are quite thick and sturdy. The thing that makes this paper more enthusiastic is the "Exclusive" impression. The use of this paper is now in great demand.



Figure 3. Packaging design planning.

Especially in the process of making food box or paper bag. In addition to the thickness, this paper also turns out to be one type of food grade paper (not harmful to food consumed). Standard paper for printing with offset machines and digital print with semi-shiny and smooth front and rear surfaces. This Art paper is perfect for all types of full color/color separation. To add an elegant impression to the mold can be added with doff laminating, laminating glossy and UV print (Ultra Varnish). Based on its function, packaging has a variety of functions, namely protection function or product protection, security function which means that the material used does not pollute the contents of the product, the marketing function is that the packaging is able to answer the aspirations of consumers [22]. Based on the design of the label and packaging design above it is expected that it might be used as a reference by CV ocean fresh in designing packaging for crispy fish seaweed products.

4. Conclusion

The process of making crispy fish seaweed includes dozing of fish meat, mixing of ingredients that are mixed, printing, oven, cutting and packaging. The best formula test results from sensory diagram web analysis are 200 g catfish, 10 g margarine, 1 grain egg, 20 g cornstarch, 1 g SP, 1 g carrageenan, 0.5 g salt, garlic 6. Crispy fish seaweed quality test results which are 1.5% water content, 3.7% ash content, 54% protein, 11.6% fat, 29.6% carbohydrate, TPC 1.8 x 10², negative mold. The results of the calculation of the number of nutritional adequacies in crispy fish seaweed is a total energy of 329.1 kcal. Design of label design and packaging in accordance with Indonesian Law No. 7 of 1996.

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