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Chemical and Sensory Characteristics of *Flakes* Made from Seaweed (*Eucheuma cottonii*) and Soybean (*Glycine max* (L.) Merill)

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Abstract. Nowdays, food consumption pattern has change and demands practicality without compromising nutritional fulfillment. Therefore flakes are produced, which can support today's consumption pattern and take advantage of Indonesia's marine product. Seaweeds that are high dietary food can be combined with protein from soybean. This study aims to find out the effect of seaweed and soy flour concentration toward chemical and sensoric properties of flakes. The experimental design used is Completely Randomized Design. The data were analyzed using ANNOVA and proceeded with Duncan's Multiple Range Test. The best flake was found in the treatment with seaweed and soybean concentration of 2:1.
Keywords: seaweed, soybean, flakes

1. Introduction

Indonesia is a country with abundant natural resources, especially from marine and fisheries products. Total domestic production of seaweed has reached 11 million tons (Statistical Data from Ministry of Maritime Affairs and Fisheries, 2016). The abundant commodities also come from agriculture, including soybeans. According to the statistical data from Ministry of Agriculture, soybean production in Indonesia reached 954,000 in 2014.

Seaweed contains good nutrients for the body. It is also a good source of nutrition and mineral (Yunizal, 2004). Dietary fiber in seaweed is satiating and helping the body metabolism process. Soybean is a source of protein and fat as well as vitamins A, E, K, several types of vitamin B, and mineral K, Fe, Zn and P (Health Department RI, 2004).

The abundant local food source in Indonesia is potential to develop as flakes product diversification in order to maximize the production and consumption of local comestibles, which are non-rice and non-flour carbohydrate source (Hildayanti, 2012). As a ready-to-eat breakfast food product, flakes should contain nutrition standard as breakfast foods that are commonly made from the sources of protein, carbohydrate in the form of starch, fiber, vitamin, and mineral (Supartono, 2006).

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Based on the explanation above, this study was conducted on the chemical and sensoric characteristics of flakes made from *Kappaphycus alvarezii* seaweed as high fiber source and soy bean (*glycine max (L.) Merill*) as high protein source.

2. Method

2.1. Time and place

This study was conducted at Educational Laboratory of the Faculty of Fisheries and Marine Universitas Airlangga, Surabaya**.** Proximate analysis on the raw material and flakes product was conducted in Feed Laboratory of the Faculty of Veterinary Universitas Airlangga, Surabaya in April 2017.

2.2. Tools and material

The tools used in this study were stainless steel knives, mixers, ovens, noodle milling, grinders, sieves, baking sheets, spoons, plastic containers, pans, scales, stoves, stopwatches, bowls and thermometers, measuring cups. The tools used in the analysis of nutrient content included alumium plates, porcelain saucers, ovens, furnaces, desiccators, condensors, soxhlets, Kjedahl flasks, distillation devices, erlenmayer flasks, volumetric flask, measuring cups, hotplates, burettes, pipettes, filter paper, and tongs. In addition, for organoleptic and acceptance testings of flakes, questionnaires and plates were used.

The main ingredients used in this study were wet seaweed purchased from Sumenep (Madura) and powdered dried soybean, while the additional ingredients were sugar, water, vanilla, aluminum foil, tissue, and label paper. The materials used for chemical analysis included aquadest, 40% NaOH, kjedahl tablets, pp indicators, methyl red indicators, 3% boric acid, 0.10 N HCl, aquadest, petroleum ether, boiling H2SO4 solution, boiling NaOH, 10% K2SO4, alcohol 95%, litmus paper, coarse filter paper, and fine filter paper.

2.3. Procedure

2.3.1. Formula design

The formula of flakes consisted of three substitution levels of seaweed and soy flour, with the ratio of seaweed: soy formulated as follows: P1 1:1, P2 2:1 and P3 1:2. The amount of seaweed used in each formula was 140 grams, which was the substitution of the amount of arrowroot starch used in a study by Chairil (2014).

2.3.2. Mixing

Seaweed and soy flour were weighed according to the proportions (1:1, 2:1, and 1:2), and then were mixed with other ingredients such as sugar, salt, tapioca flour, and water until they became homogeny. Afterwards, the mix was stirred until dull.

2.3.3. Steaming

The mix was steamed for three minutes at the temperature of 70°C in order to increase the preservative characteristic, food quality, suitability, or endurance after the cooking due to gelatinization process.

2.3.4. Dough flattening

The steamed dough was made into sheets using dough sheeter with the thickness of ±0.5 mm. During the making of the sheets, the dough experienced pressure, air release, consistency change, and increased density.

2.3.5. Molding

The flattened dough then was molded and shaped in the size of 2 x 2 cm.

2.3.6. Baking

After molded and shaped, the flakes were baked using oven for 30 minutes at the temperature of 150°C. The baking was aimed to create porous texture, reduce water content, and change the color appearance due to Maillard reaction and caramelization.

2.3.7. Research variables

The flakes produced then observed for their chemical characteristics, such as carbohydrate level (by difference), protein level (AOAC, 2005), fat level (Soxhlet) and crude fiber content (AOAC, 2005). Sensoric characteristics, including flavour, aroma, colour and texture, were also observed using oganoleptic test.

2.3.8. Data Analysis

The data obtained were processed using Analysis of Variance (ANOVA) and then followed by Duncan's Multiple Range Test (Kusriningrum, 2012). The result of descriptive analysis was obtained from organoleptic test.

3. Result and discussion

3.1. Proximate test

Proximate analysis was conducted to find out the chemical characteristics of three types of flakes by adding seaweed and soy flour and, as the comparison, arrowroot starch flakes and soy protein isolates flakes. The result of proximate test on the flakes with the addition of seaweed and soy flour compared according to the standard (SNI-01-4270-1996) is presented in Table 1.

Table 1. The result of proximate test on flakes by adding seaweed and soy flour according to the standard.

Parameter (%bb)	**Treatment**				**Standard (%)**	
	P0 %	**P1 %**	**P2 %**	**P3 %**		
Protein	15.4304^{b}	16.1271^{b}	8.8236^{a}	17.7223^{c}	5 at Minimal	SNI 01-4270-1996
Fat	6.3650^{b}	0.7793^{a}	1.6482^{a}	8.3813^{c}	7 at Minimal	
Crude Fiber	16.1180^{a}	16.0880^{a}	20.7367^{b}	16.0603^{a}	5 at Minimal	
Carbohydrate	71.1133^{b}	74.7605^{c}	77.8755^{d}	66.4124^{a}	60 at Minimal	

Description: P0: Comparison, P1: Treatment with the ratio 1:1 for seaweed:soy flour, P2: PTreatment with the ratio 2:1 for seaweed:soy flour, P3: Treatment with the ratio 1:3 for seaweed:soy flour. Different letter notations within the same colums indicates a significant difference between treatments ($p<0.05$).

3.1.1. Protein

The result of One Way ANOVA on the mean of protein indicates a significant difference significance level of 5% ($p<0.05$). According to the results of Duncan's Multiple Range Test, the mean of protein in P0 was not much different from P1, but differed significantly from P2 and P3. The mean of protein in P2 differed significantly from P0, P1 and P3. The mean of protein in P3 differed significantly from P0, P1 dan P2.

The protein levels in the treatments P0, PI, P2, and P3 were 15.4304%, 16.1271%, 8.8236%, and 17.7223% respectively. The highest protein level was in treatment P3 (ratio of 1:2 for seaweed:soy flour) with 17.7223%. Meanwhile, the lowest protein level was in treatment P2 (ratio of 2:1 for seaweed:soy flour) yaitu 8.8236%. The flakes product has met the protein content standard according to SNI 01-4270-1996.

The result of this study shows that the increased percentage of soy flour addition affects protein content value produced. The higher amount of soy flour used in the flakes formula increases the flakes' protein level value. It is because soy flour is a protein source used in the making of the flakes. Adisarwanto (2005) stated that soybean is one of the potential plant protein sources to develop due to the high levels of protein and fat, i.e. 49% and 21%. Amino acid and peptide content in soy flour will also affect the protein level (Wahyuni, 2009).

3.1.2. Fat

The result of One Way ANOVA showed a significant difference of the mean of fat with significance level of 5% ($p<0.05$). The result of Duncan's Multiple Range Test shows that the mean of fat in P0 differed significantly from P1, P2 and P3. The mean of fat in P1 did not differ significantly from P2, while in P0 and P3 there was a significant difference. The mean of fat in P3 differed significantly from P0, P1 and P2

The fat level in the treatments PI, P2, and P3 were 6.3650%, 0.7793%, 1.6482%, and 8.3813% respectively. The highest level of fat was in P3 (ratio of 1:2 for seaweed:soy flour) with 8.3813%. Meanwhile, the lowest level of fat was in P1 (ratio of 1:1 for seaweed:soy flour) with 0.7793%. The result of this study shows that only the flakes product in treatment P3 has met the standard according to SNI 01-4270-1996 for cereal milk, i.e. 7% at minimal. The flakes in treatments P0, P1, and P2 failed to meet the SNI standard for cereal milk.

The higher soy flour level in flakes leads to higher fat level as well. This corresponds with an argument from Iriyani (2012) that the increased flour percentage will significantly increase fat level.

3.1.3. Crude Fiber

The result of One Way ANOVA on the mean of crude fiber indicates a significant difference significance level of 5% ($p<0.05$). The analysis result of Duncan's Multiple Range Test indicates that the mean of crude fiber in P0 did not differ significantly from P1 and P3, but differed significantly with P2.

The crude fiber content in the treatments P0, P1, P2 and P3 were 16.1180%, 16.0880%, 20.7367%, and 16.0603% respectively. The highest crude fiber content was produced in treatment P2 (ratio of 2:1 for seaweed:soy flour) with 20.7367%. The lowest crude fiber content was produced in treatment P3 (ratio of 1:2 For seaweed:soy flour) with 16.0603% and P1 (ratio of 1:1 for seaweed:soy flour) with 16.0880%. The flakes product has met the standard for crude fiber according to SNI 01-4270-1996 for cereal milk, i.e. 5% at minimal.

The higher amount of seaweed in the mix will result in higher fiber content in the flakes. Seaweed is known as the source of dietary fiber, the food fiber that cannot be digested by digestive enzyme and therefore is important and can be used as functional food (Santi, dkk., 2012).

3.1.4. Carbohydrate

The result of One Way ANOVA on the mean of carbohydrate indicates a significant difference significance level of 5% ($p<0.05$). The analysis result of Duncan's Multiple Range Test, the mean of carbohydrate in P0, P1, P2 and P3 shows a significant difference.

The content of carbohydrate in the treatments P0, P1, P2, and P3 were 71.1133%, 74.7605%, 77.8755%, and 66.4124% respectively. The highest carbohydrate content was produced in treatment P2 (ratio of 2:1 for seaweed:soy flour) with 77.8755%. Meanwhile, the lowest crude fiber content was produced in treatment P3 (ratio of 1:2 for seaweed:soy flour) with 66.4124%. The flakes product has met the standard for carbohydrate content according to SNI 01-4270-1996 for cereal milk, i.e. 60% at minimal.

The more amount of seaweed added into the mix will lead to higher carbohydrate content in the flakes as well. The content of fiber significantly affects the carbohydrate content (Ishak, et al., 2014).

The percentage of carbohydrate content is inversely proportional to that of protein. Semakin tinggi kadar proteinnya maka nilai karbohidratnya semakin rendah (Iriawan, 2012).

3.2. Organoleptic Test

3.2.1. Color

The flakes tested had the range of 3.8 to 5.1 from hedonic scale of 1-7. The flakes product tested showed the highest level of pleasure in treatment P2 (ratio of 2:1 for seaweed:soy flour) with the mean score 5.1 (fairly pleasant). Meanwhile, the lowest pleasure level was in treatment P3 (ratio of 1:2 for seaweed:soy flour) with the mean score 3.8 (neutral). The flakes in treatment P3 had a bit pale brown color, while those in P2 had brilliant yellowish brown color. Nevertheless, all percentages of flakes color obtained were within the pleasant range.

3.2.2. Flavor

The flakes tested had the range of 4.8 to 5.2 from hedonic scale of 1-7. The flakes product tested showed the highest level of pleasure in flavour aspect in treatment P2 (ratio of 2:1 for seaweed:soy flour) with the mean score 5.2 (fairly pleasant). Meanwhile, the lowest pleasure level was in treatment P0 (comparison treatment) and P1 (ratio of 1:1 for seaweed:soy flour) with the mean score 4.8 (fairly pleasant).

3.2.3. Aroma

The flakes tested had the range of 4.6 to 5.1 from hedonic scale of 1-7. The flakes product tested showed the highest level of pleasure in aroma aspect in treatment P2 (ratio of 2:1 for seaweed:soy flour) with the mean score 5.1 (fairly pleasant). Meanwhile, the lowest pleasure level was in treatment P0 (comparison treatment) and P1 (ratio of 1:1 for seaweed:soy flour) with the mean score 4.8 (fairly pleasant).

3.2.4. Texture

The flakes tested had the range of 4.7 to 5.2 from hedonic scale of 1-7. The flakes product tested showed the highest level of pleasure in texture aspect in treatment P2 (ratio of 2:1 for seaweed:soy flour) with the mean score 5.2 (fairly pleasant). Meanwhile, the lowest pleasure level was in treatment P0 (comparison treatment) and P1 (ratio of 1:1 for seaweed:soy flour) with the mean score 4.7 (fairly pleasant).

4. Conclusion and suggestion

The use of seaweed and soy flour with different ratios affect the proximate of content level and the panelists' acceptance toward the color, aroma, flavor and texture of the flakes. The best ratio in this study was in treatment P2 with ratio 2:1 for seaweed: soy flour addition. Based on the result of this study, a further study is required on the flakes shelf life in order to find out the product's durability.

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