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The Effect of Red Bean and Red Spinach Flour Substitution on the Organoleptic Properties and Nutritional Value of Fried Meatballs (Basreng)

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ABSTRACT

This study investigates the impact of substituting red bean flour and red spinach flour on the organoleptic properties and nutritional value of fried meatballs (Basreng). Three treatments were tested: P1 (5% red bean flour and 5% red spinach flour), P2 (10% red bean flour and 10% red spinach flour), and P3 (15% red bean flour and 15% red spinach flour). Fifty third-semester nutrition students evaluated taste, texture, aroma, and color using a 5-point hedonic scale. Statistical analysis included normality tests, ANOVA for normally distributed data, and Kruskal-Wallis tests for non-normally distributed data, followed by Duncan or Mann-Whitney tests for significant differences. Results indicated that P1 was most favored in all sensory aspects. Increasing concentrations of red bean and red spinach flours resulted in a stronger taste and aroma of these ingredients, which overshadowed the chicken flavor. P3, though less preferred organoleptically, provided the highest nutritional value with 0.06 mg of iron per slice. This study highlights the balance between sensory acceptance and nutritional enhancement using local ingredients. While P1 is optimal for consumer preference, P3 offers significant nutritional benefits. The findings suggest that red bean and red spinach flours have potential in improving the health benefits of traditional snacks like Basreng

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Key Messages:

- Substituting red bean and red spinach flour in fried meatballs (Basreng) enhances nutritional value but impacts sensory acceptance. The most preferred formulation (P1) contained the lowest levels of substitution (5% each), suggesting a balance between taste and health benefits is crucial for consumer appeal.

Introduction

Anemia is a nutritional and health problem with serious impacts across all life stages. According to the 2017 Indonesian Demographic and Health Survey, the prevalence of anemia among children aged 5-12 years is 26%, among women aged 13-18 is 23%, and among men aged 13-18 is 17% (1). Furthermore, the 2018 Basic Health Research (Riskesdas) indicates that 32% of adolescent girls suffer from anemia, meaning 3-4 out of 10 adolescents are affected (2). Nusa Tenggara (NTT), the prevalence of anemia among adolescents was 72.2% in 2021, highlighting that approximately three out of four high school students suffer from anemia (3). Adolescent girls with anemia who marry early are at risk of high-risk pregnancies, which can lead to the birth of stunted children (4). The proportion of adolescents aged 15-19 years in Kupang City in 2018 was the second largest population at 14.75%, following adults aged 20-29 years. This indicates that a significant proportion of adolescent girls in Kupang City are at risk of anemia, necessitating preventive efforts through the utilization of local foods.

East Nusa Tenggara has a variety of local food ingredients, such as red beans and red spinach, which can be utilized to address anemia (5). Red beans are a type of legume high in protein and contain arginine, which activates growth hormone (Human Growth Hormone) essential for muscle growth and immune system regulation. The protein content in 100 grams of red beans is 22.3 grams, with a complete amino acid composition, including a high arginine content at 56.8 mg/g protein (6). Spinach (Amaranthus sp.), particularly red spinach, is beneficial due to its high iron and vitamin C content. In

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100 grams of red spinach, there are 50 kcal of energy, 3 grams of protein, 0.8 grams of fat, 10 grams of carbohydrates, 520 mg of calcium, 2.2 grams of fiber, 7 mg of iron, and 62 mg of vitamin C, making it superior to green spinach for preventing anemia(7).

Spinach (Amaranthus sp.) is a perennial plant originating from the tropical regions of America(8). There are two types of spinach, red spinach and green spinach. Both types have beneficial properties. In 100g of green spinach, there are 16 kcal of energy, 0.9g of protein, 0.4g of fat, 2.9g of carbohydrates, 166mg of calcium, 0.7g of fiber, 3.5mg of iron, and 41mg of vitamin C (9). Meanwhile, 100g of red spinach contains 50 kcal of energy, 3g of protein, 0.8g of fat, 10g of carbohydrates, 520mg of calcium, 2.2g of fiber, 7mg of iron, and 62mg of vitamin C. Thus, to prevent anemia, it is recommended to consume spinach, especially red spinach, which has higher iron and vitamin C content compared to green spinach (9).

Snacks have become an integral part of the lives of both urban and rural communities. Almost all age groups and social classes have the habit of consuming snacks. The nutritional content of snacks varies, depending on the type of raw materials and portion sizes. One of the trending snacks among teenagers today is Basreng (fried meatballs). Fried meatballs, or Basreng, are one of the most popular meatball products among teenagers, made from tapioca flour, chicken meat, garlic, shallots, pepper, seasoning, and ice water, which are blended and made into meatballs, then sliced thinly and fried(10). The purpose of this study is to determine the effect of substituting red bean flour and red spinach flour on the acceptability of fried meatballs (Basreng).

Methods

This research is experimental in nature, using a completely randomized design (CRD) with three treatments: P1: fried meatballs with 5% red bean flour and 5% red spinach flour substitution, P2: fried meatballs with 10% red bean flour and 10% red spinach flour substitution, and P3: fried meatballs with 15% red bean flour and 15% red spinach flour substitution. This research was conducted from January to May 2024 in the Food Technology Laboratory, Nutrition Department, Health Polytechnic of the Ministry of Health, Kupang.

Table 1: Composition of Ingredients for Making Fried Meatballs with 4 Treatments

Ingredient Name	Unit	P0	P1	P2	P3
Chicken Meat	Gram	250	250	250	250
Tapioca Flour	Gram	250	237.5	225	212.5
Red Bean Flour	Gram	0	12.5	25	37.5
Red Spinach Flour	Gram	0	12.5	25	37.5
Shallots	Gram	3	3	3	3
Garlic	Gram	3	3	3	3
Fried Shallots	Teaspoon	1	1	1	1
Fried Garlic	Teaspoon	1	1	1	1
Salt	Teaspoon	0.2	0.2	0.2	0.2
Ground Pepper	Teaspoon	0.2	0.2	0.2	0.2
Egg	Piece	1	1	1	1
Water	Ml	100	100	100	100

Flowchart of Fried Meatball (Basreng) Production is shown in figure 1. The panelists in this study consisted of 50 third-semester nutrition students who had passed the third semester. Data collection in this study was conducted through an organoleptic test to determine the panelists' responses to the produced fried meatballs, covering aspects such as color, aroma, texture, and taste to identify more specific properties of the product. Each panelist was given 3 different samples of fried meatballs according to the treatments. Each panelist was asked to provide their response regarding color, aroma, texture, and taste by giving a score from 5 (strongly like), 4 (like), 3 (somewhat like), 2 (dislike), to 1 (strongly dislike).

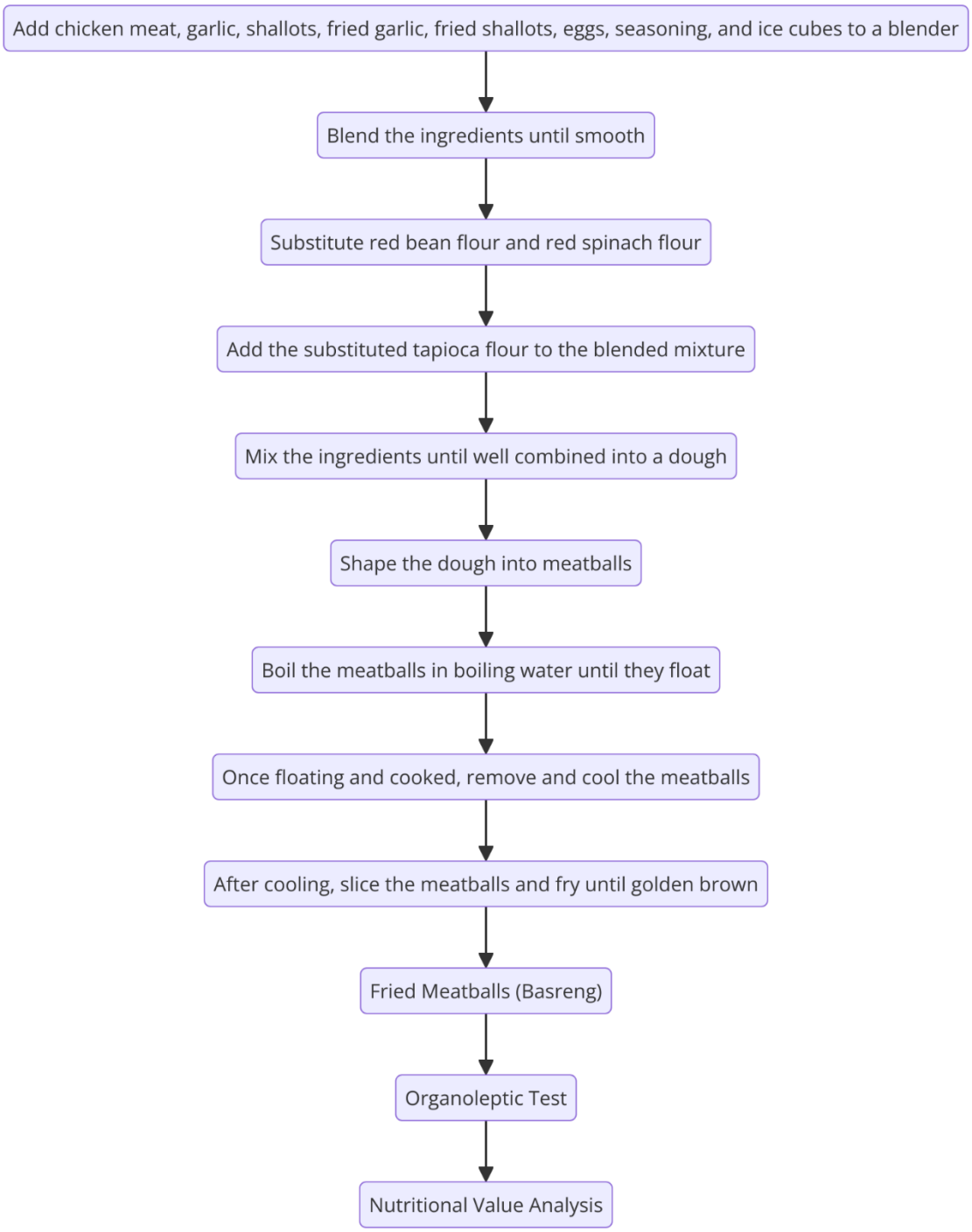


Figure 1. Flowchart of Fried Meatball (Basreng) Production

Data Analysis

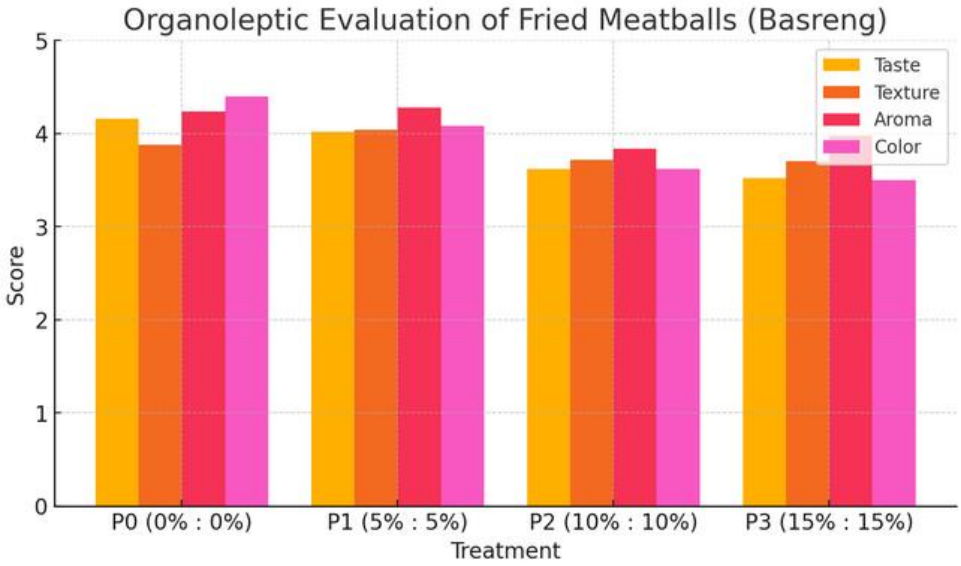
The data from the organoleptic test in this study were analyzed descriptively based on the average values and the percentage of panelist acceptance for each treatment. To determine the type of formula on the panelists' preference level (organoleptic) for the fried meatball product, a statistical analysis will be performed starting with a Normality test. If the obtained data are normally distributed, an ANOVA test will be conducted. If significant differences are found, a Duncan test will follow. However, if the data are not normally distributed, the analysis will be performed using the Kruskal-Wallis test, and if significant differences are found, the Mann-Whitney test will follow. The data will be processed using Microsoft Excel 2007 and SPSS programs. The macronutrient values of the fried meatball products will be tested using statistical tests and analyzed using the Indonesian Food Composition Table.

Results

Based on Table 2, the conversion of red beans and red spinach into flour can be concluded that 500 grams of red beans can produce 400 grams of red bean flour with a conversion factor of 0.8, and 870 grams of red spinach can produce 80 grams of red spinach flour, with a conversion factor of 0.09.

Table 2. Conversion of Red Beans and Red Spinach into Flour

Ingredient	Net Weight	Flour	Conversion
Red Beans	500 grams	400 grams	01:00.8
Red Spinach	870 grams	80 grams	01:00.1



5 = Strongly Like; 4 = Like; 3 = Somewhat Like; 2 = Dislike; 1 = Strongly Dislike
Figure 2. Organoleptic Evaluation of Fried Meatballs (Basreng)

Figure 2 show that P1 received the highest scores overall, especially in taste, texture, and aroma, indicating that 5% red bean flour and 5% red spinach flour is the most preferred substitution level among the panelists. As the concentration of red bean flour and red spinach flour increases (P2 and P3), the scores for all organoleptic properties tend to decrease, indicating a lesser preference. P0 and P1 are the most preferred treatments, with P1 slightly edging out in overall sensory acceptance.

Table 3. Kruskal-Wallis Test Results

Aspect	P value	Explanation
Taste	0.017	P value < 0.05, shows significant difference
Texture	0.077	P value > 0.05, shows no significant difference
Aroma	0.015	P value < 0.05, shows significant difference
Color	0.000	P value < 0.05, shows significant difference

Table 3 shows that the Kruskal-Wallis test for Taste has a significance value of 0.017 < 0.05, for Texture the significance value is 0.077 > 0.05, for Aroma the significance value is 0.015 < 0.05, and for Color it is 0.000 < 0.05. This indicates that out of the four parameters, Taste, Color, and Aroma show significant differences, while Texture shows no significant difference.

Table 4. Organoleptic Test of Basreng

Treatment	Taste	Texture	Aroma	Color
	Mean	Mean	Mean	Mean
P1 (5%:5%)	4,02^{a}	4,04^{a}	4,24^{ab}	4,08^{a}
P2 (10%:10%)	3,62^{b}	3,72^{a}	3,84^{b}	3,62^{bc}
P3 (15%:15%)	3,52^{b}	3,70^{a}	3,98^{b}	3,50^{c}

Table 4 shows that treatment P1 consistently provides the best results in all tested categories, namely taste, texture, aroma, and color. This is indicated by the highest average scores in each parameter, marked with the superscript 'a'. Treatments P2 and P3 have lower scores compared to P1,

with P2 generally having higher values compared to P3 in the taste and color parameters, while in the aroma parameter, P3 shows better results compared to P2. P1 is the most effective formulation in influencing the organoleptic quality of Basreng compared to the other two treatments.

Table 5. Nutritional Value of Basreng per Serving for Treatments P1, P2, and P3

Treatment	Energy (kcal)	Protein (gram)	Fat (gram)	Carbohydrates (gram)	Iron (mg)
P1 (5%:5%)	1,632.20	49.73	63.82	213.9	6.76
P2 (10%:10%)	1,611.90	51.23	63.91	207.3	7.31
P3 (15%:15%)	1,591.70	52.72	64	200.8	7.84

Table 5 shows that the combination of red bean flour and red spinach flour proportions affects the macro and micro nutritional values (energy, protein, fat, carbohydrates, iron) of Basreng. The higher the proportion of red bean flour and red spinach flour, the higher the macro and micro nutritional content (energy, protein, fat, carbohydrates, and iron) contained in it.

Table 6. Nutritional Value of Basreng per Slice for Treatments P1, P2, and P3

Treatment	Energy (kcal)	Protein (gram)	Fat (gram)	Carbohydrates (gram)	Iron (mg)
P1 (5%:5%)	9.95	0.3	0.38	1.3	0.04
P2 (10%:10%)	9.82	0.31	0.38	1.26	0.05
P3 (15%:15%)	9.7	0.32	0.39	1.22	0.06

Table 6 shows that the study recommends treatment P1 as it is the most preferred in terms of color, aroma, texture, and taste with a substitution of red bean flour and red spinach flour (5%:5%). However, from a nutritional standpoint, treatment P3 is recommended as it contains the highest iron content with a value of 0.06 mg per slice, aligning with the aim of this study which is to address anemia.

Discussion

This study shows that the increasing use of red bean flour and red spinach flour results in a stronger taste of spinach and red beans compared to chicken meat. This finding is consistent with Meirina Sulastri Loaloka's 2021 study, which found that the higher the concentration of red spinach flour extract, the lower the panelists' preference for the taste of the resulting chicken meatballs(11). This is because the addition of red spinach can diminish the characteristic chicken flavor in the product. Panelists did not favor a high proportion of red spinach as they felt that the chicken flavor in the meatballs was reduced due to the large amount of added spinach. The fat content in the meatball ingredients influences the savory taste of the meatballs (12). The lower the amount of red bean flour added, the more pronounced the chicken flavor in the chicken meatballs. If more red bean flour is added, the distinctive meatball taste is masked by the unique flavor of red beans because the panelists are familiar with meat-based meatballs. This observation aligns with studies on the influence of ingredient substitution on sensory properties in meat products, where the incorporation of plant-based flours can alter the flavor profile significantly (13,14).

This study also indicates that the processing method was not sufficiently considered, resulting in a harder texture for the Basreng, and the increased use of red bean flour and red spinach flour resulted in a less chewy meatball texture. The high nitrogen content in spinach causes the spacing between proteins to increase, which in turn increases the amount of bound water that cannot escape and evaporate, leading to higher binding capacity values in the product(15). Increasing the concentration of spinach lowers the texture acceptability because spinach affects the chewiness of the food product. The high fiber content in the ingredients makes the meatball texture less chewy (tending to be soft), as red beans contain a lot of carbohydrates and dietary fiber, which makes the meatball texture softer when more red beans are added (16,17).

This study also shows that the increasing use of red bean flour and red spinach flour results in a stronger beany aroma from red spinach flour in the Basreng. This finding is consistent with Hidayati 2022, who stated that the higher the concentration of spinach added to the product, the more noticeable the beany aroma becomes(15). Additionally, the beany aroma in spinach is caused by the lipoxygenase enzyme contained in spinach. The more red beans added in the meatball processing, the less the panelists liked the meatball aroma due to the lipoxygenase enzyme producing a beany aroma in red beans.

Conclusion

The substitution of red bean flour and red spinach flour significantly impacts the organoleptic properties and nutritional value of fried meatballs (Basreng). Treatment P1 (5% red bean flour and 5% red spinach flour) is the most preferred in terms of taste, texture, aroma, and color, making it the best formulation for sensory attributes. However, from a nutritional perspective, treatment P3 (15% red bean flour and 15% red spinach flour) is recommended due to its higher iron content, making it beneficial in addressing anemia. This study highlights the potential of using local ingredients like red beans and red spinach to enhance both the sensory qualities and nutritional benefits of traditional food products.

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Conflicts of Interest: The authors declare no conflict of interest

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