

Acceptance and Content of Iron of Nahukol (Broccoli Tofu Nugget) as an Alternative Food to Prevent Anemia

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ABSTRACT

Anemia is a condition of low red blood cell mass or hemoglobin. Another way of prevention and control is to consume food sources of iron such as tofu. The general objective of this study was to determine the characteristics of "NAHUKOL" on the results of the acceptability test and iron levels of alternative snacks to prevent anemia. The research design used was experimental research with a total sample of 3 samples, the iron test sample used the most preferred sample and the control group. Data collection techniques used acceptability test and iron content test. The study was conducted from October to March 2023. The analytical technique used in the acceptability test was the Kruskal Wallis test and in the iron, test using the atomic absorption spectrophotometer method. The results of the research on the acceptability test obtained the most preferred formula was formulation 2. The iron content test obtained results in formulation 2 of 4.43 mg/100 g and the control group of 4.2 mg/100 g. NAHUKOL products (Tofu and Broccoli Nuggets) can be used as an alternative food to prevent anemia.

INTRODUCTION

Anemia is characterized by a low erythrocyte mass and/or low hemoglobin mass, resulting in impaired organ function. There are several types of anemia, but the most common is iron deficiency anemia.¹

The prevalence of anemia in 2019 was 30% (539 million) among non-pregnant women and 37% (32 million) among pregnant women aged 15-49 years.² According to the 2018 Riskepdas data, the prevalence of anemia among adolescents was 32%.³ Based on data from the Provincial Health Office of East Java in 2020, the prevalence of anemia among adolescent girls in East Java was 42%.⁴

Anemia is relatively easy to identify. It can be recognized through various clinical signs, such as pallor in certain body parts (eyelids, lips, tongue, skin, and palms), frequent dizziness, seeing spots in front of the eyes, weakness, fatigue, lethargy, and listlessness.⁵ In addition to the mentioned symptoms, anemia sufferers may experience shortness of breath even during light activities, chest pain, cold or numb hands and feet, and irritability (easily getting upset in children).⁶

Anemia can have detrimental effects on sufferers, leading to fatal consequences in both the short and long term. Short-term effects of anemia include frequent feelings of weakness, fatigue, lethargy, lassitude, and exhaustion, which subsequently lead to decreased learning performance and work productivity.⁷ Additionally, there are long-term impacts, particularly on pregnant women and fetuses, including the risk of delivering Low Birth Weight (LBW) babies, premature birth, Intrauterine Growth Restriction (IUGR), fetal death, and postnatal infant death.⁸ The impacts mentioned should be addressed promptly as they can result in fatal consequences.

The Indonesian government has implemented a program to reduce the incidence of anemia known as the Iron Supplementation Tablet program since 1990. This program aims to prevent and reduce the prevalence of iron deficiency anemia.⁹ Mother has a crucial role in the prevention and management of anemia because she is responsible for meal planning at home. The selected food ingredients should include iron-rich foods, one of which is tofu. Tofu is a smooth-textured, white-colored food made from coagulated soy milk and pressed into blocks.¹⁰

From the preliminary study, that conducted among students of the Nutrition Department at Poltekkes Kemenkes Surabaya, it was found that nuggets were the most preferred snack among the students. Therefore, I chose nuggets as my processed product. I opted for tofu as the raw material because, besides being a source of protein and iron, tofu is affordable and can be consumed by people from all economic backgrounds.

Nugget is one of the processed foods typically made from seasoned meat mixed with flour as a binder, then coated with bread crumbs. Currently, there are many recipe modifications, one of which is tofu nuggets. Tofu is known for its high protein content and affordable price.¹¹ The product name you have chosen, "NAHUKOL" (Broccoli and Tofu Nuggets), is clear and concise, effectively indicating the ingredients used in the product.

Sensory acceptance testing is a test conducted by panelists to evaluate the level of liking towards a product. This test is performed using the human sensory organs to measure the degree of preference for the product.¹² In sensory acceptance testing, a hedonic scale is used as a scoring system to assess the level of liking. Common categories on the hedonic scale include: like very much, like, somewhat like, neither like nor dislike, dislike, and dislike very much, among others.¹³ The criteria assessed in sensory acceptance testing are color, aroma, texture, and taste.

Panelists are individuals or a group of people appointed to conduct sensory acceptance testing, whether it's subjective or objective in nature. Based on their expertise, panelists are categorized into 7 types: individual panelists, limited panelists, trained panelists, somewhat trained panelists, untrained panelists, consumer panelists, and child panelists.¹⁴

Tofu is highly nutritious. In 100 grams of tofu, there are 68 kilocalories of energy, 7.8 grams of protein, 4.6 grams of fat, 1.6 grams of carbohydrates, 124 milligrams of calcium, 63 milligrams of

phosphorus, and 3.4 milligrams of iron. With this iron content, tofu can meet 67.5% of the daily iron needs for adults. Besides iron, there are essential nutrients that support iron absorption, such as Vitamin C or ascorbic acid.

Iron is a macro mineral that plays a crucial role in transporting oxygen from the lungs to all body tissues, carried through the bloodstream.¹⁵ Iron absorption occurs in the duodenum, where it is then transported into cells or bone marrow for erythropoiesis purposes. Iron absorption can reach its maximum with the assistance of facilitators (enhancers). Facilitators of iron absorption include ascorbic acid (vitamin C).¹⁶ Other studies also indicate that iron absorption becomes more effective when consumed together with vitamin C.¹⁷

Ascorbic acid (vitamin C) is one of the supportive components for iron absorption. Ascorbic acid works by converting iron from ferric form (Fe³⁺) to ferrous form (Fe²⁺), which makes iron more soluble, thus enhancing iron absorption in the intestines. Besides vitamin C, there are several other nutrients that can accelerate iron absorption, including vitamin A, Vitamin B12, folic acid, zinc, and others.¹⁸

Vitamin C is commonly found in vegetables and fruits, with broccoli being one example. Broccoli consists of 90% water and contains few calories. The content of vitamin A and C in broccoli is higher compared to other vegetables such as chayote leaves, sweetleaf, and winged bean. The vitamin C content in broccoli is 68.00 mg, and the vitamin A content is 210 RE.¹⁹

Hemoglobin (Hb) is composed of heme and globular protein (globin), with a weight of 64.4 kDa or 33% of the erythrocyte weight. Hemoglobin synthesis occurs in two stages: the erythroblast stage, accounting for about 66%, and the reticulocyte stage, accounting for 33%. Hemoglobin synthesis originates from ferric ions that are reduced to ferrous ions and bind with the protoporphyrin ring, and this synthesis occurs in the mitochondria.²⁰

MATERIALS AND METHODS

The research design employed in this study is experimental research. According to Sugiyono (2015, p.107), experimental research aims to observe the cause and effect of a treatment under controlled conditions. Experimental research is a type of quantitative research characterized by the presence of treatment and control groups.²¹

The research was conducted from October to March 2023. The research was carried out at several locations. The production of NAHUKOL (Broccoli and Tofu Nuggets) products and the sensory evaluation of the products were conducted at the Department of Nutrition, Polytechnic of Health Ministry Surabaya, located at Pucang Jajar Selatan Street No. 24B. The iron content testing of the NAHUKOL (Broccoli and Tofu Nuggets) products was conducted at PT. Saraswati Indo Genetech Surabaya, located at AMG Tower, 12th Floor, Jln. Dukuh Menanggal No.1-A, Surabaya.

The formulas in this study are tofu and broccoli nuggets, consisting of 3 formulas: F1 and F2 as treatments and F3 as the control group. These formulas underwent sensory evaluation and iron content testing. Sensory evaluation was conducted using three formulations, including treatments and the control group, with a panel of 25 semi-trained panelists selected from the Nutrition Department D3 students at Polytechnic of Health Ministry Surabaya. For the iron content testing, the most preferred formula and the control group were chosen, each tested once for iron content, with each formula weighing 100 grams.

The chosen data collection method is experimentation on various formulations of NAHUKOL (Broccoli and Tofu Nuggets). The tests conducted include a sensory evaluation using a Hedonic Scale Test with criteria such as color, aroma, texture, and taste. Additionally, an iron content test was conducted using the Atomic Absorption Spectrophotometer (AAS) method.

The iron content analysis of the formulas was conducted based on the ratio of tofu to broccoli, where in NHK 1 it was 60:40, in NHK 2 it was 70:30, and in NHK 3 it was 100:0. The sensory evaluation was conducted based on 4 criteria: color, aroma, texture, and taste of the NAHUKOL (Broccoli and Tofu Nuggets). The sensory evaluation was performed by 25 panelists, including semi-trained ones. The results of the sensory evaluation were then analyzed using the Kruskal-Wallis statistical test to determine the acceptability and the most preferred formulation by the panelists with a significance level of 0.05 ($\alpha = 0.05$).

RESULTS

NAHUKOL (Broccoli and Tofu Nuggets) is a nugget made from tofu and broccoli in specific proportions to produce a formulation. Formulations 1 and 2 are treatment groups with different ratios, while formulation 3 serves as the control group. The variations in the formulas aim to determine the organoleptic characteristics, differences among each formula, and the iron content in the most preferred formula. The characteristics of NAHUKOL formulations can be observed in Table 1.

Table 1 Characteristics of NAHUKOL (Tofu and Broccoli Nuggets) Formulations

	Indicator	Formulation		
		NHK 1	NHK 2	NHK 3
		Treatment formulas Tofu: broccoli (60 : 40)	Treatment formulas Tofu: broccoli (70 : 30)	Control formula Tofu: broccoli (100 : 0)
1	Color	Whiter with a tinge of green	Whitish-green	White
2	Texture	Somewhat dense and slightly coarse	Dense and slightly coarse	Denser and smoother
3	Flavor	Smells like broccoli	Smells like broccoli	Smells like tofu
4	Taste	Savory and distinct broccoli flavor	Savory and distinct broccoli flavor	Savory like tofu

Based on Table 1, the characteristics of each formulation can be identified. Formulation 1 (NHK 1) has the following characteristics: whitish-green color, somewhat dense and slightly coarse texture, broccoli scent, and savory and distinctive broccoli flavor. Formulation 2 (NHK 2) exhibits whitish-green color, dense and somewhat coarse texture, broccoli aroma, and savory and distinctive broccoli flavor. Formulation 3 (NHK 3), serving as the control, demonstrates white color, denser and smoother texture, tofu scent, and savory tofu flavor.

The three formulations were subjected to a acceptability test by 25 panelists to determine the level of preference among the three Nahukol (Broccoli and Tofu Nugget) formulations, with criteria evaluated including color, aroma, texture, and taste. Here are the average acceptability test results for the three Nahukol (Broccoli Tofu Nugget) formulations.

Table 2: Mean Acceptance Test Results of NAHUKOL (Tofu and Broccoli Nuggets)

	Indicator	Formulation		
		NHK 1	NHK 2	NHK 3
		Treatment formulas	Treatment formulas	Control formula
		Tofu: broccoli (60 : 40)	Tofu: broccoli (70 : 30)	Tofu: broccoli (100 : 0)
1	Color	3.72	2.52	4.24
2	Flavor	3.52	3.72	3.8
3	Texture	3.52	3.96	4.04
4	Taste	3.2	4.08	3.76
	Average	3.49	3.57	3.96

Description: Preference level (1) strongly dislike, (2) dislike, (3) neutral/like moderately, (4) like, (5) strongly like

Based on Table 5.6, the results of the acceptance test (hedonic test) for the three formulations of NAHUKOL (Broccoli and Tofu Nuggets) can be determined. Based on the overall average preference assessment for color, texture, aroma, and taste between the two treatment formulas, the highest value is obtained by formula NHK 2, which is 3.57 and falls into the like category.

After conducting the acceptance test, a Kruskal-Wallis statistical test was performed on the three formulations to determine differences in the indicators of color, aroma, texture, and taste of NAHUKOL (Broccoli and Tofu Nuggets). Below are the results of the Kruskal-Wallis test for the three formulations.

Table 3: Kruskal-Wallis Test Results for NAHUKOL (Broccoli and Tofu Nuggets)

	Indicator	Kruskal wallis test values
1	Color	0.000
2	Flavor	0.457
3	Texture	0.045
4	Taste	0.001

Based on Table 3, it can be observed that the Kruskal-Wallis test results for the indicators of color, texture, and taste have a p-value < 0.05, indicating rejection of the null hypothesis (H0). This suggests that there are differences in color, texture, and taste among the three formulations of NAHUKOL (Broccoli and Tofu Nuggets). However, for the aroma indicator, the p-value is > 0.05, indicating acceptance of H0, meaning there is no difference in aroma among the formulations of NAHUKOL (Broccoli and Tofu Nuggets).

For the indicators of color, texture, and taste, the Mann-Whitney test was conducted to determine whether there are differences among the three formulations. Below are the results of the Mann-Whitney test.

Table 4: Mann-Whitney Test Results for NAHUKOL (Broccoli and Tofu Nuggets)

Indicator		Mann-Whitney test value		
		NHK1 : NHK2	NHK1 : NHK3	NHK2 : NHK3
1	Color	0.091	0.014	0.000
2	Texture	0.032	0.034	0.488
3	Taste	0.000	0.031	0.202

Based on Table 5.8, the Mann-Whitney test results for the color indicator between formulation 1:2 with codes NHK1: NHK2 show a p-value > 0.05, indicating acceptance of H0, which means there is no difference in color for this formulation. However, for formulation 1:3 with codes NHK1: NHK3 and formulation 2:3 with codes NHK2: NHK3, the p-values are < 0.05, indicating rejection of H0. This suggests that there are differences in color among these formulations.

Based on the texture indicator, for formulation 1:2 with codes NHK1: NHK2 and formulation 1:3 with codes NHK1: NHK3, the p-values are < 0.05, indicating rejection of H0. This implies that there are differences in texture among these formulations. However, for formulation 2:3 with codes NHK2: NHK3, the p-value is > 0.05, indicating acceptance of H0. This suggests that there are no differences in texture among the formulations.

Based on the taste indicator, for formulation 1:2 with codes NHK1: NHK2 and formulation 1:3 with codes NHK1: NHK3, the p-values are < 0.05, indicating rejection of H0. This implies that there

are differences in taste among these formulations. However, for formulation 2:3 with codes NHK2: NHK3, the p-value is > 0.05 , indicating acceptance of H_0 . This suggests that there are no differences in taste among the formulations.

After conducting the acceptance test, the iron content test was performed on the most preferred formula and the control group for comparison. The purpose of the iron content test is to determine the iron levels in the most preferred formulation and the control group, which are then compared with the iron requirements for snacks. Below are the results of the iron content test.

Table 5: Iron Content Analysis Results

Weight (g)	Iron content in 100 g	
	NHK2	NHK3
100	4.43 mg/100 g	4.2 mg/100 g

Based on the iron content analysis table, the comparison of iron levels between the most preferred formulation (NHK2) and the control formulation (NHK3) indicates that NHK2, with a tofu and broccoli formulation ratio of 70:30, has an iron content of 4.43 mg/100 grams. Meanwhile, the control formulation, with a tofu and broccoli ratio of 100:0, has an iron content of 4.2 mg/100 grams.

Discussion

- Characteristics of the NAHUKOL (Tofu and Broccoli Naget) formulation

Each formulation has different proportions of raw materials, thus resulting in different characteristics for each formulation. Several criteria were observed, namely color, aroma, texture, and taste. Here are the observations of the characteristics of the three formulations:

1. Color

Each formulation exhibits a distinct color. Formulation 1 yields a whitish-green hue, formulation 2 results in a greenish-white color, while formulation 3 produces a plain white color.

This research is supported by previous studies conducted by.²² In this study, it is explained that fried tempeh nuggets yield a golden brown color, while tempeh nuggets with added broccoli result in a greenish-brown color.

2. Flavor

Each formulation possesses a distinctive aroma. Formulation 1 (NHK1) emits a fragrant broccoli scent, formulation 2 (NHK2) also emits a broccoli fragrance, while formulation 3 (NHK3) yields a tofu aroma.

This research is supported by previous studies conducted by.²³ In this study, it is explained that the higher the composition of chicken meat in chicken sausage and broccoli,

the higher the fat content in the sausage, which can enhance the hedonic value of the Flavor. The fat used in my research is derived from tofu with added broccoli.

3. Texture

Each formulation exhibits a different texture. Formulation 1 (NHK1) yields a somewhat dense and slightly coarse texture, formulation 2 (NHK2) produces a dense and slightly coarse texture, while formulation 3 (NHK3) results in a denser and smoother texture.

This research is supported by previous studies conducted by.²⁴ In this study, it is stated that nuggets made with a higher proportion of catfish have a firmer texture, while nuggets made with a higher proportion of young jackfruit will result in a more elastic texture. The higher protein content influences the formation of gel, causing the nugget's texture to become somewhat firmer. Proteins become denser when cooked due to the breaking of amino acid chains by heat, and the reduction in water content during the cooking process also contributes to the denser texture of the product when cooked.

4. Taste

Each formulation yields a different taste profile. Formulation 1 (NHK1) produces a savory and distinctive broccoli flavor, formulation 2 (NHK2) also yields a savory and distinctive broccoli flavor, while formulation 3 (NHK3) results in a savory tofu flavor.

This research is supported by previous studies conducted by.²⁵ In this study, it is stated that the panelists prefer nuggets with a higher proportion of tofu and young jackfruit. This is because the panelists are still unfamiliar with nuggets that have a strong vegetable taste.

- Acceptance Test Results of NAHUKOL (Tofu and Broccoli Naget)

Based on the acceptance test conducted on the three formulations, the treatment formulation that was most preferred was formulation 2 (NHK2) with a total average of 3.57. Following the acceptance test, formulation 2 (NHK2) as the most preferred formulation and formulation 3 (NHK3) as the control were subjected to iron content testing.

- Iron Content Test Results of NAHUKOL (Tofu and Broccoli Naget).

Iron content testing was conducted using the Atomic Absorption Spectrophotometer (AAS) method. This test was performed on formulation 2 (NHK2) and formulation 3 (NHK3). The iron content in formulation 2 (NHK2) is 4.43 mg/100 g, while in formulation 3 (NHK3) or the control, it is 4.2 mg/100 g. From the test, formulation 2 (NHK2) has a higher iron content compared to formulation 3 (NHK3) as the control group.

CONCLUSION

Based on the evaluation of three formulations of NAHUKOL (Tofu and Broccoli Naget) using hedonic scale, the formulation most preferred was formulation 2 (NHK2). These three formulations were then subjected to Kruskal-Wallis and Mann-Whitney tests. The results showed that in terms of color, texture, and taste, the p-value was <0.05 , indicating differences among the three formulations. However, the aroma indicator had a p-value >0.05 , indicating no difference in aroma among the three formulations. Following the acceptance test, iron content testing was conducted on the most preferred formulation, formulation 2 (NHK2), and formulation 3 (NHK3) as the control group. The results showed that formulation 2 (NHK2) had an iron content of 4.43 mg/100 grams, while formulation 3 (NHK3) had an iron content of 4.2 mg/100 grams. Suggestions for future research include addressing the shortcomings of NAHUKOL formulations, conducting acceptance tests with new formulations to obtain the appropriate composition, and modifying formulations using high-calorie solid ingredients.

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