ORGANOLEPTIC TEST AND NUTRITIONAL CONTENT OF CHIPS WITH THE ADDITION OF GREEN SPINACH FLOUR TO PREVENT ANEMIA IN TEENAGE GIRLS

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ABSTRACT

Anemia is a health problem that is often experienced by young women in Indonesia, especially due to iron deficiency. Efforts to prevent anemia can be done by increasing the consumption of food commodities in the region that are rich in iron, such as green spinach. This study aims to determine the results of organoleptic tests (color, aroma, taste, and texture) and nutritional content, especially iron levels, in chip products with the addition of green spinach flour. The study was conducted in Denai Kuala Village, Pantai Labu District. This type of research uses an experimental method with a Completely Randomized Design (CRD) design with 1 control, 3 treatments namely with the addition of green spinach flour (F0 = 0 gr, F1 = 20 gr, F2 = 40 gr, and F3 = 60 gr) with 3 replications. The results of the study can be analyzed by ANOVA test, if it shows a significant effect, it is continued with Duncan's Multiple Range Test. Organoleptic tests were conducted on 30 panelists of young women aged 14-20 years. The results showed that F1 was the most preferred formulation by the panelists, with an average score of 4.03 for color, 4.13 for aroma, 3.43 for taste, and 3.47 for texture. However, F3 had the highest iron content, even exceeding the daily iron requirement of teenage girls, thus creating a dilemma between the formulation with the best acceptance and the formulation with the highest nutritional value in F3 (100.2 mg/kg). This condition shows that further research is still needed to find the right balance between taste and nutritional content in the development of local food products.

Keywords: Organoleptic Test, Chips, Green Spinach, Iron, Anemia.

Introduction

Adolescence is a transitional period from childhood to adulthood, marked by major changes in physical, psychological, and social aspects. At this stage, adolescents are exploring their identity and shaping their personality. If they are able to overcome the developmental challenges they face, adolescents will grow into strong individuals who are capable of facing the obstacles of adult life. Healthy and capable adolescents are valuable assets for the future progress of the nation. Therefore, maintaining the health and nutrition of adolescents from an early age is very important so that they can become an innovative, competitive, and high-quality generation (Suryana et al, 2022).

One of the most common health problems affecting adolescent girls in Indonesia is iron deficiency anemia. This condition not only weakens the immune system but also affects concentration, physical stamina, and growth. The incidence of anemia among Indonesian adolescent girls remains quite high, reaching 57.1% in the 10–18 age group, and can even increase to 71% in some rural areas such as Deli Serdang Regency. Anemia is more common in adolescent girls because they lose iron during menstruation, so they need a higher iron intake. Unfortunately, iron intake, whether through food or supplements, is still relatively low. (S, Choirunnisa LF, Putri AF, 2024).

Anemia is a common health disorder, particularly in developing countries such as Indonesia. This condition is a major factor behind prolonged disability, which has a significant impact on the health, economy, and welfare of the community. In general, anemia affects adolescent girls more often than adolescent boys. (Yulita et al. 2020).

Table 1. Nutritional Adequacy Intake (AKG) for Adolescent Girls

Nutrients	Ages		
	10-12 Years	13-15 Years	16-18 Years
Energy (kcal)	1900	2050	2100
Protein (g)	55	65	65
Fat (g)	65	70	70
Carbohydrate (g)	280	300	300
Fiber (g)	27	29	29
Iron (g)	8	15	15
Iodine (mcg)	120	150	150
Calcium (mcg)	1200	1200	1200

According to the Recommended Dietary Allowance (RDA), adolescent girls require approximately 15–18 mg of iron daily. To avoid iron deficiency, it is recommended to consume iron-rich foods, such as liver, lean and white meat, various types of nuts, and green vegetables. Anemia in adolescents can reduce concentration while studying, weaken physical fitness, and stunt growth, ultimately affecting height and weight, which ultimately affect normal height and weight. (Herwandar & Soviyati, 2020)

The Indonesian government has taken steps to address anemia by providing iron supplements (IBT) in schools. However, compliance with iron supplement consumption is still not optimal, meaning that the majority of adolescents do not reach the recommended amount. In addition to iron supplements, strategies based on local foods are also crucial in the fight against anemia. Using local food ingredients, such as green leafy vegetables with high iron content, can be a sustainable approach in the long term. For example, amaranth (Amaranthus) is an easy-to-grow plant with high nutritional value, containing iron, calcium, and vitamins A and C, which support iron absorption in the body. (Kereh PS, Montol AB, Legi NN, Lontaan A, Robert D, 2024)

In addition to iron supplementation, an approach utilizing local foods is an important strategy for preventing anemia in adolescents. Green vegetables such as spinach are readily available, inexpensive, and rich in iron, making them potential functional food ingredients. Several previous studies have developed various spinach-based products, such as spinach flour, biscuits, or iron-fortified snacks. However, most studies have focused on increasing the iron content or nutritional characteristics of the product, without considering the balance between optimal nutritional content and product acceptability by adolescents, a target group sensitive to taste and aroma.

To date, there has been little research examining the formulation of spinach flour-based chip products with specific attention to the dilemma between sensory acceptance and iron content. Products with a high spinach content typically have greater iron content, but are often less preferred in terms of color, aroma, or taste. Conversely, formulations with a low spinach content tend to be more preferred, but have lower iron content. Therefore, research is needed that can optimize this balance in chip products that are popular with teenagers, so that they can become a more acceptable and sustainable local food alternative for anemia prevention.

According to the Indonesian Ministry of Health, the incidence of anemia in adolescent girls aged 10-18 years in Indonesia is 57.1%, while in the 19-45 age group it is 39.5%. Meanwhile, the latest data obtained in rural areas of Deli Serdang Regency shows that anemia cases have reached 71%. Based on data from the Pantai Labu District Health Center, there were 242 cases of anemia in adolescent girls in 2024. (Julaecha, 2020)

Increasing your intake of nutrient-dense foods derived from plant proteins, such as spinach, is one strategy to avoid anemia. (Petricka et al, 2023)

Spinach is a good source of calcium, phosphate, iron, fat, protein, carbohydrates, and vitamins A, B1, and C. The various nutrients in spinach provide many health benefits.(EP., 2018) Spinach contains various important nutrients such as protein, minerals, calcium, iron, and vitamins that are needed by the body. Spinach contains iron, which is important for hemoglobin synthesis, as can be seen in table 1: (Qadri et al., 2022)

Table 2: Nutritional Content of Green Spinach per 100 grams

Nutrient content	Amount per 100 grams
Energy	23 kkal
Protein	2,9 g
Fat	0,4 g
Carbohydrates	3,6 g
Dietary Fiber	2,2 g
Calcium	99 mg
Iron	2,7 mg
Magnesium	79 mg
Phosphorus	49 mg
Potassium	558 mg
Vitamin A	469 µg
Vitamin C	28,1 mg
Folate	194 µg

Spinach flour is a flour made from spinach leaves through several stages, starting with washing the leaves, separating them from the stems, and weighing them. The leaves are then dried at 60°C for 19 hours. After drying, the leaves are ground using a grinder until smooth, and the ground spinach flour is then sieved through an 80-mesh sieve. (Harlyanti Muthma'innah Mashar, 2024)

Table 3. Contents of Green Spinach Flour per 100 grams:

Nutrients	Quantity
Crude protein (g)	18,93
Crude fat (g)	4,42
Moisture content (g)	6,68
Ash content (g)	12,86
Crude fiber (g)	16,82
Carbohydrate (g)	40,29
Iron (mg)	32,93

One innovation in snack processing that is expected to help anemia sufferers meet their iron needs is the addition of spinach flour to chip recipes. Chips are now a common snack in thin slices due to their crunchy texture, savory taste, not too filling, and availability in a variety of flavors, such as salty, spicy, and sweet. (Dahlan et al., 2023) Furthermore, this procedure can increase the shelf life of spinach and create business prospects in the food processing industry.

Method

This study used an experimental method with a Completely Randomized Design (CRD), consisting of one control group (F0) and three treatment groups (F1, F2, F3), with three replications. F0: 0 g amaranth flour; F1: 20 g amaranth flour; F2: 40 g amaranth flour; F3: 60 g amaranth flour. Organoleptic data were obtained from female adolescent panelists, while nutritional analysis was conducted by laboratory tests. Duncan's Multiple Range Test (DMRT) was used consistently for post-hoc analysis. (Laili RD, Ethasari RK, 2023)

Tools and materials

Table 4. Chip Making Tools:

No	Tools	Amount of ingredients
1	Scales	1
2	Container	7
3	Knife	1
4	Spoon	2
5	Sieve/Strainer	1
6	Blender	1
7	Measuring cup	1
8	Frying pan	1
9	Spatula	1
10	Stove	1

Research Procedures

Step 1: Making Green Spinach Flour

Making green spinach flour begins by separating the spinach leaves from their stems, washing them thoroughly, boiling them for 1 minute, and then drying the boiled spinach leaves in the sun for 48 hours, or approximately 2 days. Once the spinach leaves are dry, the next step is to grind the spinach using a blender or pestle to form a flour. After blending or pounding, the spinach flour is sieved through an 80-mesh sieve to form a fine spinach flour. The green spinach flour can be used in making chips. (Awaliyah et al., 2023)

Once the green spinach flour is complete, the next step is to make chips using the green spinach flour. This process involves several steps, starting with the creation of various control formulas and chip formulas containing the green spinach flour, followed by organoleptic testing of these formulas. The next step is to analyze the nutritional content of the chips.

Step 2: Making Control Chips

The process of making control chips begins by gradually mixing ingredients such as 2 tablespoons of butter, ½ egg, ¼ tablespoon of salt, ¼ tablespoon of chicken stock, ¼ tablespoon of pepper, 3 cloves of garlic, 1 clove of shallot, and 2 stalks of celery until evenly combined. Next, 100 grams of wheat flour is added to the mixture and stirred until a homogeneous dough forms. The dough is then shaped using an onion cake mold, then fried until cooked through, and the chips are ready to eat.

Step 3: Making Green Spinach Flour Chips

The first step in making spinach chips is to gradually mix ingredients such as 2 tablespoons of butter, half an egg, ¼ tablespoon of salt, ¼ tablespoon of chicken stock, ¼ tablespoon of pepper, 3 cloves of garlic, 1 clove of shallot, and 2 stalks of celery until thoroughly combined. Next, combine the mixture with spinach flour and wheat flour in three different ratios: F1 (20 g: 80 g), F2 (40 g: 60 g), and F3 (60 g: 40 g). Each mixture is stirred until a homogeneous dough forms. Once the dough is formed, the next step is to shape the dough using an ampia (onion cake mold). The molded dough is then fried until cooked through, becoming spinach chips that are ready to eat.

Stage 4. Acceptability Test

At this stage, organoleptic evaluation is conducted. Organoleptic evaluation is an approach to product assessment that uses the human senses. People selected as panelists to evaluate the products provided can carry out this organoleptic evaluation. Various aspects, such as taste, color, smell, and nutritional content, have a major impact on the assessment of food or other products. The main focus in organoleptic evaluation is the color, taste, texture, and aroma of food or beverages. (Rahmani & Gusnadi, 2024)

The preference test in this study included five levels of scale, as listed in Table 5.

Table 5. Panelist Preference Test Level

Hedonic Scale	Numerical Scale
Very Dislike	1
Do not like	2
Kinda Like	3
Like	4
Really like	5

The panel participants in this study consisted of 30 young women aged 14 to 20 years from Denai Kuala Village, Pantai Labu Subdistrict, and they were selected by the researchers.

Stage 5. Nutrient Content Analysis

The nutritional content of spinach flour chips was examined using Atomic Absorption Spectrophotometry (AAS). The iron content analysis was conducted at the

Medan Industrial Research and Standardization Center, Jl. Sisingamangaraja No. 24, Pasar Merah Barat, Medan Kota District, Medan City, North Sumatra, 2017.

Stage 6. Data Processing and Analysis

Organoleptic test data, including color, aroma, taste, and texture, of green spinach flour chips were analyzed using the SPSS statistical program using ANOVA. If the results were significant or showed a value <0.05, further testing was conducted using the Duncan New Multiple Range Test (DNMRT). The iron content test results are presented in tabular form.

Results

Sample Characteristics

The spinach chips produced in this study were characteristically green, similar to the color of green mayam. The green color of green spinach is due to the pigment chlorophyll, but the most well-known nutrient found in green spinach is iron.

The spinach chips produced in this study weighed 2 grams before and after frying. Based on BPOM Regulation Number 26 of 2021 concerning Nutritional Information (ING), the recommended serving size for chips is between 20 and 40 grams.(BPN, 2021) In this study, the chips were served at 30 grams, equivalent to 15 chips.

Figure 1. Control chips and chips with the addition of green spinach flour

Organoleptic Test

1. Color Aspect

Table 6. Acceptability (Color) of Chips with the Addition of Green Spinach Flour

Sample	Mean ± Std. Deviation	*P value*
F0	(4,37±0,61) [c]	
F1	(4,03 ±0,85) [bc]	.000
F2	(3,87±0,68) [b]	
F3	(3,30± 0,75) [a]	

Description: a,b,c,d = The same notation indicates that there is no real difference at the Duncan test level (DMRT) which has a value of 5%.

The addition of green spinach flour significantly affected the color of the chips ($p < 0.05$). The results of the DMRT follow-up test showed that treatments F0, F2, and F3 differed significantly from each other. However, F0 did not show a significant difference from F1 or F1 with F2, so at the initial substitution level, the color change was still acceptable.

2. Aroma Aspect

Table 7. Acceptability (Aroma) of Chips with the Addition of Green Spinach Flour

Sample	Mean ± Std. Deviation	*P value*
F0	(4,43 ± 0,72) [c]	
F1	(4,13 ± 0,86) [c]	.000
F2	(3,70 ± 0,91) [b]	
F3	(3,23 ± 0,81) [a]	

Description: a,b,c, = The same notation indicates that there is no real difference at the Duncan test level (DMRT) which has a value of 5%.

The addition of green spinach flour significantly affected the aroma of the chips ($p < 0.05$). The results of the DMRT test revealed significant differences between treatments F1, F2, and F3. Conversely, there were no significant differences between F0 and F1, indicating that the initial substitution level did not significantly affect the aroma.

3. Taste Aspect

Table 8. Acceptance of Chips with Added Green Spinach Flour

Sample	Mean ± Std. Deviation	*P value*
F0	$(4,33 \pm 0,60)^{d}$	
F1	$(3,43 \pm 0,72)^{c}$	.000
F2	$(2,73 \pm 0,74)^{b}$	
F3	$(1,50 \pm 0,82)^{a}$	

Note: Identical notation such as a, b, c, d indicates that there is no significant difference in Duncan's test (DMRT) with a significance level of 5%.

The addition of green spinach flour was found to have a significant effect on the taste of the chips ($p < 0.05$). The results of the DMRT follow-up test showed that each treatment, namely F0, F1, F2, and F3, had significant differences from one another, indicating a noticeable change in taste as the substitution level increased.

4. Texture Aspect

Table 9. Acceptance level of chip texture with the addition of green spinach flour

Sample	Mean ± Std. Deviation	*P value*
F0	$(4,03 \pm 0,76)^{c}$	
F1	$(3,73 \pm 0,69)^{cb}$	.000
F2	$(3,46 \pm 0,57)^{ab}$	
F3	$(3,13 \pm 0,81)^{a}$	

Description: a,b,c, = The same notation indicates that there is no real difference at the Duncan test level (DMRT) which has a value of 5%.

The addition of green spinach flour significantly affected the texture of the chips ($p < 0.05$). Further DMRT tests showed no significant differences between F0 and F1, F1 and F2, or F2 and F3. However, there were significant differences between F0 and F2 and between F1 and F3, indicating that higher levels of substitution caused significant changes in texture.

5. Iron Analysis

Table 10. Average results of iron (Fe) content analysis.

Parameters	Treatment		
	Chips F1	Chipsk F2	Chips F3
Iron (mg/kg)	63,5	87,9	100,2

Based on Table 10, the highest iron content was found in the best treatment, namely the addition of 60 grams of green spinach flour (F3), which produced 100.2 mg/kg. The next treatment was F2, with the addition of 40 grams of green spinach flour, which produced an iron content of 87.9 mg/kg, and F1, with 20 grams of green spinach flour, produced an iron content of 63.5 mg/kg.

Discussion

1. Color Aspect

Color is the first thing people notice about food. Color acts as an indicator of the degree of doneness of a food.(Khuzaimah S., 2018) Because color is the first thing people notice about a food, it influences its acceptance. Attractive colors can make people want to buy the product. (Yusuf et al., 2023).

Bright color was also important to the judges because the three chip samples with added spinach flour tended to have the same color, specifically a brownish green. Chips in the control formulation had a yellow-brown color similar to regular chips, in contrast to chips without the addition of spinach flour (F0/Control). According to the panelists' evaluation, formulation F1, which replaced spinach flour with wheat flour (20:80 grams), produced chips with the most desirable color, with an average score of 4.03; however, F0 chips received a higher rating than chips without the addition of spinach flour (F0/Control). This is because the panelists are more accustomed to seeing yellow-brown chips. The reason sample F1 is most preferred is because it produces a green color in this formulation, while sample F2, which replaces green spinach flour with wheat flour (40:60 grams), produces a slightly darker green color, and F3 with a substitution ratio of green spinach flour: wheat flour (60:40 grams) produces a dark green color, where the greater the amount of green spinach flour added, the darker the color of the chips produced.

The ANOVA test showed a difference in color between the green spinach chip treatments ($p<0.05$). Duncan's Multiple Test showed that the F0 and F1 samples were not significantly different, and neither were the F1 and F2 samples. The F0 sample differed significantly from the F2 and F3 samples due to the clear color difference in the chips produced.

Research by Sharma et al. (2021) in the Journal of Food Science and Technology states that color is one of the most important sensory attributes influencing consumer decisions about food products. In research on vegetable-based product development, it was found that the addition of natural green ingredients, such as spinach, can cause the product to become darker in color, depending on the concentration used. Products with a bright green color are generally more desirable than those with a darker green color, as they are considered to reflect freshness and a natural impression. However, colors that are too dark can reduce visual appeal and affect consumers' taste perceptions of the product. (Waseem, M., Akhtar, S., Manzoor, M. F., Mirani, A. A., Ali, Z., & Ismail, 2021).

Singh and Jha's (2020) research showed that the color of spinach-based snacks was significantly influenced by the level of substitution. A spinach substitution of more than 40% resulted in a less desirable dark green color, while a proportion of 20–30% resulted in a yellowish green color, which panelists preferred because it resembled the snack's natural color. (Shevkani, K., Singh, N., Rattan, B., Singh, J. P., Kaur, A., & Singh, 2019)

2. Aroma Aspect

One of the elements that influences the deliciousness of food is aroma. (Agustina R, Fadhil R, 2023) This aroma comes from volatile compounds found in food products. When the product is consumed and in the mouth, these compounds are detected by the olfactory system in the nose. (Chairuni et al., 2022)

In this study, eggs and margarine were food elements that influenced aroma. It was expected that the addition of eggs and margarine would mask the usually strong aroma of green spinach flour. The aroma of green spinach chips that was most preferred by panelists based on the results of the organoleptic test was the aroma of F1 chips which had an average value of 4.13 and a ratio of spinach flour to wheat flour (20:80 gr). This may have occurred because panelists have a reputation for liking the distinctive and less pleasant aroma of green spinach flour. When compared with samples F2 and F3, panelists considered the formulation of the addition of green spinach flour in sample F1 to have an appropriate aroma, while the aroma of sample F1 was too strong. Therefore, panelists preferred sample F1. Based on the results of the organoleptic test conducted on chips, the aroma component in the chip formulation with the addition of green spinach flour was still higher than the F0 chips without the addition of green spinach flour. This is because chips containing green spinach flour have a strong aroma.

When green spinach flour was added to the chips, the aroma changed ($p < 0.05$), according to the results of the statistical analysis test using the ANOVA test. Continued with Duncan's Multiple Test, found no clear difference between samples F0 and F1. There was a significant difference between F0 and F2 and F3. In addition, the F1 sample was significantly different from samples F2 and F3. In addition, there was a substantial difference between samples F2 and F3. The increasing percentage of green spinach flour added resulted in variations in the chip samples, and the resulting aroma was generally not well received.

Research conducted by Almeida et al. (2020) explains that the aroma in food products is produced by volatile compounds formed during the thermal processing. Vegetable-based snacks, such as spinach, generally have a fairly strong and distinctive aroma, so it is necessary to add other ingredients, such as margarine and eggs, to help balance the aroma. (Almeida, D.T, Nascimento, M. S., & Bastos, 2020)

3. Taste Aspect

Taste is the third factor that has been proven to have a significant influence on the panelists' acceptance level of a product. The taste aspect greatly determines the extent to which a food can be accepted, as it serves as a benchmark for consumers in assessing the deliciousness of food. The resulting taste characteristics are greatly influenced by the basic ingredients used during the processing.

Components such as flavoring, salt, and spinach flour play a role in shaping the taste of the product. The addition of salt and flavoring is intended to reduce the dominance of spinach flour, which is considered unfamiliar and tends to be less preferred by panelists. Based on the organoleptic test results, chips without the addition of spinach flour (F0/control) obtained the highest score of 4.33. Chips with the F1 formulation, which had an average score of 3.43 and a ratio of spinach flour to wheat flour (20:80 g), were the chips with the addition of spinach flour that the panelists preferred most in terms of taste. Based on the flavor component, the F0 chips had a higher organoleptic test score than the chips with the addition of spinach flour, which nevertheless tasted strange to the panelists.

After statistical analysis using ANOVA, the results showed that the addition of green spinach flour to the chips changed the taste with a value of ($p<0.05$). After data analysis using ANOVA, Duncan's Multiple Test showed significant variations in the taste of samples F0, F1, F2, and F3 across all green spinach flour chip treatments.

Arun et al. (2021) found that dried spinach can produce a bitter aftertaste or an unpleasant "grassy" taste, so adding salt, spices, and the right proportion of flour is necessary to maintain a balanced taste. Excessive use of spinach flour has the potential to reduce the level of enjoyment of the resulting product. (Arun, R, Kumar, M., & Singh, 2021)

4. Texture Aspect

Texture is the fourth factor that influences the level of acceptance of a product. In food quality assessment, texture is an important indicator because it can be felt through the touch of the fingers, tongue, and palate. Texture reflects the characteristics of food ingredients that are formed from a combination of physical and chemical properties, and can be recognized through the senses of touch, sight, and hearing. Through sensory testing, food texture can be analyzed and assessed, for example in terms of hardness, crispness, ease of crushing, and ease of consumption. (Rahmawati et al, 2024)

The same procedure was applied in conducting the organoleptic test, which involved asking the panelists to taste the chips to assess their overall texture and feel the surface of the product.

Based on the organoleptic test results, chips without the addition of green spinach flour (F0/control) obtained a texture score of 4.03. Meanwhile, chips in treatment F1 with a ratio of green spinach flour to wheat flour of 20:80 grams obtained an average score of 3.73, making it the variant most preferred by the panelists. Chips made with green spinach flour had a coarser texture than chips made with wheat flour, making them less soft than chips made without wheat flour. Consequently, chips with and without green spinach flour had varying selling prices.

The addition of green spinach flour resulted in a significant difference ($p < 0.05$) in chip texture, according to statistical analysis using ANOVA. Duncan's Multiple Test (MDR) found no significant difference between F0 and F1 samples. Furthermore, there were no significant differences between F1 and F2, or F2 and F3. The amount of green spinach flour administered varied up to 40 grams, resulting in substantial differences between F0 and F2 treatments, as well as between F1 and F3. We can conclude that the texture of the final chip product is influenced by the amount of green spinach flour added.

Based on organoleptic testing, the best recommended formulas for adding green spinach flour to chip products are formula F1 with 20 grams of green spinach flour, followed by formula F2 with 40 grams of green spinach flour. Meanwhile, the highest iron content analysis result was in F3, at 100.2 mg/kg.

In terms of texture, this is in line with research by Sivam et al. (2018), which shows that vegetable fiber content affects the hardness and crispiness of the product. A combination of vegetable flour and wheat flour in a proportion of 20–30% can produce an optimal texture that consumers prefer. (Sivam, A. S., Sun-Waterhouse, D., Perera, C. O., & Waterhouse, 2018)

5. Iron Analysis

The body naturally excretes about 1 mg of iron daily through the skin and intestinal lining. Therefore, it is important to consume about 1 mg of iron per day from food to maintain a balance between iron absorption and excretion in the body. (Chalifaturrachim & Sofyaningsih, 2022)

Because it helps produce heme, which binds and transports oxygen to every part of the body, iron is a crucial mineral essential for hemoglobin development. Iron plays a crucial role for adolescent girls because it helps produce red blood cells and myoglobin, both of which are essential for muscle development. (Devi et al., 2023)

Based on the results of iron content tests, between spinach flour and wheat flour, it was found that sample F1 (20:80) had an average iron content of 63.5 mg/kg, while sample F2 (40:60) contained an average iron content of 87.9 mg/kg, and sample F3 (60:40) contained an average iron content of 100.2 mg/kg. Among the three samples, sample F3 had the highest iron content, with a composition of green spinach flour and protein flour (60:40).

According to the USDA Table, the iron content in green spinach reaches 2.7 mg per 100 grams of edible material (BDD). Meanwhile, green spinach flour contains much higher iron, namely 32.93 mg per 100 grams according to Product Nutrition Facts. Due to its high iron content, this study assumes that the greater the proportion of green spinach flour used, the higher the iron content of the chips to which the flour is added. This is in line with Na's findings in the study of adding spinach to donuts, which showed that the more spinach added, the higher the iron content of the final product.

100.2 mg/g, compared to F0 chips at 63.5 mg/g and F1 chips at 87.9 mg/g. The increase in iron levels is thought to be influenced by the addition of red beet flour to the chip formulation. Spinach contains several important nutrients such as protein, minerals, calcium, iron, and vitamins that the body needs. However, consuming iron supplements excessively and over a long period of time can damage the intestinal lining, change the body's pH, cause shock, and even lead to liver failure. Alternatively, iron needs can be met by consuming iron-rich foods, such as green spinach (Amaranthus). Spinach contains iron, which is essential for hemoglobin synthesis. (Jumiati J, Ardyanti DPI, Kusrini K, 2023)

6. Iron Contribution

In this study, the chips were served in a 30-gram serving, equivalent to 15 chips. The iron content of F1 chips, which used 20g of green spinach flour, contributed 238% of the daily requirement for children aged 10–12 years, and 127% for adolescents aged 13–15 and 16–18 years. In F2 chips, which used 40g of green spinach flour, the iron contribution increased to 330% for children aged 10–12 years, and 176% for those aged 13–15 and 16–18 years. Meanwhile, F3 chips, containing 60g of green spinach flour, contributed 376% of the iron requirement for children aged 10–12 years and 200% for those aged 13–15 and 16–18 years.

Conclusions

1. The results of organoleptic tests on young women showed that chips with the addition of 20 grams (F1) and 40 grams (F2) of green spinach flour were the most preferred formulations by panelists based on color, aroma, taste, and texture indicators.
2. F3 had the highest iron content. Although F3 had the highest iron content, panelists preferred F1 and F2. This was because adding too much green

spinach flour resulted in a slightly bitter taste in the chips.

3. The addition of green spinach flour in varying amounts had a significant effect on the taste, color, and aroma of the chips, but did not show any significant differences in the texture aspects among the four formulations.
4. Organoleptic assessment of chips consisting of one control (without green spinach) and three treatments (addition of 20 grams, 40 grams, and 60 grams of green spinach flour) respectively obtained the following scores: color 4.36; 4.03; 3.86; 3.3; aroma 4.43; 4.13; 3.7; 3.23; taste 4.33; 3.43; 2.73; 1.5; and texture 4.03; 3.73; 3.46; 3.13.
5. Iron content tests showed that the average iron content in chips with the addition of 20 grams of green spinach flour (F1) was 63.5 mg/kg, 40 grams (F2) was 87.9 mg/kg, and 60 grams (F3) was 100.2 mg/kg.
6. Based on the results of the ANOVA test analysis, the p value <0.05 obtained indicates that the alternative hypothesis is accepted, so it can be concluded that the addition of green spinach flour has a significant effect on the organoleptic test results by the panel of young women.

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