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Soft cookies substituted with green mung beans and *Ulva lactuca* seaweed for anemia prevention in adolescents

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ABSTRAK

Latar Belakang: *Untuk mengatasi permasalahan gizi pada remaja putri, khususnya anemia, perlu dilakukan langkah-langkah pencegahan, salah satunya dengan menyediakan makanan fungsional menggunakan bahan makanan lokal seperti kacang hijau dan rumput laut Ulva lactuca.*
Tujuan: *Penelitian ini bertujuan untuk mengembangkan produk soft cookies dengan substitusi kacang hijau dan rumput laut Ulva lactuca sebagai makanan fungsional potensial untuk pencegahan anemia pada remaja. Studi ini juga akan mengevaluasi karakteristik fisik, kimia, sensorik, dan kandungan zat besi dari produk yang dihasilkan.*
Metode: *Penelitian ini menggunakan pendekatan penelitian dan pengembangan (R&D) dengan model 4D (define, design, develop, disseminate). Produk tersebut diuji pada 80 panelis, dan data dianalisis menggunakan uji t berpasangan untuk membandingkan soft cookies referensi dan yang dikembangkan. Analisis nutrisi dilakukan di Laboratorium Saraswati Indo Genentech, Bogor (SIG).*
Hasil: *Formulasi terbaik menggunakan substitusi 50% kacang hijau. Produk yang dikembangkan lebih disukai (4,07) daripada referensi (3,87). Per 100 g, mengandung zat besi 4,39 mg, protein 8,29 g, lemak 22,73 g, karbohidrat 61,91 g, energi 485,53 kkal, air 5,21%, dan abu 1,82%.*
Kesimpulan: *Formulasi optimal adalah substitusi 50% kacang hijau dengan 7,50% rumput laut Ulva lactuca. Produk yang dikembangkan lebih disukai (4,07) daripada referensi (3,87). Per 100 g, produk ini mengandung zat besi 4,39 mg, protein 8,29 g, lemak 22,73 g, karbohidrat 61,91 g, energi 485,53 kkal, air 5,21%, dan abu 1,82%. Produk ini memiliki potensi sebagai camilan sehat untuk remaja putri.*

KATA KUNCI: *kacang hijau; rumput laut ulva; soft cookies*

ABSTRACT

Background: *To address nutritional problems in adolescent girls, especially anemia, preventive measures are needed, including the provision of functional foods made with local ingredients such as mung beans and Ulva lactuca seaweed.*

Objectives*: This study aims to develop soft cookies with mung bean and Ulva lactuca substitution as a potential functional food for preventing anemia in adolescents. It also evaluates the physical, chemical, sensory characteristics, and iron content of the developed product.*

Methods: *This cross-sectional study involved 55 adolescents from State Junior High School 1 Cibungbulang selected using purposive sampling. Data were collected on breakfast habits (questionnaire), dietary intake (2×24-hour food recall), cognitive performance using the Letter Cancellation Test (attention) and Digit Letter Substitution Test (processing speed), and academic achievement based on midterm exam scores. Bivariate analysis was conducted using Spearman's test, Pearson's test, and independent t-test.*

Results: *The best formulation used 50% mung bean substitution. The developed product was more preferred (4.07) than the reference product (3.87). Per 100 g, it contains 4.39 mg of iron, 8.29 g of protein, 22.73 g of fat, 61.91 g of carbohydrates, 485.53 kcal of energy, 5.21% moisture, and 1.82% ash.*

Conclusions: *The optimal formulation is 50% mung bean substitution with 7.50% Ulva seaweed. The developed product was more preferred (4.07) than the reference (3.87). Per 100 g, it contains 4.39 mg iron, 8.29 g protein, 22.73 g fat, 61.91 g carbohydrates, 485.53 kcal energy, 5.21% moisture, and 1.82% ash. This product has potential as a healthy snack for adolescent girls.*

KEYWORDS*:* *mung beans, soft cookies, Ulva lactuca seaweed*

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INTRODUCTION

Anemia is one of the common health problems in adolescents, especially in developing countries such as Indonesia. Based on the 2023 Indonesian Health Survey (IHS) report, the prevalence of adolescent anemia among 15-24 year olds is 15.50%, with 18% among female adolescents and 14.40% among male adolescents. Although it has decreased compared to five years ago, the 15.50% figure is still considered high. According to the WHO, anemia affects 10% of the population (1). The high rate of anemia is due to various factors, including inadequate iron intake, an unbalanced diet, and increased iron requirements during puberty. Anemia, left unchecked, can negatively impact adolescents' concentration, productivity, and endurance. Adolescent girls' anemia is something that needs to be considered. When hemoglobin (Hb) levels are less than 12 g/dL, the disease is known as anemia. Worldwide, anemia affects 30% of women aged 15-49 (2). Adolescent girls who suffer from anemia may experience a few negative consequences, including decreased endurance, which makes them more vulnerable to infectious diseases, decreased fitness and cognitive agility due to oxygen deprivation of brain and muscle cells, and decreased learning achievement and work productivity/performance (3). Research by Chaparro & Suchdev shows that iron deficiency in adolescents can impair cognitive development, academic performance, and immune function (4).

Adolescent girls have a high potential for anemia, which can lower immunity and increase the risk of disease. If left untreated, the high prevalence of anemia can have serious impacts in adulthood, contributing to maternal mortality, premature birth, and low-weight babies (5). According to Georgieff et al., iron deficiency during adolescence can also affect long-term reproductive health (6). To prevent anemia, adolescent girls are advised to maintain adequate sleep and increase their consumption of nutritious foods. Animal foods such as meat, fish, chicken, liver, and eggs, as well as plant foods such as dark green vegetables, beans, tempeh, and spinach, are highly recommended (7).

To overcome the nutritional problems of adolescent girls, preventive measures are needed, including providing functional foods made with local ingredients such as mung beans and Ulva lactuca seaweed. Mung beans have high nutritional value, with 100 g containing 323 calories, 22.9 g protein, and 7.5mg iron (8). Central Java is the largest producer of mung beans in Indonesia. In 2018, it produced 234.718 tons of mung beans, a high yield for an agricultural crop (9). On the other hand, Ulva lactuca seaweed is also gaining attention as a source of functional nutrition. Ulva lactuca contains iron, vitamin C, and other bioactive compounds, such as chlorophyll and polysaccharides, that help support blood health and the immune system. The combination of mung beans and seaweed in one food product has the potential to complement each other, especially in terms of optimal iron absorption. Ulva lactuca. contains more than 44% protein by dry weight, a complete amino acid profile, PUFA omega-3 and 6, a source of polysaccharides, and a source of dietary fiber, minerals, and vitamins. Ulva lactuca has been shown to have antioxidant, anti-inflammatory, antimicrobial, antiviral, and anticancer properties (10).

Soft cookies were chosen as teen snacks because they have a soft texture and a sweet taste, in line with most adolescents' preferences. These snacks can be consumed anytime, anywhere, making them suitable for the active, dynamic lifestyle of adolescents. In addition, soft cookies can be made with various nutritious additives, such as mung beans, oats, or seaweed, to increase fiber, protein, and iron content, which are important for teenage growth and health. The attractive shape and appearance are additional value, as food visuals influence adolescents' interest in consumption. In terms of product development, soft cookies have strong potential to be a small business that is student-friendly, both as an entrepreneurial opportunity and as a medium for education about balanced nutrition and healthy eating.

However, the challenge in consuming these functional ingredients is how to present them in foods that adolescents like. Soft cookies are a popular snack among adolescents and have potential as a medium for nutrient fortification. With its shape and sweet taste, this snack attracts adolescents. Formulating cookies with mung beans and Ulva lactuca seaweed is expected to increase the product's iron content and other nutrients while maintaining a taste acceptable to target consumers. According to Guiné et al., the development of sensorially acceptable functional food products is key to the success of nutritional interventions (11). Therefore, this study aims to develop soft cookies with mung bean and *Ulva lactuca* seaweed substitution as a potential functional food for the prevention of anemia in adolescents. This study will also evaluate the physical, chemical, sensory, and iron content characteristics of the products produced.

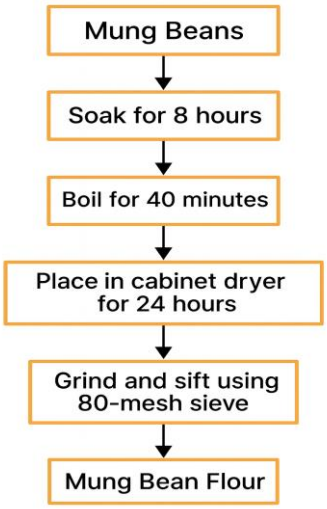
MATERIALS AND METHODS

This research began in September-December 2024. The main ingredients in this study were wheat flour, mung bean flour, and *Ulva lactuca* seaweed. These ingredients were obtained from certified local suppliers in Yogyakarta, Indonesia, and were then processed as needed before use (the *Ulva lactuca* seaweed was cleaned, dried, and milled into flour prior to incorporation into the cookie dough). This research employed a Research and Development (R&D) approach using the 4D model (define, design, develop, and disseminate). In the define stage, three soft cookie reference recipes were selected from several sources to obtain an appropriate base formulation.

In the design stage, soft cookie formulations were developed by substituting wheat flour with mung bean flour at levels of 30%, 40%, and 50% of the total wheat flour weight and then fortifying the dough with *Ulva lactuca* seaweed flour at levels of 5%, 7.50%, and 10% of the total flour weight, resulting in soft cookies substituted with mung bean flour and *Ulva lactuca* seaweed flour. In the development stage, the formulations and packaging design were validated by two food experts. In the dissemination stage, the products were evaluated by 80 panelists for aroma, taste, texture, shape, and overall acceptability and were further analyzed for proximate composition (moisture, ash, fat, protein, carbohydrates, energy, and calories) and iron content in both the reference and developed products.

The process of making soft cookies begins with making mung bean flour. Mung beans are

washed thoroughly, then soaked for 8 hours. Furthermore, mung beans are boiled until cooked for 40 minutes. After that, the mung beans are drained and laid out on a baking sheet. After that, it is dried using a cabinet dryer machine for 24 hours. After drying, the mung beans are ground and sieved using a flour sieve. Mung bean flour and *Ulva lactuca* seaweed flour are then used to make soft cookies. The stages of the process of making mung bean flour are shown in **Figure 1**.



Reference: (12).

Figure 1. Process of making mung bean flour

Next, *Ulva lactuca* seaweed flour is made. *Ulva lactuca* seaweed is washed thoroughly. Then boil the water until it boils, *Ulva lactuca* seaweed boiled for 3 seconds and flush using running water. Drain and arrange on a baking sheet. After that, it is dried using a cabinet dryer machine for 24 hours. Then, the dried *Ulva lactuca* seaweed is ground and filtered. *Ulva lactuca* seaweed pea flour is then used to make soft cookies. Next, the preparation process for Soft Cookies with Mung Bean and *Ulva lactuca* Seaweed Substitution is as follows: Begin by preparing all ingredients. Cream the butter, brown sugar, eggs, and granulated sugar with a mixer until light and fluffy. Add wheat flour, mung bean flour, baking powder, vanilla, mocaf seaweed, and instant coconut milk. Mix until well combined. Fold in chocolate chips, then shape the dough into portions weighing 20 g each. Bake at 175°C for 17 minutes. Ready to serve.

The organoleptic test used a 5-point hedonic scale, where 1 = very dislike, 2 = dislike, 3 = somewhat like, 4 = like, and 5 = very like. The sensory evaluation involved 80 untrained panelists aged 18–22 years, purposively selected from students in the Culinary Arts/Vocational Education program at the University/School, who regularly consume cookies and have no allergies to the product's ingredients. Each panelist evaluated the aroma, taste, texture, shape, and overall acceptability of both the reference and developed soft cookies. The hedonic scores were tabulated using Microsoft Excel, and the mean values were then analyzed using a paired t-test at a 5% significance level to determine differences between the reference and developed soft cookie products. Proximate analysis included the determination of moisture, ash, fat, protein, carbohydrate, and energy, while iron content was also measured for the cookie samples. Proximate analyses were carried out using standard gravimetric and volumetric methods according to AOAC procedures, and iron content was determined by spectrophotometry, with references to AOAC (2000/2012) and FAO/Wende proximate analysis guidelines. All nutritional analyses of the soft cookies were conducted at Saraswati Indo Genentech Laboratory, Bogor (SIG).

RESULTS AND DISCUSSIONS

The define stage

At the defined stage, a reference recipe was selected from three recipes with different sources.

The analysis in the define stage was conducted by five individuals: two lecturers and three classmates. of the three reference recipes, the optimal formulation was chosen based on texture, color, taste, aroma, and shape: reference recipe 2. Recipe 2 produces soft cookies with results in terms of the right taste and has a soft texture inside and outside the pansy; the aroma is typical of soft cookies. Reference recipe 3 formulation recipe is wetter, and after test baking, the powder is quite pronounced. Meanwhile, Recipe 1 exhibited a less dense texture. The reference recipe can be seen in T**able 1**.

Table 1. Recipe of Soft Cookies Reference

Ingredient	Reference Recipe 1	Reference Recipe 2	Reference Recipe 3
Wheat flour (g)	200	200	350
Butter (g)	110	115	150
Margarine (g)	-	-	50
Brown sugar (g)	75	100	100
Granulated sugar (g)	60	50	50
Eggs (g)	60	60	60
Salt (g)	2.50	2.50	2.50
Baking powder (g)	2.50	2.50	-
Vanilli (g)	3	3	-
Dark chocolate (g)	100	-	250
Chocochips (g)	-	150	-

Description:
Recipe 1: Cookpad hel 2024)
Recipe 2: Cooking with hel 2023)
Recipe 3: Choco Rosella cookies (2019)

Design stage

At this stage, the selected reference recipe was further developed by substituting wheat flour with mung bean flour and fortifying the dough with *Ulva lactuca* seaweed flour. In the design phase, mung bean flour was used to replace wheat flour at 30%, 40%, and 50% of the original wheat flour weight, and sensory evaluations by five trained panelists indicated that the 50% substitution level was the most preferred. The product at this level showed the desired color, aroma, texture, and shape, namely a brown color, a characteristic mung bean aroma, a sweet taste, and a soft cookie structure that was tender inside and slightly crispy on the outside. *Ulva lactuca* seaweed flour was then added at levels of 5%, 7.50%, and 10% of the total flour weight, and the panelists favored the 7.50% level, as this addition did not adversely affect the color or texture of the soft cookies. At 5%, the greenish color was insufficient, and the texture tended to be too crispy, whereas at 10%, the color became too dark and the texture slightly hard. Therefore, the formulation with 50% substitution of mung bean flour and 7.50% addition of *Ulva lactuca* seaweed flour was selected as the best treatment based on sensory scores.

At this stage, the selected reference recipe was further developed by substituting wheat flour with mung bean flour and fortifying the dough with *Ulva lactuca* seaweed flour. In the design phase, mung bean flour was used to replace wheat flour at levels of 30%, 40%, and 50% of the original wheat flour weight. Sensory evaluation by five trained panelists indicated that the 50% substitution level was the most preferred, as it produced a desirable brown color, characteristic mung bean aroma, sweet taste, and a soft cookie texture that was tender inside and slightly crispy on the outside.

Following this, *Ulva lactuca* seaweed flour was incorporated into the selected formulation (50% mung bean flour substitution) at levels of 5%, 7.50%, and 10% of the total flour weight. Based on sensory evaluation, the addition of 7.50% seaweed flour was the most preferred by

panelists, as it maintained a balanced color and texture of the soft cookies. At the 5% level, the greenish color was less noticeable, and the texture tended to be overly crispy, while at the 10% level, the product exhibited a darker color and a slightly harder texture.

Therefore, the formulation consisting of 50% mung bean flour substitution and 7.50% *Ulva lactuca* seaweed flour addition was selected as the optimal treatment, as it provided the best sensory characteristics without negatively affecting product quality.

The development stage

An expert panel, comprising two food technology lecturers acting as food experts, evaluated the prototype soft cookies during the development stage. At the development stage, the prototype soft cookies were evaluated by an expert panel consisting of two food technology lecturers who acted as food experts. The evaluation aimed to validate both the formulation and the sensory quality of the product, including color, aroma, taste, texture, and overall appearance. Based on the expert assessment, the formulation containing 50% mung bean flour substitution and 7.50% *Ulva lactuca* seaweed flour was considered acceptable and met the expected quality standards. The product exhibited a balanced sensory profile, with an appealing color, distinctive aroma, pleasant taste, and a soft texture. However, the experts recommended improving product uniformity by standardizing the size and shape of the cookies to enhance visual consistency and consumer appeal. The final prototype of soft cookies, substituted with mung bean flour and fortified with *Ulva lactuca* seaweed, is presented in **Figure 2**.

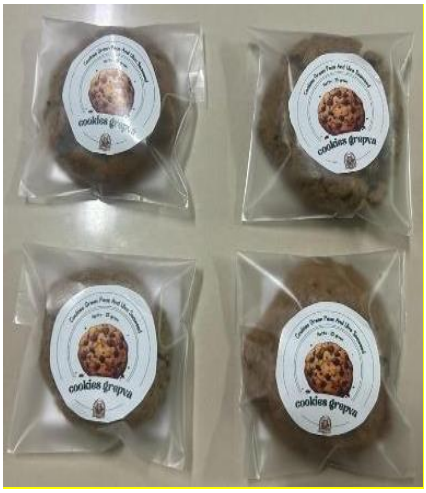


Figure 2. Soft Cookies Substituted with Green Mung Beans and *Ulva lactuca* Seaweed

Dissemination stage

At the dissemination stage, consumer acceptance testing was conducted with 80 untrained panelists using a 5-point hedonic scale (1 = very dislike to 5 = very like) to assess the reference and developed soft cookies. The evaluation was carried out using a structured hedonic test questionnaire, and the data were analyzed descriptively using mean scores and inferentially using a t-test to determine significant differences between the products. In contrast, proximate composition and iron content were analyzed in the laboratory according to standard procedures.

Organoleptic test

The results of the organoleptic test are influenced by two factors, namely external and internal. This organoleptic test was carried out on reference and development products to determine which of the two products is the most popular for the reference product or the soft cookie development. Based on the results of the organoleptic test, the developed product is preferred, as evidenced by the parameters of color, aroma, taste, texture, and overall. This shows the differences between the reference product, soft cookies, and the development of soft cookies.

Color

Color analysis of preference for the reference product yielded a score of 3.44, while the development product yielded a score of 3.50. Therefore, in terms of color, the development recipe was preferred by the panelists, with a color test result of 3.5.0 The t-test results for color show p=0.009, indicating a significant difference between the reference soft cookies and the developed soft cookies with green bean and seaweed substitutes. Although the difference is small, it is due to the addition of green beans and *Ulva lactuca* seaweed, which produce a different color effect between the reference and developed products. Color is the first aspect that consumers observe before tasting food, so it plays an important role in determining panelists' preferences (14). The color of the developed product is more intense than that of the reference product, so the reference product is preferred. Processing methods and the addition of certain ingredients can cause color changes in food (15). Processing methods and the addition of certain ingredients can cause color changes in food, particularly through reactions involving chlorophyll and other bioactive pigments present in plant-based ingredients (16).

Aroma

The aroma preference level analysis shows that the reference product scored 3.44, while the developed product scored 4.14. This condition indicates that the aroma of the developed product was preferred by the panelists, with a score of 4.14. The aroma t-test shows p=0.003, indicating a significant difference between the reference soft cookie product and the developed soft cookie product with green bean and seaweed substitutes. This significant difference in scores shows that the panelists preferred the aroma of the developed recipe variant. This finding is in line with the concept of sensory acceptance, which emphasizes that aroma plays a crucial role in shaping initial perceptions before tasting. The presence of a unique aroma can elicit positive expectations among panelists about the product's taste (17). The intensity of the aroma in the developed product is associated with the characteristic aroma compounds released from mung beans during baking (18). Additionally, the distinctive marine aroma contributed by *Ulva lactuca* seaweed provides a novel sensory dimension that enhances overall aroma acceptability (19).

Taste

The taste-preference analysis shows that the reference product scored 3.47, while the developed product scored 4.27. This indicates that in terms of taste, respondents preferred the developed product with a score of 4.27. The results of the t-test show a p-value of 0.29, indicating that there is no significant difference between the reference soft cookies and the developed soft cookies with green beans and seaweed. This increase is significant and indicates that the panelists prefer the developed variant for taste. This occurs because the combination of green beans and *Ulva lactuca* creates a more complex, distinctive flavor profile, offering a natural savory sensation not found in ordinary soft cookies. Green beans provide a light sweetness that contributes positively to the product's overall taste (20). Meanwhile, seaweed provides a mild salty or umami flavor that enhances the complexity of the taste profile (21). The presence of such complementary flavor notes from plant-based and marine-based ingredients has been reported to improve overall taste acceptability in fortified cookie products (22).

Texture

Texture analysis showed a preference score of 3.84 for the control product, while the developed product obtained a higher score of 4.09. This indicates that in terms of texture, respondents preferred the developed product with a score of 4.09. The texture test results showed 0.003, indicating a significant difference between the reference soft cookies and the developed soft cookies with green bean and seaweed substitutes. Texture is an important aspect of food quality because it can also affect the overall taste perception (23). These results indicate that the panelists preferred the texture of the developed product. One reason for this is that mung bean flour is rich in vegetable protein and fiber, which contributes to a softer yet dense (soft-grained) texture (24). Meanwhile, the addition of *Ulva lactuca* seaweed provides light elasticity due to its

polysaccharide content, resulting in a more appealing mouthfeel (13). The textural improvement observed in this study is consistent with findings by Nusaibah et al., who reported favorable texture scores in cookies substituted with *Ulva lactuca* flour (10).

Overall

The analysis of overall acceptability showed that the control product obtained a score of 3.87, while the developed product achieved a higher score of 4.07. This indicates that, in terms of overall preference, respondents favored the developed product with a score of 4.07. This difference suggests that, overall, the panelists preferred the developed soft cookies. The overall score represents a composite of all organoleptic aspects, reflecting how well the product is received by consumers in total (25). The use of mung beans in this recipe contributed a savory note, a softer texture, and enhanced protein and fiber content (9).

Meanwhile, the addition of *Ulva lactuca* seaweed not only enriched the nutritional profile with fiber, minerals, and antioxidants but also imparted a natural green color and a slightly distinctive marine taste (26). This combination of more complex and natural flavors, colors, and textures elevated overall liking, as sensory complexity in functional food products has been associated with greater consumer acceptability (11). Therefore, the higher overall score (4.07 for the developed product) confirms that the combination of mung beans and *Ulva lactuca* successfully produced richer, more appealing sensory characteristics than regular soft cookies. This aligns with current consumer trends that increasingly favor foods with unique flavors, natural appearance, and a healthy image associated with local or functional ingredients (17).

Comparison of the reference product and the soft cookies development

The comparison between the reference product and the development product is based on the results of the paired t-test. The parameters tested were color, aroma, taste, texture, and overall properties. From the paired-sample t-test, it is evident that there is a significant difference between the reference and development products in color, aroma, and texture parameters. There is no significant difference in the taste or overall between the reference product and the development product. There is a significant difference between the two samples of reference and development products that have been accepted by the community.

Nutritional content

The results of the proximate test and iron content analysis of soft cookies weighing 100 g showed that the iron content in mung bean and *Ulva lactuca* seaweed soft cookies was 4.39 ± 0.03 mg/100g, higher than that of the original soft cookies at 4.19 ± 0.02 mg/100g. This indicates that substituting mung beans and *Ulva lactuca* seaweed affects iron content. Mung bean flour has a relatively high iron content, namely around 7.5 mg per 100 g, which directly contributes to the increased iron level of the developed product (9). Furthermore, mung beans have been confirmed to be a rich source of iron, with a range of 5.9–7.6 mg per 100 g of dry weight across various varieties (27). *Ulva lactuca* seaweed also contains iron and various important minerals that further contribute to the mineral profile of the product (26). The higher the level of substitution of mung beans and *Ulva lactuca* seaweed, the higher the iron content in the product (13). The increased iron content in this formulation has the potential to help prevent anemia, especially among vulnerable groups such as adolescents and women of reproductive age (28). Iron is an essential component of hemoglobin, which transports oxygen throughout the body (6).

The nutritional test results showed that the ash content in mung bean and *Ulva lactuca* seaweed soft cookies was 1.84 ± 0.01%, higher than that of the original soft cookies (1.10 ± 0.01%). This increase in ash content is due to the use of food ingredients with higher mineral content, such as green spinach puree and mung bean flour (16). In 100 g of mung bean flour, there are 223 mg of calcium, 319 mg of phosphorus, and 7.5 mg of iron (29). The ash content of *Ulva lactuca* seaweed has been reported at approximately 2.24%, reflecting its naturally high mineral content (13). *Ulva lactuca* spp. have further been confirmed to contain important

minerals, including calcium, iron, and magnesium, at levels beneficial for human nutrition (30). The increase in ash content in this research product is consistent with findings on products incorporating high-mineral marine ingredients (10). Several factors that can affect the ash content in food are the drying method, type of food ingredient, temperature, and drying time; the longer the drying time and the higher the temperature, the higher the ash content tends to be (31). The high mineral content, including iron, in these ingredients enhances the product's potential as a functional snack that can help maintain the body's iron status and support efforts to manage natural anemia (22).

The energy from fat in mung bean and *Ulva lactuca* seaweed soft cookies was 204.75 ± 2.67 Kcal/100g, higher than that of the original soft cookies at 190.76 ± 1.59 Kcal/100g. The total fat content of mung bean and *Ulva lactuca* seaweed soft cookies was 22.75 ± 0.30% per 100 g, higher than that of the original soft cookies at 21.20 ± 0.18% per 100 g. The fat content in mung bean flour itself is relatively low, at approximately 1.05 g per 100 g; therefore, the difference in fat content produced is thought to be influenced by the type of composite flour and additives such as margarine used in the formulation (18). Changes in flour composition during substitution can alter fat distribution across the final product (31).

The protein content of mung bean and *Ulva lactuca* seaweed soft cookies was 8.29 ± 0.06%, higher than that of the original soft cookies at 5.72 ± 0.04%. This increase indicates that the protein content of mung bean flour, approximately 22.75%, directly contributes to the higher protein level in the developed product (32). The more mung bean flour added, the higher the protein content in the product, as mung bean is widely recognized as a rich source of plant protein (27). *Ulva lactuca* seaweed has great potential as a sustainable food source with high nutritional content, including protein, vitamins, and minerals, making it an attractive alternative to conventional protein sources (26). This is consistent with the study by Mohibbullah et al., which showed that adding *Ulva lactuca* intestinalis to cookies increased protein and mineral content without significantly compromising sensory quality (22). The protein and important minerals, such as iron, in this product contribute to improving nutritional status and blood health, supporting metabolic function (20). Protein adequacy alongside sufficient iron intake is particularly critical for adolescent girls to support hemoglobin synthesis and prevent iron deficiency (6).

Table 2. Nutritional Content Results

Parameter	Unit	Soft Cookies	Parameter
Iron (Fe)	mg/100g	4.19 ± 0.02	4.39 ± 0.03
Ash Content	%	1.10 ± 0.01	1.84 ± 0.01
Calories by Fat	Kcal/100g	190.76 ± 1.59	204.75 ± 2.67
Total Fat Content	%	21.20 ± 0.18	22.75 ± 0.30
Water Content	%	5.92 ± 0.11	5.22 ± 0.05
Calories Total	Kcal/100g	477.94 ± 0.43	485.53 ± 1.74
Carbohydrate (By Diff)	%	66.08 ± 0.33	61.91 ± 0.17
Protein Content	%	5.72 ± 0.04	8.29 ± 0.06

The water content of mung bean and *Ulva lactuca* seaweed soft cookies was 5.22 ± 0.05%, lower than that of the original soft cookies at 5.92 ± 0.11%. This reduction was due to the pre-drying process applied to mung bean flour and *Ulva lactuca* seaweed before their incorporation into the formula (16). The higher the temperature and the longer the drying time, the greater the heat energy carried by the air, so the amount of liquid mass evaporated from the surface of the cookies increases (31). A lower moisture content generally contributes to a longer shelf life and a crispier texture in cookie products (19). The energy content of mung bean and *Ulva lactuca* seaweed soft cookies was 485.53 ± 1.74 Kcal/100g, higher than that of the original soft cookies at 477.94 ± 0.43 Kcal/100g. This increase reflects the contribution of higher protein and fat content from the nutritionally rich substitute ingredients (20). The increase in energy value is consistent with the

increase in protein and fat levels that accompany the substitution of wheat flour with mung bean flour and *Ulva lactuca* seaweed (10). The carbohydrate content test results showed that the mung bean and *Ulva lactuca* seaweed soft cookies have a content of 61.91 ± 0.17% per 100 g, lower than the original soft cookies at 66.08 ± 0.33% per 100 g. This decrease was due to the reduction in wheat flour, which was replaced with mung bean flour and *Ulva lactuca* seaweed, which have relatively lower available carbohydrate content (16). Moreover, carbohydrate values calculated using the by difference method are also influenced by other nutritional components; if the values of protein, fat, water, and ash are high, the calculated carbohydrate content will be correspondingly lower (20). This condition indicates that substituting wheat flour with mung bean flour and *Ulva lactuca* seaweed not only alters the protein and mineral profiles but also creates a more balanced carbohydrate profile (26).

Based on the results of all nutritional analyses (**Table 2**), the substitution of mung beans and *Ulva lactuca* seaweed in soft cookie formulations resulted in significant increases in iron, protein, and other key minerals that play vital roles in hemoglobin formation and metabolic functions. Therefore, this product has potential as a functional food to help prevent anemia, especially among vulnerable groups such as adolescents and women of reproductive age. Routine consumption of soft cookies made from mung beans and *Ulva lactuca* seaweed is expected to support the community's nutritional status, aid the diversification of locally sourced, nutritious foods, and contribute to optimal public health.

CONCLUSION AND RECOMMENDATION

The best formulation of mung bean and *Ulva lactuca* seaweed soft cookies, with 50% mung bean flour and 7.50% *Ulva lactuca* seaweed, is not only preferred organoleptically but also rich in iron, at 4.39 g per 100 g. This high iron content indicates that the product has potential as a functional snack to help prevent anemia, especially among adolescents, who are a vulnerable group for anemia. Regular consumption of soft cookies made from mung beans and *Ulva lactuca* seaweed can help meet daily iron needs, thereby supporting anemia prevention through healthy, nutritious food intake.

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