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FORMULATION FLAKES CEREAL OF LOTUS (*Nelumbo nucifera*) AND SEAWEED (*Eucheumma cottoni*) AS FUNCTIONAL FOOD

Formulasi Sereal Flakes Lotus (*Nelumbo Nucifera*) dan Rumput Laut (*Eucheumma Cottoni*) Sebagai Sumber Pangan Fungsional

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ABSTRACT

The swamp waters in Indonesia are dominated by lotus plants, especially lotus seeds which are abundant but limited in processing. This study aimed to determine formulation flakes cereal from the composition of lotus seed (Nelumbo nucifera) and seaweed (Eucheumma cottoni) flour as functional food. This research was carried out in a laboratory experiment using the Completely Randomized Design (CRD) method with 4 treatment (100% tapioca; 50% tapioca, 20% lotus, 30% seaweed; 20% tapioca, 30% lotus, 50% seaweed, and 30% tapioca, 50% lotus, 20% seaweed) with 3 replications.The parameters were consisted of chemical analysis (moisture content, ash, fat, protein, carbohydrates, and crude fiber), physical (water absorpsion and solubily index), and sensory. The results have showed that the moisture (3.13% - 3.61%), ash (1.03% - 8.25%), fat (8.38% - 9.19%), protein (1.45% - 10.96%), carbohydrates (67.69% - 86.71%), crude fiber (1.08% - 5.73%). For the water absorpsion index has ranged from 11 g/g to 5,07 g/g. and water solubily index levels ranged from 0,017g/mL to 0,057g/mL. While the sensory analysis showed a significant effect on the value of aroma and color, but not a significant effect on the value of taste and texture.

Keywords : cereal, flakes, lotus, seaweed

ABSTRAK

Perairan rawa di Indonesia didominasi tanaman lotus, khususnya biji lotus yang melimpah namun pengolahannya terbatas. Penelitian ini bertujuan untuk mengetahui formulasi sereal flakes dari komposisi tepung biji lotus (*Nelumbo nucifera*) dan rumput laut (*Eucheumma cottoni*) sebagai pangan fungsional. Penelitian ini dilaksanakan dalam percobaan laboratorium menggunakan metode Rancangan Acak Lengkap (RAL) dengan 4 perlakuan (100% tapioka; 50% tapioka, 20% teratai, 30% rumput laut; 20% tapioka, 30% teratai, 50% rumput laut, dan 30% tapioka, 50% teratai, 20% rumput laut) dengan 3 ulangan. Parameter terdiri dari analisis

kimia (kadar air, abu, lemak, protein, karbohidrat, dan serat kasar), fisik (daya serap air dan indeks kelarutan), dan sensori. Hasil penelitian menunjukkan bahwa kadar air (3.13% - 3.61%), abu (1.03% - 8.25%), lemak (8.38% - 9.19%), protein (1.45% - 10.96%), karbohidrat (67.69% - 86.71%) , serat kasar (1.08% - 5.73%). Untuk indeks penyerapan air berkisar antara 11 g/g hingga 5.07 g/g. dan tingkat indeks kelarutan air berkisar dari 0.017g/mL hingga 0.057g/mL. Sedangkan analisis sensori menunjukkan pengaruh yang nyata terhadap nilai aroma dan warna, namun tidak berpengaruh nyata terhadap nilai rasa dan tekstur.

Kata Kunci : flakes, lotus, rumput laut, sereal

INTRODUCTION

Swamp waters in Indonesia are dominated by water hyacinth, lotus (Sarti *et al.,* 2019). Optimizing the potential of marine and fishery products properly can support the national food security program, namely the consumption of local food ingredients as a source of non-rice and non-wheat carbohydrates (Hadi, 2017). Lotus (*Nelumbo nucifera*) is a swamp plant that has high nutritional content and bioactive compounds (Zhu *et al.,* 2017). Lotus seeds contain 61% -62% carbohydrates, 16% -21% total protein, 2.40% -3% crude fat with a water content of 5% -9% (Shahzad *et al.,* 2021). According to research by Baehaki *et al.* (2015), lotus seeds contain phytochemical components such as flavonoids, tannins and saponins. However, the high nutritional content of this lotus is rarely utilized by the community. Its availability is abundant during the rainy season, so efforts to utilize lotus seeds are needed through the manufacture of flour and then flour as a flakes product.

Seaweed (*Eucheuma cottoni*) has the potential due to its high nutritional and bioactive components (Erniati *et al.,* 2016), so it can be used as an alternative fiber from water. Seaweed contains very high fiber and plays an important role in body health (Zhu *et al.,* 2017). According to Hadi (2017), the combination of lotus flour and seaweed as an effort to increase the effectiveness and efficiency of processed food products. The nutritional components of seaweed in dry units are 13.9% water, 2.6% protein, 0.4% fat, 0.9% crude fiber, 5.7% carbohydrates, and 67.5% carrageenan (Zhu *et al.,* 2017).

The combination of the two flours is used as a Flakes product for carbohydrate-rich intake so that it can be consumed like rice, human diet (Sukarno *et al.,* 2020). Cereals are usually produced from wheat, corn, and wheat. The flakes processed in this study will be made by adding a composition of aquatic plant products that are still rarely utilized in the form of lotus seed flour and seaweed. The mixture of these two ingredients has never been used by other researchers. Flakes itself has the highest carbohydrate content and must be considered because it is used as a staple food to replace rice. Research on flakes using other flours has been widely conducted, including jackfruit seed flour and corn flour flakes (Hadi, 2017), tapioca flour flakes enriched with coconut pulp flour fiber (Dewi, 2015), and flakes made from brown seaweed flour (Hadi, 2017).

The utilization of lotus seed flour and seaweed flour is estimated to be able to meet the nutritional content, if seen from its content that lotus seed flour itself is rich in carbohydrates and protein, while the advantage of seaweed flour is high fiber, so this research is important to be done in order to obtain a food diversification product as a functional food based on fishery and marine products that have not been utilized optimally. The formulation of cereal flakes from the composition of lotus seed flour (*Nelumbo nucifera*) and seaweed flour (*Eucheumma cottoni*) as a source of functional food in the form of cereal flakes products is the core of this research, in addition this research can contribute to producing breakfast cereal products with good quality.

RESEARH METHODS

Time and Place

This research was conducted from September to October 2022 at the Fishery Product Processing Technology Laboratory, Fishery Product Microbiology and Biotechnology Laboratory and Fishery Product Chemistry Laboratory, Fishery Department, Faculty of Agriculture, Sriwijaya University.

Materials and Tools

The raw materials used in making flakes are commercial lotus seeds, commercial seaweed from the Palembang market, and chemicals for analysis. Meanwhile, the tools used for processing flakes are a grinding machine, Ohaus analytical scales, Memmert ovens, 80 mesh sieves, PLC-03 Gemmy centrifuges, centrifuge tubes, vortex VM-300 Gemmy, and other glassware.

Research Methods

Lotus flour from lotus seeds (*Nelumbo nucifera*) and seaweed flour of the Eucheumma cottoni type is in the form of a powder that has been dried and processed into 80 mesh flour so that it can be used as an ingredient in cereal flakes formulation.

Making cereal flakes

Flakes are made based on the modified Dewi (2015) method with raw materials combined according to the formulation comparison (Table 1) below. Then, the mixture is added with 80 ml of warm water, 2 grams of salt, 10 grams of sugar and butter each. The mixture is stirred until homogeneous, then the mixture is rolled out, then thinned and molded into a box measuring 1 cm x 1 cm. The final stage is baking in the oven for ± 25 minutes at 150°C. This research used a Completely Randomized Design (CRD), with 3 repetitions.

Table 1. Formulation of ingredients for making cereal flakes.

Materials	Treatment (amount of material in grams)			
	P1	P2	P3	P4
Tapioca	100	50	20	30
Lotus Seeds	-	20	30	50
Seaweed	-	30	50	20
Butter	10	10	10	10
Milk	5	5	5	5
Sugar	5	5	5	5
Salt	2	2	2	2
Water	80 ml	80 ml	80 ml	80 ml

Testing Parameters

The parameters tested include proximate content, crude fiber based on AOAC (2005), water solubility index value and water absorption index based on Muchtadi (1989), and hedonic quality including color, aroma, hardness and taste (Setyaningsih *et al.,* 2010).

Data Analysis

Data processing using parametric statistics continued with Honestly Significant Difference (HSD). For non-parametric statistics, the Kruskal-Walis test was used followed by Mann Whitney comparison.

RESULT

Proximate Content

The results showed that the water content (3.13% - 3.61%), ash (1.03% - 8.25%), fat (8.38% - 9.19%), protein (1.45% - 10.96%), carbohydrates (67.69% - 86.71%), crude fiber (1.08% - 5.73%). For the water absorption index (IPA) ranges from 11 g / g to 5.07 g / g. and the water solubility index (IKA) ranges from 0.017 g / mL to 0.057 g / mL, as seen in Table 1. below.

Table 1. Proximate data, absorption index, and water solubility of cereal flakes products

Treatment	Parameter							
	Water (%w/w)	Ash (%w/w)	Fat (%w/w)	Protein (%w/w)	Carbohydrate (%w/w)	Crude Fiber (%w/w)	IPA (g/g)	IKA (g/mL)
P1	3.31±0.06ab	1.03±0.02a	9.19±0.05d	1.45±0.15a	86.71±0.19d	1.085±0.07a	4.11±0.05a	0.057±0.00c
P2	3.51±0.012bc	6.63±0.27b	8.84±0.01c	7.50±0.21b	72.68±0.28c	4.72±0.05b	4.44±0.03b	0.044±0.00bc
P3	3.61±0.011c	8.25±0.06c	8.38±0.06a	8.72±0.24c	70.67±0.43b	5.73±0.15c	5.07±0.01d	0.017±0.00a
P4	3.13±0.014a	7.76±0.26c	8.54±0.03b	10.96±0.25d	69.69±0.39a	5.035±0.10b	4.87±0.05c	0.031±0.00b

Description: The same letters in the numbers are not significantly different at the 95% confidence level.

Sensory Test

Table 2. below shows the changes in the sensory results of the hedonic test between P1 as a control against treatments P2, P3, P4; the values of all sensory attributes range from 4.6 to 6.0.

Table 2. Hedonic quality test data on cereal flakes products

Treatment	Hedonic Quality Test Parameters				
	Color	Aroma	Taste	Serving Texture without Milk	Serving Texture with Milk
P1	5.28±1.10ab	4.64±1.13b	5.54±1.08	6.32±0.62	6.6±0.76
P2	5.64±1.18bc	4.84±1.52bc	5.6±1.11	6.24±0.66	6.36±0.70
P3	4.6±1.41a	2.6±1.19a	6.08±0.86	5.96±0.61	5.68±1.06
P4	6.0±0.81c	2.76±1.12a	6.2±0.86	5.84±0.89	5.36±1.55

Description: The same letters in the numbers are not significantly different at the 95% confidence level.

The treatment of tapioca ratio formulation, lotus flour, and seaweed flour showed a significant effect on panelists' preferences (hedonic) for color and aroma parameters, except for taste and texture attributes. The higher the addition of lotus flour and seaweed, the panelists tended to like the resulting flakes product even though the aroma of the flakes was not liked, allegedly due to the high fat component of lotus flour and the fishy aroma of seaweed.

DISCUSSION

Proximate Content

Based on Table 1. shows the ratio treatment of tapioca, lotus flour, and seaweed flour addition affects the physicochemical characteristics of the flakes produced. In terms of water content, flakes have a water content between 3.13 ± 0.014 to 3.61 ± 0.11% due to the high concentration of seaweed. The low water content in the P4 treatment is due to the high amylose from the material, namely lotus (Pratiwi *et al.,* 2011; *Su et al.,* 2019). Amylose in flour has high hygroscopic properties so that it is easily released when the temperature increases (baking flakes), and its crystalline structure is different from amylopectin which is amorphous, hollow but difficult to release bound water (Sutedja *et al.,* 2013). According to Rakhmawati (2013), lotus and seaweed flours have strong absorption of water in making cookies. The average water

content of flakes in the study met the SNI standard of a maximum of 3.0%, although several flakes studies showed that the water content of the cereal flakes produced was high (Dewi, 2015; Firdarini & Kismiyati, 2019). The ash content of flakes was also influenced by the addition of lotus and seaweed flour, where the higher the addition of lotus or seaweed flour resulted in an increase in the ash content of flakes. The results of the flakes ash analysis exceeded the cereal quality standard, which was a maximum of 4% (SNI 01-4270-1996). Making cakes and pancakes in the study of Paiyarach *et al.* (2009) can increase the ash value by 4.03-5.6% for lotus flour, and 15.13% for seaweed.

The average fat content of the flakes in this study was 8.38 ± 0.06 to 9.19 ± 0.05, the addition of lotus flour and seaweed affected the fat content of the flakes, this is in line with the research of Antarkar (2019); Firdarini and Kismiyati (2019). However, the manufacture of cereal flakes using tapioca flour, red beans and konjac with a fat content of 2.69% -3.69% (Apriliana *et al.,* 2017). Susanti *et al.* (2017) supports the high fat content in cereal flakes due to the ability of amylose and amylopectin to bind fat which affects the texture of the flakes. The more complex bonds of fat and amylose ingredients, the harder the cereal flakes are (Pratiwi, 2011). Meanwhile, the highest protein in cereal flakes was found in the highest in the P4 treatment, namely 10.96%. This is in line with the research of rolled cookies from Mia (2022) which uses lotus up to 10%, lotus flour protein of 17.16% -21.41% (Singthong and Meesit, 2017). Purnamasari and Putri (2015), that the protein in the brains of the kurisi fish increases with the increase in carrageenan concentration. The protein content of flakes in this study meets the SNI cereal flakes standards, and the protein flakes combination of tapioca, lotus, and seaweed is higher than the results of the flakes study from Hermawati *et al.* (2015).

The results of the analysis of the highest carbohydrate content were in the P1 treatment, which was 86.71%, while the lowest carbohydrate content was in the P4 treatment, which was 67.69%. The decrease in carbohydrate content was due to an increase in seaweed concentration (Hasanah, 2017), in line with the results of the study by Situmorang *et al.* (2018) and the SNI quality standards for cereal flakes. For crude fiber content, the lowest average value was in the P1 treatment without the addition of lotus and seaweed. High fiber will affect the texture of the product, such as the research of Dewi flakes (2015) and Rahmah *et al*. (2017) which had a higher crude fiber value than the flakes in this study. The crude fiber in lotus and seaweed is quite high (Antarkar, 2019; Gultom *et al.,* 2015). The formulation of lotus and seaweed in flakes also affects the IPA value, where the IPA value ranges from 4.11 ± 0.05 to 5.07 ± 0.01 g / g. The IPA capability of the product is greatly influenced by the ratio of amylose and amylopectin of the material, and the number of hydroxyl groups (OH) where the more hydroxyl groups, the greater the water absorption of the material (Gandhi & Shing, 2013). Lotus amylose is known to be 35-45% (Chen, 2021), Rahmah *et al.* (2017) said that the IPA value is more influenced by amylose, the amylose polymer structure without branches and is more hydrophilic because of the many hydroxyl groups. The results of the IPA value of this study are in accordance with the theoretical statements of Muchtadi (2013) and Malinda (2013), that the starch gelatinization process can be influenced by the amorphous part (amylose). It was also added that the IPA value is also influenced by the fiber content and hydrophilic properties of Pratiwi (2011) and Sukarno *et al.* (2020) seaweed. In contrast to the decreasing average IKA value, where the highest IKA value was in treatment P1, which was 0.057 g/mL, while treatment P3 had the lowest IKA value, which was 0.017 g/mL. According to Chen *et al.* (2017) and Sukarno et al. (2020), the decrease in the IKA value can be caused by the breakdown of starch when the water content is low, resulting in the formation of simpler molecules which have an impact on low water solubility.

Sensory Test

The results of the Kruskal-Wallis hedonic quality analysis showed that the ratio of lotus and seaweed addition had no significant effect on the taste, texture of serving without/with milk (Table 2). The color quality attribute of the cereal flakes produced was brownish yellow with a score of 4 to 6. The more lotus or seaweed flour was added, the higher the intensity of the brownish yellow color. This phenomenon occurs due to non-enzymatic browning reactions (Maillard and Caramelization) in the flakes making process (Hustiany, 2016; Mustafa, 2016; Nurhidayati, 2017). However, the brown color of flakes with high seaweed concentrations is more dominant due to the phycocyanin content (brownish) (Hustiany, 2016). The aroma attribute of flakes has a quality of 2.6 to 4.4, the aroma produced is predominantly lotus and milk aroma compared to seaweed. Wet noodles made from 35% seaweed do not affect the aroma of the noodles, the resulting aroma tends to be normal (Adha *et al.,* 2016). In line with Singthong and Meesit (2017) who stated that lotus flour is able to substitute wheat in terms of sensory taste, aroma, and texture.

Cereal flakes have a taste quality score of 5.54 to 6.2, all flakes products have a sweet and savory taste. The addition of lotus flour and seaweed does not affect the taste of flakes, it is suspected that the tendency of the two main ingredients does not provide flavor or is plain so that the taste of the product is more dominated by supporting ingredients such as eggs, butter (Chung *et al.,* 2014). The original texture of flakes without serving with milk has a value of 5.04 to 6, the texture characteristics are from crunchy to slightly hard. In line with the taste attribute, the addition of lotus flour and seaweed does not affect the texture without serving milk. Although, the higher the concentration of lotus flour and seaweed, the harder the texture is compared to the treatment of flakes only from tapioca. Cookie research by Chung *et al*. (2014), the hardness of cookies increases due to the content of lotus flour, namely amylose and protein. Different reasons for seaweed flakes are due to high fiber content (Pratiwi, 2011; Susanti, 2017). Hedonic quality analysis of texture components with milk presentation produces intact, soft, and not easily broken texture characteristics (5.36 to 6.6). So, the texture of flakes served with/without milk is greatly influenced by the amount of lotus flour and seaweed added. The ratio of tapioca, lotus flour, and seaweed will affect the formation of cavities due to the bonds between amylose, amylopectin, and fiber; a lot of water is trapped in the flakes due to the influence of the many cavities formed so that there is an increase in the level of rehydration (Purnamasari & Putri, 2015).

CONCLUSION

Based on the research that has been done, it shows that the proximate values starting from water, ash, protein, fat, carbohydrates, crude fiber, water absorption index, and water solubility index have a significant effect due to the concentration of lotus flour and seaweed. The same is true for the hedonic quality parameters on the color and aroma attributes, except for the texture of the flakes when served with/without milk. Treatment P2 is the best treatment with characteristics of 3.51% water, 6.63% ash, 7.50% fat, 8.72% protein, 72.68% carbohydrates, 4.72% crude fiber, 4.4g/g IPA index, and 0.044 g/mL for the IKA index.

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