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Effect of Seaweed (*Eucheuma cottonii*) Flour Addition on the Level of Preference of Choux Pastry

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ABSTRACT

Choux pastry is a baked product that generally has low fiber content due to its primary ingredient, wheat flour, which contains minimal dietary fiber. Incorporating alternative ingredients rich in fiber can enhance its nutritional value. One such ingredient is *Eucheuma cottonii* seaweed flour, which is high in dietary fiber and offers potential for innovation in the utilization of fishery-based products. Dietary fiber plays an important role in binding water, improving digestion, and reducing the risk of certain diseases such as cancer. This research aimed to determine the optimal level of *Eucheuma cottonii* seaweed flour addition to choux pastry based on consumer preference. The study was conducted in December 2024 at the Fishery Product Technology Laboratory, Faculty of Fisheries and Marine Sciences, and at the Chemistry Application Laboratory and PPBS Service Building, Faculty of Mathematics and Natural Sciences, Padjadjaran University. An experimental method was used with four treatments: 0% (control), 7.5%, 10%, and 12.5% seaweed flour. Organoleptic tests (appearance, aroma, taste, and texture) were performed by 25 semi-trained panelists, and proximate analysis was conducted. The results showed that the choux pastry with 10% seaweed flour was the most preferred, with organoleptic scores of 7.8 for appearance, 7.6 for aroma, 7.5 for texture, and 7.7 for taste. Proximate analysis indicated that the 10% seaweed flour choux pastry contained 0.3% crude fiber, 2.9% moisture, 2.28% ash, 27.43% fat, 11.27% protein, and 56.09% carbohydrates.

INTRODUCTION

Seaweed is one of Indonesia's leading commodities, widely distributed across its waters, and has significant potential as an export commodity (Agusman *et al*., 2021). Seaweed contains carrageenan, which functions as a stabilizer, thickener, gelling agent, emulsifier, and more (Winarno, 1996). Due to its high market value, seaweed is a highly sought-after commodity in the aquatic sector, especially among seaweed farmers. According to BRIN (2023), Indonesia ranks second in global seaweed production, producing 9.6 million tons of

seaweed in 2022. This accounts for 65% of the national aquaculture production, with approximately 65,000 households engaged in seaweed farming (Fahrurrozi, 2023).

Eucheuma cottonii is one of the most widely cultivated seaweed species along the northern coast of Java (Nurwati, 2021). It is rich in essential minerals, such as iodine, as well as protein, fat, fiber, and carbohydrates, making it highly beneficial for health. The nutritional composition of *Eucheuma cottonii* includes 17.27% ash content, 26.51% water, 2.59% fat, 10.73% protein, and 42.9% carbohydrates (Agusman *et al*., 2021). Additionally, *Eucheuma cottonii* contains a high amount of dietary fiber, which plays a crucial role in maintaining a healthy body. It has a total dietary fiber content of 70.14% (Anggraini, 2018).

Fiber helps bind water, facilitates digestion, and reduces the risk of cancer. Consuming fiber is particularly essential for individuals with high activity levels, as it supports digestive health. One alternative use of *Eucheuma cottonii* to increase its added value is by processing it into seaweed flour. Seaweed flour can be utilized as an additive in pastry production, such as choux pastry.

Choux pastry is a type of pastry known for its light texture and significant volume expansion (Indra *et al*., 2023). There are two main variations: soft choux pastry (cream puffs) and crispy choux pastry. According to Bramantyo (2019), soft choux pastry is characterized by a crispy outer layer with a soft, hollow center that can be filled with various fillings, while crispy choux pastry has a crunchier texture and smaller size. Choux pastries also come in two shapes: elongated (éclairs) and round (cream puffs). According to USDA (2019), soft choux pastry contains 38.6 g of water, 0.9 g of ash, 19 g of fat, 4.4 g of protein, 37 g of carbohydrates, and 0.9 g of fiber. The fiber content in choux pastry is relatively low because its primary ingredient, wheat flour, has a low fiber content. Conversely, *Eucheuma cottonii* seaweed flour, which is rich in fiber, presents an opportunity for innovation in the utilization of fishery products, specifically by incorporating *Eucheuma cottonii* seaweed flour into soft choux pastry.

Adding *Eucheuma cottonii* seaweed flour to soft choux pastry can enhance its fiber content while also influencing its acceptability. Research by Ethasari *et al*. (2024) showed that adding seaweed flour to cookies affects consumer preference levels, with 10% seaweed flour yielding the most favored product. Another study by Nurwati & Hasdar (2021) incorporated *Eucheuma cottonii* seaweed flour into brownies. Therefore, further research is needed to evaluate the effect of seaweed flour as a fiber source on the preference level of soft choux pastry.

Preliminary research was conducted to determine the most preferred percentage of *Eucheuma cottonii* seaweed flour in soft choux pastry. The study tested four formulations with different seaweed flour concentrations: 0% (control), 10%, 20%, and 30%. The results indicated that soft choux pastry with 10% *Eucheuma cottonii* seaweed flour was the most preferred by ten semi-trained panelists, based on organoleptic evaluations. The median scores were 7 for color, 7 for aroma, 9 for taste, and 7 for texture. Based on these findings, it is hypothesized that adding *Eucheuma cottonii* seaweed flour at a 10% concentration produces the most preferred product.

METHODS

The research was conducted in December 2024 at Universitas Padjadjaran, Jatinangor. The research method used was an experimental method with four treatments: without the

addition of seaweed flour (0%), and with the addition of *Eucheuma cottonii* seaweed flour at concentrations of 7.5%, 10%, and 12.5%.

The equipment used included a scale, measuring cup, spoon, sieve, mixing bowl, mixer, spatula, oven, stove, baking tray, and cake mold. The ingredients used were wheat flour, *Eucheuma cottonii* seaweed flour, eggs, margarine, water, and salt.

The preparation of choux pastry in this study was based on the modified formulation of Asnawi & Eliska (2023) with the following steps:

1. Heat 200 ml of water and 125 grams of margarine in a saucepan until the margarine melts.
2. Once the margarine has melted, add 150 grams of wheat flour and seaweed flour (with concentrations of 0%, 7.5%, 10%, or 12.5%), then stir for 2–3 minutes until the dough becomes smooth.
3. Remove the saucepan from the stove and let the dough cool for 10–15 minutes.
4. Add two eggs to the dough and mix until it forms a thick cream for about 3–5 minutes.
5. Preheat the oven to a high temperature, around 250°C, for 10–15 minutes.
6. Pipe or spoon the dough onto a baking tray lined with parchment paper or greased with margarine.
7. Bake in the oven at 200°C for 25–30 minutes using both top and bottom heat.

The chemical analysis results were evaluated using a descriptive comparative analysis method. Descriptive comparative analysis involves presenting research findings and analysis in a scientific narrative, followed by drawing conclusions from the conducted analysis (Cangara *et al*., 2024).

A parametric analysis was performed on the hedonic test data using a two-way analysis of variance (ANOVA) with the Friedman test and Chi-square test based on Sudradjat (1999). A Multiple Comparison Test was conducted to determine the differences between treatments involving the addition of *Eucheuma cottonii* seaweed flour to choux pastry. Finally, the Bayes method was used to determine the optimal seaweed flour concentration that was most preferred. The Bayes method is a technique used to analyze and make the best decision among multiple alternatives, considering various criteria to achieve the optimal outcome (Marimin, 2004).

RESULTS

Preference Level of Choux Pastry Color

The observation results on the preference level of choux pastry color with the addition of *Eucheuma cottonii* seaweed flour are presented in Table 1 below.

Table 1. Preference Level of Choux Pastry Color

Addition of Seaweed Flour (%)	Median Value	Average Color
0	9	7.2 b
7.5	9	7.4 b
10	9	7.8 b
12.5	7	5.9 a

Note: The average treatment values followed by the same letter indicate no significant difference according to the multiple comparison test at a 95% confidence level.

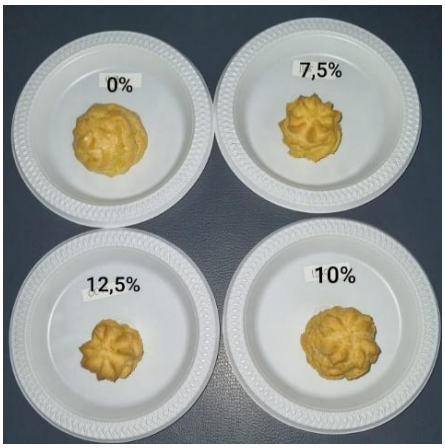

Figure 1. Appearance of Choux Pastry Based on the Addition of *Eucheuma cottonii* Seaweed Flour

Based on the results of the multiple comparison test, the addition of *Eucheuma cottonii* seaweed flour at 12.5% showed a significantly different color compared to the treatments without seaweed flour (0%) and with 7.5% and 10% seaweed flour. The 10% *Eucheuma cottonii* seaweed flour treatment received the highest score, making it the best treatment based on the average color value of the choux pastry.

Aroma Preference Level of Choux Pastry

The results of the observation on the preference level of the color of choux pastry with the addition of *Eucheuma cottonii* seaweed flour are presented in Table 2 below.

Table 2. Aroma Preference Level of Choux Pastry

Addition of Seaweed Flour (%)	Median Value	Average Aroma
0	7	7.5 ab
7.5	7	7.4 ab
10	7	7.6 b
12.5	5	6.0 a

The aroma of choux pastry with the addition of *Eucheuma cottonii* seaweed flour showed different average values. The results of the multiple comparison test indicated that the treatment with 10% *Eucheuma cottonii* seaweed flour received the highest score. Thus, based on the average aroma score, the best treatment was the 10% addition of *Eucheuma cottonii* seaweed flour.

Based on the panelists' evaluation of the aroma, it was found that the choux pastry was still acceptable and preferred, as the score remained above the product rejection threshold (less than 5).

Preference Level of Choux Pastry Texture

The observation results on the preference level of choux pastry texture with the addition of *Eucheuma cottonii* seaweed flour are presented in Table 3 below.

Table 3. Preference Level of Choux Pastry Texture

Addition of Seaweed Flour (%)	Median Value	Average Texture
0	7	7.4 a
7.5	7	7.4 a
10	9	8 a
12.5	5	5.8 a

Note: The mean values of treatments followed by the same letter indicate no significant difference according to the multiple comparison test at a 95% confidence level.

The results of the Friedman analysis test showed that the level of *Eucheuma cottonii* seaweed flour addition did not have a significant effect on the texture preference of choux pastry. Based on the panelists' evaluation, the texture of the choux pastry was still acceptable and preferred, as it remained above the product rejection threshold (less than 5).

Preference Level of Choux Pastry Taste

The observation results on the preference level of the color of choux pastry with the addition of *Eucheuma cottonii* seaweed flour are presented in Table 4 below.

Table 4. Preference Level of Choux Pastry Taste

Addition of Seaweed Flour (%)	Median Value	Average Taste
0	7	7.7 a
7.5	7	7.3 a
10	7	7.7 a
12.5	7	6.4 a

Note: The average treatment values followed by the same letter indicate no significant difference according to the multiple comparison test at a 95% confidence level.

The results of the Friedman test showed that the level of *Eucheuma cottonii* seaweed flour addition did not have a significant effect on the preference level of the taste of wet choux pastry. Based on the panelists' evaluation, the taste of the wet choux pastry was still acceptable and preferred, as it remained above the product rejection threshold (less than 5).

Decision-Making on Wet Choux Pastry Preference Level Using the Bayes Method

The calculation results for the weight criteria of appearance (color), aroma, texture, and taste of wet choux pastry with the addition of *Eucheuma cottonii* seaweed flour are presented in Table 5.

Table 5. The Criterion Values of Wet Choux Pastry

Criteria	Priority Value
Color	0.16
Aroma	0.12
Texture	0.19
Taste	0.54

Based on Table 5, the matrix calculation results for the weight of the criteria, including appearance (color), aroma, texture, and taste, in choux pastry with the addition of *Eucheuma cottonii* seaweed flour indicate that the taste criterion has the highest weight, at 0.54. This suggests that panelists prioritize taste when evaluating the choux pastry product.

Next, based on the Bayes method, the evaluation continues by multiplying the obtained criterion weights by the median value of the organoleptic test results for each treatment, and then summing them to obtain the alternative value. The results of these calculations are presented in Table 6.

Tabel 6. Decision Matrix for Choux Pastry Evaluation Using the Bayes Method

Treatment	Criteria				Alternative Values	Priority Value
	Color	Aroma	Texture	Taste		
A	7	7	7	7	7.1	0.25
B	7	7	7	7	7.1	0.25
C	9	7	7	7	7.4	0.26
D	5	5	7	7	6.5	0.23
Criteria Value	0.16	0.12	0.19	0.54	28	1

Based on the calculations using the Bayes method, the data above indicates that taste is the most important criterion in the final decision of panelists when selecting the wet choux pastry. The treatment with a 10% addition of *Eucheuma cottonii* seaweed flour achieved the highest alternative value of 7.4 with a criterion weight of 0.54, meaning it was preferred over other treatments. This was followed by aroma with a criterion weight of 0.12, appearance at 0.16, and texture at 0.19.

Analysis of Proximate Composition of Wet Choux Pastry from the Best Treatment

The results of the analysis of the most preferred wet choux pastry (10%) and the control (0%) are presented in Table 7.

Tabel 7. Proximate Test Results of Wet Choux Pastry

Chemical Composition	Treatment		SNI Cookies
	0%	10%	
Crude Fiber Content	0.1	0.3	Max 0.5 %
Water Content	3.74	2.9	Max 5%
Ash Content	1.34	2.28	Max 1.6%
Fat Content	27.59	27.43	Min 9.5%
Protein Content	12.74	11.27	Min 5%
Carbohydrate Content	54.58	56.09	Min 70%

Source: 01-2891:1992

Crude Fiber Content

Based on Table 7, it can be seen that choux pastry with 0% seaweed flour addition has a crude fiber content of 0.1%, while with 10% seaweed flour addition, the crude fiber content reaches 0.3%. This indicates an increase of 0.2% in crude fiber content. The crude fiber content of the choux pastry with the addition of seaweed flour meets the quality requirements for dry cakes based on SNI 01-2973-1992, which stipulates a maximum of 0.5%.

Water Content

Based on Table 7, it can be seen that choux pastry with 0% seaweed flour addition has a water content of 3.74%, while with 10% seaweed flour addition, the water content decreases to 2.9%. This represents a 22.46% reduction in water content. The water content of

the choux pastry with the addition of seaweed flour meets the quality standards for dry cakes based on SNI 01-2973-1992, which sets a maximum limit of 5%.

Ash Content

Based on Table 7, it can be seen that choux pastry with 0% seaweed flour addition has an ash content of 1.34%, while with 10% seaweed flour addition, the ash content increases to 2.28%. This represents a 0.94% increase in ash content. The ash content of the choux pastry with the addition of seaweed flour does not meet the quality standards for dry cakes based on SNI 01-2973-1992, which sets a maximum limit of 1.6%.

Fat Content

Based on Table 7, it can be seen that choux pastry with 0% seaweed flour addition has a fat content of 27.59%, while with 10% seaweed flour addition, the fat content decreases to 27.43%. This represents a reduction of 0.58% in fat content. The fat content of the choux pastry with the addition of seaweed flour meets the quality standards for dry cakes based on SNI 01-2973-1992, which requires a minimum of 9.5%

Protein Content

Based on Table 7, it can be seen that choux pastry with 0% seaweed flour addition has a protein content of 12.74%, while with 10% seaweed flour addition, the protein content decreases to 11.27%. This represents a reduction of 11.54% in protein content. The protein content of the choux pastry with the addition of seaweed flour meets the quality standards for dry cakes based on SNI 01-2973-1992, which requires a minimum of 5%.

Carbohydrate Content

Based on Table 7, it can be seen that choux pastry with 0% seaweed flour addition has a carbohydrate content of 54.58%, while with 10% seaweed flour addition, the carbohydrate content increases to 59.09%. This represents a 1.51% increase in carbohydrate content. However, the carbohydrate content of the choux pastry with the addition of seaweed flour does not meet the quality standards for dry cakes based on SNI 01-2973-1992, which requires a minimum of 70%.

DISCUSSION

Organoleptic Characteristics

Organoleptic characteristics are one of the essential aspects used to measure the panelists' preference level for a food product. Organoleptic testing, also known as sensory evaluation, is a testing method that involves human senses as the primary tool to assess the acceptance level of a product (Nurhuda *et al*., 2017). This evaluation is conducted using a hedonic scale with observed parameters including appearance, aroma, taste, and texture (Pardede *et al*., 2020).

Preference Level of Choux Pastry Color

Color is one of the crucial factors that influence the quality of food products and often serves as the primary determinant in visual assessment. According to Lanudi *et al*. (2017), color is a vital organoleptic attribute because it is the first aspect evaluated by consumers. Even if a food product has a delicious taste, good nutritional content, and appealing texture, it may still fail to attract consumers if its color appears unappealing or deviates from the expected shade.

The results of the Friedman analysis test indicate that the level of *Eucheuma cottonii* seaweed flour addition significantly affects the preference for the color of the choux pastry, necessitating a multiple comparison test. Each treatment produced different colors, with

higher additions of *Eucheuma cottonii* seaweed flour resulting in a yellowish-brown hue in the choux pastry. This finding aligns with the research by Pasi *et al*. (2024), which showed that increasing the amount of *Eucheuma cottonii* seaweed flour in sweet bread resulted in a more brownish color.

The color change in the choux pastry is influenced by the Maillard reaction. According to Ridhani *et al*. (2021), the Maillard reaction is a non-enzymatic browning process that occurs between carbohydrates, reducing sugars (such as aldoses and ketoses), and primary amine groups derived from amino acids, proteins, or other compounds containing amine groups. The protein content in *Eucheuma cottonii* seaweed flour can enhance Maillard reaction activity, leading to a darker product color. The higher the *Eucheuma cottonii* seaweed flour composition, the darker the appearance of the product (Gultom, 2014).

Apart from the Maillard reaction, caramelization also contributes to the color change in choux pastry. Caramelization occurs due to the interaction of sugars at high temperatures (80°C), above their melting point (Sachriani & Mariani, 2024).

Aroma Preference Level of Choux Pastry

Aroma is one of the key sensory parameters used to evaluate food quality, encompassing attributes such as deliciousness, pleasant fragrance, or rancid odor (Nurwati & Hasdar, 2021). The sense of smell plays a crucial role in the panelists' assessment of food products (Winarno, 2004).

The highest average aroma score was observed in the treatment with 10% *Eucheuma cottonii* seaweed flour, achieving a mean score of 7.6, while the lowest average aroma score was found in the 12.5% *Eucheuma cottonii* treatment, with a mean score of 5.9. This finding is consistent with the research of Laili *et al*. (2023), which showed that adding 10% *Eucheuma cottonii* seaweed flour to cookies resulted in the highest preference score, characterized by a sweet and savory aroma.

The aroma variation in choux pastry is influenced by the amount of *Eucheuma cottonii* seaweed flour incorporated into the dough. A higher percentage of *Eucheuma cottonii* seaweed flour leads to a stronger fishy aroma in the choux pastry. According to Sholiha (2019), *Eucheuma cottonii* seaweed flour has a distinctive marine odor, and when used in high concentrations as an additive, it can cause an undesirable aroma, making the product less appealing to panelists.

Preference Level of Choux Pastry Texture

Texture plays a crucial role in influencing the taste perception of food. According to Setyaningsih *et al*. (2010), texture is a complex property related to the structural characteristics of a material, which can be categorized into three main elements: mechanical (e.g., hardness and chewiness), geometric (e.g., grainy or crumbly texture), and mouthfeel (e.g., oily or watery sensation).

Texture is also a key factor affecting the acceptance of a product. Texture evaluation is conducted to determine panelists' responses to elasticity or chewiness, which can be perceived through the sense of touch (Pardede *et al*., 2020).

The highest average texture score was found in the treatment with 10% *Eucheuma cottonii* seaweed flour, with a mean score of 8, producing a crispy texture. Meanwhile, the lowest average texture score was observed in the treatment with 12.5% *Eucheuma cottonii*, with a mean score of 5.8, resulting in a less crispy texture. This finding aligns with the research by Ethasari & Lalili (2024), which reported that adding 10% *Eucheuma cottonii* seaweed flour to cookies yielded the highest preference score due to the crunchy texture.

The addition of *Eucheuma cottonii* seaweed flour across four treatment levels in choux pastry production showed no significant difference in texture characteristics from the initial to intermediate treatments. However, at the highest concentration of *Eucheuma cottonii* seaweed flour, the average texture score declined. This decrease is likely due to the high fiber content in *Eucheuma cottonii* seaweed flour, which can disrupt the dough structure. According to Samsia *et al*. (2022), *Eucheuma cottonii* seaweed flour, when dissolved, forms a thick and slightly coarse texture with a sticky consistency due to the presence of fiber granules. This condition directly affects the texture of the resulting food product.

This observation aligns with Agustin *et al*. (2017), who stated that *Eucheuma cottonii* seaweed flour has properties similar to tapioca flour, functioning as a gelling agent, thickener, stabilizer, and emulsifier.

Preference Level of Choux Pastry Taste

Taste is one of the most critical parameters determining a product's acceptability, as it can be influenced by several factors. Even if a food product has an appealing texture, color, and aroma, it will not be well-received if it lacks a pleasant taste. According to Herawati (2018), taste is the most important quality attribute considered in consumer acceptance of food products.

The highest average taste score was observed in the treatment with 10% *Eucheuma cottonii* seaweed flour, with a mean score of 7.7, producing a sweet and savory taste. Meanwhile, the lowest average taste score was found in the treatment with 12.5% *Eucheuma cottonii*, with a mean score of 6.4, resulting in a dominantly savory taste with a bitter aftertaste. This result is consistent with the study by Laili *et al*. (2023), which reported that adding 10% *Eucheuma cottonii* seaweed flour to cookies resulted in the highest preference score, as the cookies had a predominantly sweet flavor.

The taste characteristics of choux pastry with *Eucheuma cottonii* seaweed flour across four treatment levels showed no significant differences from the initial to the intermediate treatments. However, at the highest concentration of *Eucheuma cottonii* seaweed flour, the average taste score decreased. This reduction was due to the dominant taste of seaweed flour, which included a slightly fishy or bitter taste, leading to a bitter aftertaste.

According to Winarno (2008) in Aditia (2021), *Eucheuma cottonii* seaweed flour contains phenolic compounds, which can cause bitterness when used in high concentrations. Additionally, Lukito *et al*. (2017) stated that *Eucheuma cottonii* seaweed flour contains proteins that, when degraded into simpler amino acids, can contribute to a bitter taste. This occurs because proteins are key components in forming flavor and taste.

Decision-Making on Wet Choux Pastry Preference Level Using the Bayes Method

Decision-making is the process of selecting one option from various available alternatives. A decision is the final outcome of choosing the best course of action based on the given choices. This process requires careful consideration and comparison to determine the most optimal choice (Siregar, 2014).

In selecting the best choux pastry using the Bayes method, the evaluation is based on the highest score from each treatment. The process of assigning weight values to criteria such as appearance (color), aroma, taste, and texture is carried out using the Pairwise Comparison method. The results from this comparison are then processed in a matrix format to represent the relative priority weights of the criteria and the tested treatment alternatives.

The matrix calculation results for the weight of the criteria—appearance (color), aroma, texture, and taste—indicate that taste holds the highest weight. This finding aligns with Rahmadita (2020), who stated that taste is the primary factor in consumers' decisions to

accept or reject a food product. Even if a food product has appealing color, aroma, texture, and nutritional value, it can still be rejected if it does not taste good.

Analysis of Proximate Composition of Wet Choux Pastry from the Best Treatment

In choux pastry, proximate analysis is conducted to determine its complete nutritional composition, which is essential for assessing product quality and nutritional value. The purpose of this analysis is to ensure that choux pastry meets food quality standards and provides consumers with information about the product's nutritional content. The principle of proximate analysis involves separating food components into major fractions, such as water content, ash, protein, fat, crude fiber, and carbohydrates, through a series of laboratory tests (Seftiono *et al*., 2019).

Crude Fiber Content

Crude fiber is the portion of food that cannot be broken down by chemicals such as sulfuric acid and sodium hydroxide, which are commonly used to measure crude fiber content (Dean *et al*., 2023). Fiber plays an essential role in the body, particularly in food, by helping to bind water, cellulose, and pectin (Tamungku *et al*., 2020).

The increase in crude fiber content can be influenced by the addition of seaweed flour in choux pastry. This aligns with research by Slamet (2018), which found that the crude fiber content in cookies increased as the concentration of seaweed flour increased.

The rise in crude fiber levels in choux pastry with added seaweed flour occurs because seaweed flour contains high dietary fiber, both soluble fibers such as alginate, agar, and carrageenan, and insoluble fibers like cellulose and hemicellulose. These fibers naturally resist degradation during food processing, significantly contributing to the total crude fiber content in the final product (Pratiwi *et al*., 2016). According to Husni *et al*. (2019), adding seaweed flour to food products can increase crude fiber content because seaweed contains fiber components from the polysaccharide group and water-soluble fiber. Consequently, the more seaweed flour added, the higher the crude fiber content. Additionally, the fiber in seaweed flour, which can absorb water and form a gel structure, also plays a role in increasing the proportion of crude fiber in the product.

Water Content

Water content is one of the essential characteristics influencing food materials, particularly in terms of appearance, texture, and flavor. High water content can trigger the growth of bacteria, molds, and yeasts, leading to changes in food quality (Winarno, 1991). Therefore, water content plays a crucial role in food processing and significantly determines food quality.

A decrease in water content can be influenced by the addition of seaweed flour in choux pastry. This aligns with research by Pasi *et al*. (2024), which found that water content in bread decreases as the concentration of seaweed flour increases.

The reduction in water content in choux pastry with added seaweed flour occurs because seaweed flour contains hydrophilic polysaccharides such as alginate, agar, and carrageenan. Herawati (2018) stated that polysaccharides have the ability to absorb and bind water within a gel structure, making the water more bound and less measurable. Additionally, cooking affects water retention as high temperatures during processing can enhance protein denaturation and reduce water-holding capacity, leading to lower water content (Pasi *et al*., 2024). This is consistent with the research by Tarigan (2020), which showed that adding high-fiber ingredients like seaweed reduces free water content because water becomes bound within the matrix of soluble and insoluble fibers.

Ash Content

Ash is the residual inorganic mineral that remains after a substance is burned until all carbon and water are completely removed. The ash content in a product reflects its purity level, which is significantly influenced by its composition and mineral content (Widyaningrum *et al*., 2024).

The increase in ash content can be influenced by the addition of seaweed flour in choux pastry. This is consistent with research by Sandrasari & Chusna (2020), which found that ash levels in crispy cookies increased as the concentration of seaweed flour increased.

The rise in ash content in choux pastry with added seaweed flour occurs because seaweed flour contains high mineral levels, comprising 7-38% minerals of its dry weight. According to Syafitri *et al*. (2022), seaweed flour is rich in various minerals such as calcium, magnesium, potassium, sodium, and other elements, which are key components of ash content. The addition of seaweed flour in food formulations increases the total mineral content, leading to a higher ash content in the final product. This aligns with research by Lukito *et al*. (2017), which demonstrated that seaweed-based food products exhibit a significant increase in ash content as the proportion of seaweed flour increases, due to the substantial contribution of seaweed minerals to the overall ash composition.

Fat Content

Fat is an essential nutrient for the human body, serving as a necessary source of calories. Understanding the fat content in food is crucial, as fat influences the quality, shelf life, and characteristics of food products (Asikin *et al*., 2023).

A decrease in fat content can be influenced by the addition of seaweed flour in choux pastry. This is consistent with research by Sandrasari & Chusna (2020), which found that fat levels in crispy cookies decreased as the concentration of seaweed flour increased.

The reduction in fat content in choux pastry with added seaweed flour occurs because seaweed flour has hydrophilic properties, tending to bind water rather than fat. According to Sipahutar & Siregar (2016), seaweed flour primarily functions as a water binder rather than a fat binder, as it is not soluble in fat but can interact with proteins. Sipahutar *et al*. (2020) explain that fat is typically bound by the positive pole of proteins; however, with the addition of seaweed flour, proteins focus more on binding water, reducing their ability to bind fat. Additionally, seaweed flour can be used as a partial fat replacer in food formulations.

Protein Content

Protein is a key parameter in determining food quality. Protein molecules are composed of 12 to 18 linked amino acids. The human body requires protein to function as a building block for growth and maintenance of body structures, regulate physiological processes, and ensure optimal brain function in children (Munawwarah, 2017).

A decrease in protein content can be influenced by the addition of seaweed flour in choux pastry. This aligns with research by Kaudin *et al*. (2019), which found that protein levels in dried noodles decreased as the concentration of seaweed flour increased.

According to Nurwin *et al*. (2019), the reduction in protein content in food products containing seaweed flour is due to the hydrocolloid properties of the flour. The addition of hydrocolloids tends to increase carbohydrate content, making the measured protein content appear lower. Furthermore, Wulandari *et al*. (2019) explained that seaweed flour is rich in polysaccharides such as agar, carrageenan, and alginate, which are hydrophilic and capable of forming gels. The dominance of these polysaccharides contributes to the reduction of protein content in food products, as seaweed flour naturally has a low protein content.

Carbohydrate Content

Carbohydrates are nutrients that serve as the body's primary source of energy. They play a crucial role in enabling various bodily functions and supporting daily activities. Carbohydrates are organic compounds with different molecular structures but share similarities in their chemical composition and function. They consist of carbon, hydrogen, and oxygen (Elfandi *et al*., 2022).

Changes in carbohydrate levels in choux pastry are influenced by the calculation method used and the nutritional composition of the ingredients. Lukito *et al*. (2017) explained that carbohydrate content calculated using the by-difference method is affected by the presence of other nutrients in the ingredients. The lower the content of other nutrients, the higher the calculated carbohydrate level. Diniyah *et al.* (2019) further stated that an increase in moisture, ash, fat, protein, and crude fiber content will reduce carbohydrate levels, while a decrease in these components will lead to higher carbohydrate content.

CONCLUSION

The addition of 10% *Eucheuma cottonii* seaweed flour in the formulation of choux pastry resulted in the most preferred product. The 10% treatment was the most favored in terms of color, with an average score of 7.8 (liked), aroma 7.6 (liked), texture 7.5 (liked), and taste 7.7 (liked). Based on the Bayes test, taste was the most important criterion in selecting the choux pastry, with the 10% treatment being the most preferred product.

Choux pastry with the addition of 10% seaweed flour produced a proximate composition of 0.3% crude fiber, 2.9% moisture content, 2.28% ash content, 27.43% fat content, 11.27% protein content, and 56.09% carbohydrate content.

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