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Nutritional Content and Consumer Acceptance of *Gajaberry* Cookies as Supplementary Food for Malnourished Toddlers

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Abstract

The *Gajaberry* cookies are cookies made by substituting wheat flour with snakehead fish flour and corn flour with the addition of strawberry jam. This research aims to find out the best formulation for *Gajaberry*, which is an additional food for malnourished toddlers that has high energy, protein, iron, and calcium content. This type of research is a non-factorial completely randomized design (CRD). Data collection methods include organoleptic tests with test analysis Friedman, to find out the selected formula from 80 panelists, then proceed with proximate test analysis. The research results show that the test value Friedman has the highest average rank from the organoleptic test assessment with a hedonic scale in terms of taste, aroma, texture, and color that the panelists like cookies F3 (60 grams of snakehead fish meal, 40 grams of corn flour) with analysis results for energy levels of 500.54 Kcal/100 g, protein, 21.40%, iron 2.65 mg and calcium 179.5 mg. Cookies of *Gajaberry* can be accepted as additional food for malnourished toddlers and developed as a snack based on local food.

Keywords: Malnutrition, Cookies, Snakehead Fish Flour, Corn Flour, Strawberry Jam

Full length article

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1. Introduction

Malnutrition is a condition caused by insufficient intake of energy and protein in daily food consumption, indicated by a z-score of weight for age (WFA) less than -2 standard deviations (SD) based on the World Health Organization (WHO) standards [13]. Malnutrition in toddlers is caused by two factors: direct factors due to infectious diseases and nutritional intake, while indirect factors are attributed to economic status, parenting practices, maternal knowledge, and environmental sanitation [18]. The short-term adverse effects of nutritional problems in toddlers include disrupted brain development, intelligence, physical growth disorders, and metabolic disturbances in the body. In the long term, the negative consequences may include a decline in cognitive abilities and learning achievements, a weakened immune system leading to susceptibility to illnesses, as well as non-competitive work quality resulting in reduced economic productivity [1].

The Basic Health Research Results of 2018 state that the prevalence of malnutrition in Indonesia is 13.8%. Meanwhile, the prevalence of malnutrition among toddlers aged 0-59 months based on the WFA index in 2018 in South Sumatra Province is 12.31%. Similarly, the prevalence of malnutrition among toddlers aged 0-59 months based on the

WFA index in 2018 in Palembang City is 12.36% [13]. One alternative to address nutritional problems in toddlers is by increasing the consumption of balanced nutrition food rich in energy and protein. This can be achieved by providing supplementary food, known as PMT. One form of supplementary food for toddlers is *Gajaberry* cookies, which involve substituting wheat flour with flour from snakehead fish and corn flour with the addition of strawberry jam.

The nutritional content per 100 grams of snakehead fish includes 16.2 grams of protein, 0.5 grams of fat, 2.6 grams of carbohydrates, 170 mg of calcium, 335 mcg of Vitamin A, 0.40 mg of Vitamin B2, and 254.0 mg of potassium (Direktorat Departemen Gizi, 2017). Snakehead fish flour is one of the utilization methods achieved by transforming the fish into flour. The use of snakehead fish flour can be an alternative as a primary ingredient for making protein-rich cookies [17]. Corn flour is a functional food that includes dietary fiber, iron, and beta-carotene, which is a precursor to vitamin A. Corn flour contains relatively high levels of carbohydrates, protein, and fat. The nutritional content of corn flour is as follows: water 10.09%, ash 2.01%, protein 8.78%, fat 4.92%, carbohydrates 74.20%, and 3.12% crude fiber [4]. The research results from Widodo et al., 2015, regarding the administration of cookies based on snakehead fish flour for 90 days, were able to improve the nutritional status of weight for age in malnourished children.

Based on the description above, the addition of snakehead fish flour, corn flour, and strawberry creates an

innovative snack product that can contribute to meeting the energy, protein, iron, and calcium needs of malnourished toddlers and is well-received by the community. This research aims to determine the best formulation for *Gajaberry* cookies, starting with sensory tests for color, taste, texture, and aroma, as well as conducting proximate analysis and analyzing iron and calcium levels in the cookie formulations.

2. Materials and methods

2.1. Formulation design

The materials used in this research are snakehead fish, corn, and strawberries obtained from the traditional market. Snakehead fish and corn are then processed into flour. Additional ingredients for making cookies include wheat flour, margarine, cornstarch, powdered milk, icing sugar, and chicken egg yolk. The tools used in the formulation process include an oven, mixer bowl, digital food scale, flour sieve, baking pan, spatula, spoon, blender, and basin.

2.2. Acceptance measurement

The acceptance was conducted by 80 untrained panelists. The selected untrained panelists were students from the Health Polytechnic of the Ministry of Health in Palembang majoring in Nutrition, with an age range of 18 to 20 years. The implementation of the cookie acceptance test by the panelists involved collecting the samples and providing them with an explanation of the procedure for testing the acceptability based on parameters such as color, texture, aroma, and taste, using a hedonic test. The test samples were coded as F1, F2, and F3.

2.3. *Proximate, Iron Content, and Calcium Content Analysis*

The analysis of macronutrients can be performed through proximate analysis, which is a rough analysis covering total ash content, total water content, total fat, total protein, and total carbohydrates. According to SNI 01-2891-1992, proximate analysis consists of total ash content using the Dry-Ashing method, total water content using the Thermogravimetry method, total fat content using the Soxhlet method, and total protein content using the Kjeldahl method. The analysis of iron content here is a micronutrient analysis. Iron (Fe) content is tested using the Atomic Absorption Spectrophotometry (AAS) method. Spectrophotometry is an analysis based on the absorption of electromagnetic radiation, causing the displacement of electrons from low to higher energy levels [7].

The materials used in the analysis of calcium content include distilled water (aqua distillation), H2C2O4, concentrated nitric acid, ammonium oxalate, dilute acetic acid, dilute ammonium hydroxide, dilute sulfuric acid, H2O2 30%, 0.1 N potassium permanganate standard solution, and concentrated HCl. This study used some equipment such as an Erlenmeyer flask, thermometer, pipette, Bunsen burner, filter paper (Whatman No. 42), stirrer, burette, analytical balance, mortar, 100 mL and 50 mL volumetric flasks, and a funnel. An experimental study used a completely randomized non-factorial design. We were conducted from May to September 2023 at the Food Technology Laboratory, Department of Nutrition, Health Polytechnic of Palembang, and the Saraswati Genetech Laboratory in Bogor. The data types obtained include data from the acceptability test and nutritional content. Data collection was performed using a passing form with 4 evaluation items: color; aroma; texture; and taste, scored as 5=very like, 4=like, 3=neutral, 2=dislike, and 1=strongly dislike. The acceptability test was conducted by 80 non-trained panelists and nutrition department graduates who have completed the Food Technology course. The evaluation used a hedonic scale consisting of very like, like, neutral, dislike, and strongly dislike for each aspect: color, aroma, taste, and texture. Nutritional content data was obtained from proximate analysis. Acceptability test data were processed using SPSS, while nutritional content data were obtained from proximate analysis in the laboratory. Data analysis used the Friedman test. The chemical analysis included proximate analysis, iron, and calcium compared with the quality standard for cookies (SNI 01-2973-2011).

3. Results and Discussions

3.1. Formulation of Gajjaberry cookies

The formulation of *Gajaberry* cookies was conducted with 3 formulas. The determination of the formula in the making of *Gajaberry* cookies is presented in Table 1.

Table 1. Determination of *Gajaberry* Cookies Formula with Snakehead Fish Flour, Corn Flour, and Strawberry.

Ingredients (gram)	F0	F1	F2	F3
Wheat Flour	150	50	50	50
Snakehead fish Flour	-	40	50	60
Corn flour	-	60	50	40
Margarine	70	70	70	70
Cornstarch	10	10	10	10
Powdered milk	20	20	20	20
Icing Sugar	30	30	30	30
Egg yolk	15	15	15	15

Making Gajjaberry cookies with corn flour, strawberries, and snakehead fish flour the recipe below:

1. Mix margarine, egg yolks, and sugar until cream forms.
2. Next, add snakehead fish flour, corn flour, wheat flour, milk powder, and cornstarch slowly and stir until mixed evenly.
3. Then, shape the cookie dough into a flat shape, make a few holes, then add strawberry jam on top of the dough.
4. Then, bake the cookie dough at 120°C for 20 minutes.
5. Cookies are ready to be served.

3.2. Acceptance

The acceptance for *Gajaberry* cookies was conducted for 4 different aspects: color, aroma, taste, and texture. These aspects were evaluated by the senses as a measurement tool to determine the level of preference of the panelists. Each aspect was evaluated differently and followed the preferences of each panelist. From the above graph, it is evident that the cookie formula most preferred by all panelists in all aspects of assessment is F3, with the use of 60 grams of snakehead fish flour, 40 grams of corn flour, 50 grams of wheat flour, 15 grams of egg yolk, 70 grams of margarine, 30 grams of butter, 20 grams of powdered milk, 30 grams of icing sugar, and 10 grams of palm sugar.

Table 2. Mean of Consumer acceptance of *Gajaberry* Cookies in types of formulation

Specification	Specification Mean±SD			p-value
	F1	F2	F3	
Color	2.20±0.664	3.21±0.822	3.23±0.993	<0.001
Aroma	2.58±0.776	3.09±0.799	3.40±0.880	<0.001
Flavour	2.30±0.701	2.79 ±0.867	3.81±0.873	<0.001
Texture	2.48±0.826	2.93±0.854	3.54±0,927	<0.001

This indicates that the use of a higher proportion of snakehead fish flour can enhance the acceptance of the panelists, as most panelists liked the color, aroma, taste, and texture of the cookies.

3.3. Data Analysis

The results of organoleptic testing were statistically analyzed using the Friedman Test. If the analysis results have a p-value of <0.05, then there is a significant difference.

3.4. Organoleptic Characteristics of Gajaberry Cookies

Color

Based on the panelists' assessments, 4 people liked the color of cookies in Formula 1, 18 people liked the color of cookies in Formula 2, and 24 people liked color of cookies in Formula 3. This indicates that most panelists prefer the color of cookies in formula F3 with an average of 3.23±0.993 compared to F1 and F2. Based on the Friedman analysis, the p-value obtained is 0.000, meaning there is a significant difference in the color of *Gajaberry* cookies. Cookies usually have a yellowish-brown color, but the color can change depending on the raw materials used [9].

The results of this research can explain that the addition of snakehead fish flour and corn flour in different amounts will affect the color preference. This is because the raw materials for making cookies, namely corn flour and snakehead fish flour, produce a brown color when mixed in the ingredients. The baking time is also considered during the baking process because the longer the cookies are baked, the darker the color. This is in line with Handayani and Elida (2018), stating that "the longer the baking, the darker the product produced due to browning reactions." Similar results are also shown by Fitri & Purwani, stating that the more snakehead fish flour added to the biscuit formulation, the darker the color of the biscuit. Adding snakehead fish flour to biscuits will cause the color to darken due to the Maillard reaction, a non-enzymatic browning reaction that occurs between reducing sugars and free amino groups from amino acids in snakehead fish flour. The cookies tend to have a darker color due to the Maillard reaction during the baking process, which produces melanoidin compounds that cause a brown color. This reaction occurs due to the reaction between carbohydrates, in this case, reducing sugars, and amino groups from proteins at high temperatures [20].

This research is interesting because it explores the impact of adding snakehead fish flour and corn flour in the formulation of cookies on color preference. The results show that the variation in the amounts of these two ingredients affects the color of the cookies, with the brown color produced by corn flour and snakehead fish flour playing a crucial role. The research also notes that the baking time influences the color of the cookies, where the longer the baking time, the darker the color of the cookies.

3.4.1. Aroma

Based on the assessments, it was found that 7 people liked the aroma of cookies in formula 1, 16 people liked the aroma of cookies in formula 2, and 24 people liked the aroma of cookies in formula 3. This indicates that most panelists prefer the aroma of cookies in formula F3 with an average of 3.40±0.880 compared to F1 and F2. Based on the Friedman analysis, the p-value obtained is 0.000, meaning there is a significant difference in the aroma of *Gajaberry* cookies.

The results of this research indicate that there is a difference in the level of organoleptic preference for the aroma of panelists with different additions of snakehead fish flour and corn flour in the three formulations. Aroma is a difficult-to-measure sense, usually leading to differences in opinions when evaluating its quality. Differences in opinions can be attributed to individuals having different olfactory senses, even though they can distinguish aromas, each person has different preferences [12]. The dominant characteristic aroma is from corn flour. Cookies with the addition of corn flour have a lingering aroma caused by flavonoid chemical compounds [5]. This has an impact on cookies that are not liked by the panelists.

Overall, this research opens a window to the complexity of interactions between raw materials, aroma, and taste in cookie production, providing valuable insights for the development of products that are more preferred by consumers. However, cookies with the substitution of snakehead fish flour and corn flour are still acceptable to consumers.

3.4.2. Texture

Based on the assessments, it was found that 9 people liked the texture of cookies in formula 1, 16 people liked the texture of cookies in formula 2, and 33 people liked the texture of cookies in formula 3. This indicates that most panelists prefer the texture of cookies in formula F3 with an average of 3.54±0.927 compared to F1 and F2. Based on the Friedman analysis, the p-value obtained is 0.000, meaning there is a significant difference in the texture of *Gajaberry* cookies. This study shows a significant difference can be seen in the level of corn flour addition; it is concluded that the higher the addition of corn flour, the less crispy and more brittle the texture produced. The addition of corn flour affects the crispiness of cookies; the less corn flour added, the crispier the cookies. Since corn flour contains little starch, its water absorption is low, and cookies tend to be relatively less crispy.

Texture is a factor that influences consumer choices for a food product. Food texture is related to the sensation of touch. Looking at a product can give an idea of whether a product is rough, smooth, hard, or soft (Febi, R.A, et al, 2021). The texture of cookies is influenced by starch content, as mentioned by Hariadi (2017), who states that the texture of cookies is affected by starch content. Gelatinized starch undergoes a dehydration process, forming a solid framework that makes the texture hard. This result aligns with previous studies that state that the difference in fish flour content does not significantly affect the subjects' acceptance of biscuit texture (Kurnia Sari et al., 2017). Different results are shown by other studies that indicate differences in subject acceptance of biscuit texture with different fish flour content formulations. This difference highlights the complexity of understanding the interaction between raw materials,

processes, and the influence of texture on consumer acceptance.

Thus, this research not only provides a deep insight into the role of starch in shaping cookie texture but also highlights the diversity of findings in the literature. This emphasizes that understanding specific contexts and variations in formulations can be key in designing food products that meet consumer preferences, especially in terms of texture.

3.4.3. Taste

Based on the assessments, it was found that 2 people liked the taste of cookies in Formula 1, 32 people liked the taste of cookies in Formula 2, and 37 people liked the taste of cookies in Formula 3. This indicates that the majority of panelists prefer the taste of cookies in formula F3 with an average of 3.81±0.873 compared to F1 and F2. Based on the Friedman analysis, the p-value obtained is 0.000, meaning there is a significant difference in the taste of *Gajaberry* cookies. Taste assessment comes from the chemical stimuli response by the tongue, ultimately forming the overall taste or flavor of the evaluated food [19]. The research results show that in formula F3, the highest level of preference for the taste of cookies is observed. The study indicates that the more corn flour added, the higher the taste produced in the cookies, with a slightly lingering and sharp taste of corn that does not match the panelists' taste. Taste is the most important aspect in determining the quality of cookies after texture, color, and aroma. Taste arises from chemical stimuli received by the taste buds on the tongue. In the highest formula, snakehead fish flour dominates and is preferred because the more snakehead fish flour added, the savory the taste produced. Generally, the taste produced by cookies is sweet, like F0 cookies; therefore, F0 cookies have the highest value in consumer acceptance. However, the raw materials used in making cookies also influence the taste formed by the cookies themselves [9].

The difference in the substitution of the amount of snakehead fish flour given does not show a significant difference ($p>0.05$). Some subjects reported that there was still a fishy taste in snakehead fish cookies, both in the 50% and 60% formulas (substitution of 50% and 60% of wheat flour). Efforts have been made to minimize the fishy taste of snakehead fish cookies by adding lemon juice during the snakehead fish flour-making process and adding grated lemon zest during the cookie-making process [11].

The effort to overcome the fishy taste in snakehead fish cookies by adding lemon juice and lemon zest indicates a creative approach to improving the taste quality of the product. This effort reflects an adaptive response to subject feedback reporting a fishy taste and demonstrates a commitment to continually improving the product.

3.5. Proximate Analysis, Iron, and Calcium Content

The Chemical analysis conducted includes examining protein content, fat, ash content, and water content. The research results on the nutritional content of *Gajaberry* cookies are presented in Table 2.

3.5.1. Water Content

A relatively small water content will make the product have a long shelf life and can inhibit damage from microorganisms (Lidiasari et al., 2006). According to Wiranto (1991), the lowest water content will achieve optimal stability, allowing for chemical reactions such as browning, oxidation, and hydrolysis. Proximate analysis results on *Gajaberry* cookies show water content in formula 1 at 4.59%, in formula 2 at 4.62%, and in formula 3 at 5.10%, which meets the quality standards for cookies according to SNI that the water content in cookies should not exceed 5%.

Table 2. Proximate Analysis of *Gajaberry* Cookies in 100 g

Parameter	Unit	F1	F2	F3	SNI Quality Cookies (2011)
Total Energy (Kkal/100g)	Kkal/100 g	517,21	507,64	500,54	Min.400
Ash Content	%	2,91	2,85	2,93	Maks.1,5
Water Content	%	4,59	4,62	5,10	Maks.5
Carbohydrates	%	45,77	46,72	44,01	Min.70
Total Fat	%	29,45	27,50	27,50	Min.9,5
Protein	%	17,26	18,3	21,40	Min.6,5
Iron	mg/100 g	2,76	2,95	2,65	-
Calsium	mg/100 g	163,50	174,34	179,5	-

3.5.2. Ash Content

The proximate analysis results of ash content in *Gajaberry* cookies show that formula 1 has 2.91% ash, formula 2 has 2.85%, and formula 3 has 2.93%. These values are higher than the quality standard for cookies according to SNI, which is a maximum of 1.5%. This is because there is an addition of snakehead fish, which has an ash content of 1.1 g/100 g [21].

3.5.3. Fat

Fat is a source of energy for the body, and it functions more effectively than carbohydrates and protein. Fat produces 9 Kcal of energy per gram (Almatsier, 2009). The proximate analysis results on *Gajaberry* cookies show fat content in formula 1 at 29.45%, in formula 2 at 27.50%, and in formula 3 at 27.50%, meeting the quality standards for cookies according to SNI, where the minimum fat content in cookies is 9.5%.

3.5.4. Energy

Energy is the result of the metabolism of protein, fat, and carbohydrates (Almatsier, 2009). The proximate analysis results on *Gajaberry* cookies show energy content in formula 1 at 517.21 Kcal, in formula 2 at 507.64 Kcal, and in formula 3 at 500.54 Kcal, meeting the quality standards for cookies according to SNI, where the minimum energy content in cookies is 400 Kcal.

3.5.5. Protein

Protein plays an important role in the body and also functions as fuel in the body. Protein also functions as a building and regulating substance (Almatsier, Sunita, 2011). We found that the protein content in the *Gajaberry* Formula 1 cookie was 17.26%, in Formula 2 it was 18.3% and in Formula 3 it was 21.40%. It follows the quality requirements for cookies based on SNI if the protein content obtained from additional snakehead fish is 16.2 g/100 g (TKPI, 2017).

3.5.6. Carbohydrates

Carbohydrates are a source of energy for the body, and the amount of calories produced from 1 gram of carbohydrates is 4 Kcal (Almatsier, Sunita, 2011). The proximate analysis results show that the carbohydrate content in *Gajaberry* cookies formula 1 is 45.77%, in formula 2 is 46.72%, and in formula 3 is 44.01%. The carbohydrate content in *Gajaberry* cookies does not yet meet the quality standards for cookies according to SNI, where the minimum carbohydrate content in cookies is 70%. This may be because the carbohydrate content in snakehead fish flour and corn flour, which are the main ingredients in making *Gajaberry* cookies, is not too high compared to wheat flour.

3.5.7. Iron

The analysis results for the iron content in *Gajaberry* cookies show that formula 1 has 2.76 mg, formula 2 has 2.95 mg, and formula 3 has 2.65 mg.

3.5.8. Calcium

The analysis of calcium in *Gajaberry* cookies shows that formula 1 has 163.50 mg, formula 2 has 174.34 mg, and formula 3 has 179.5 mg. The increase in calcium content is suspected to be due to the use of snakehead fish flour, which has a high calcium content of 473.70/100 mg.

4. Conclusion

This research explains that the addition of snakehead fish flour, corn flour, and strawberry jam in making cookies using different proportions in each aspect can significantly affect the acceptance of cookies in terms of color, taste, aroma, and texture. Based on the research results, the Friedman test ranking average highest from the organoleptic test assessment with a hedonic scale shows that the color, aroma, taste, and texture preferred by the panelists are in the treatment with a composition of 60 g of snakehead fish flour, 40 g of corn flour, and 20 g of strawberry. The acceptance test results show that treatment F3 is preferred by the panelists based on the categories: color = 3.21, aroma = 3.4, texture = 3.54, taste = 3.81, as evidenced by the average Friedman test results. From the proximate analysis of *Gajaberry* cookies, it has met the quality standards. *Gajaberry* cookies can be accepted and developed as one of the locally based snack products to meet the needs of energy, protein, iron, and calcium. Subsequent researchers are expected to analyze the impact of giving *Gajaberry* cookies on the weight gain of malnourished toddlers.

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