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Analysis Of Protein, Fat and Carbohydrate Nutrients in F100-Based Processed Cookies with Corn Flour Substitution for Malnourished Toddlers

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Article Info

ABSTRACT

Nutrient intake is an important factor for the growth and development of toddlers, one of the causes of malnutrition in toddlers is a suboptimal feeding pattern. Problem formulation, what is the content of protein, fat, and carbohydrates and how the panelists received based on organoleptic tests on processed F100-based cookies with 10%, 20%, and 30% corn flour substitution for malnourished toddlers. The purpose of the study was to determine the content of protein, fat, and carbohydrates as well as the acceptance of panelists based on organoleptic tests on processed F100-based cookies with 10%, 20% and 30% corn flour substitution for malnourished toddlers. This type of research is quantitative by using laboratory experiments to analyze protein, fat, and carbohydrate levels. The research design used was a 1-factorial Complete Random Design (RAL) with 3 treatments (10%, 20%, and 30%). The research panelists consisted of 20 students of Public Health specializing in nutrition to determine the level of organoleptic acceptance of cookies. Data were analyzed using univariate analysis. The results of the nutrient analysis research obtained protein content of 8.29%, 9.12%, and 9.58% for each treatment, fat content of 10.10%, 11.15%, and 12.25% for each treatment and carbohydrate content of 76.12%, 73.82%, and 71.83% for each treatment. The results of organoleptic tests showed that the entire cookie formulation was well received by the panelists, especially at 30% substitution. In conclusion, the nutritional content of corn flour substitution cookies can be an alternative in meeting the nutritional needs of toddlers per day. The suggestion for the next researcher is to conduct several follow-up tests to determine the content of micronutrients (vitamins and minerals).

INTRODUCTION

Malnutrition is a serious global health problem and affects millions of people around the world, especially children and toddlers. The World Health Organization (WHO) defines malnutrition as a condition in which a person does not get enough of the essential nutrients for optimal growth and development. This condition can be caused by a lack of intake of macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals). Based on WHO data in 2022, the prevalence of malnutrition in the world is 6.8% in toddlers and 2.1% of them experience acute malnutrition, where most children who experience acute malnutrition live in Asia and Africa (Urufia et al., 2024).

Based on data from the 2022 Indonesian Nutrition Status Survey (SSGI) or Indonesian Health Survey (SKI), the prevalence of undernourished toddlers is 7.7%, this figure increased by 0.6% compared to the previous year. In 2023 there will be an increase to 8.5% and in 2024 there will be a significant decrease, namely at 7.4%. Despite the decrease, this figure still does not reach the government's target in reducing the prevalence of malnutrition in Indonesia as written in Presidential Regulation No. 18 of 2020 concerning the 2020-2024 RPJMN where the target prevalence of wasting in 2024 is <7%.

Data from the Gorontalo Provincial Health Office in 2023 shows that the prevalence of malnutrition in Gorontalo Province based on Body Weight by Age (BB/U) is 3.8% where the highest prevalence of malnutrition is in North Gorontalo Regency at 7.2% while the lowest prevalence is in Pohuwato Regency at 2.2% and based on data from the Bone Bolango Regency Health Office in 2021 there are 158 undernourished toddlers. in 2022 there will be 127 and in 2023 there will be 70 malnourished toddlers (Ramli et al., 2024).

Nutrient intake is one of the causes that can affect the nutritional status of toddlers. Nutrient intake is obtained from several nutrients, including macronutrients, including proteins, fats and carbohydrates, and micronutrients including vitamins and minerals. Macronutrients are nutrients that are needed in large quantities by the body and mostly act as energy providers. The level of consumption of macronutrients can affect the nutritional status of toddlers because it is an important foundation for their health and well-being in the future (Suryani & Natan, 2022). Based on research conducted by Khomsah (2020), it is proven that the level of protein, fat and carbohydrate consumption has a significant relationship with the nutritional status of toddlers according to the BB/U index.

The challenge of meeting balanced nutritional needs is often influenced by limited information and resources (Nurfadillah & Rahim, 2024). Therefore, the government has made various efforts in overcoming malnutrition in toddlers, including through the preparation of guidelines for the prevention and management of malnutrition in toddlers, strengthening early detection, nutrition education, monitoring the growth and development of toddlers and Supplementary Feeding (PMT) for malnourished toddlers in the form of F100, which is a therapeutic formula which are rich in energy and essential nutrients such as protein, fats and carbohydrates and are given for 2-4 weeks (Ministry of Health, 2020). However, the results of interviews conducted with the head of TFC Bone Bolango Regency show that malnourished toddlers often feel nauseous and bored when consuming F100 in the form of condensed milk which causes the administration of F100 to be less than optimal. Therefore, researchers innovated to make F100-based cookies with corn flour substitution that has high nutritional content with the aim of making toddlers get a more attractive and nutritious variety of shapes and tastes.

This study uses cookies as a container because cookies have a fairly long shelf life and are widely liked by the public, especially children. Maksum et al (2025) stated that food processing innovations in the form of cookies can be an effective alternative in increasing public acceptance of nutritious local food. In addition, the use of corn flour as a substitute ingredient is not only because of the high nutrient content but also because corn is one of the potential food sources and is easy to find in various regions, one of which is in Gorontalo. However, the processing of corn into various products has still not received special attention from the community and the government (Kadir et al., 2019). Based on BPS data for Gorontalo Province in 2024, Gorontalo occupies the eighth position as the largest corn-producing province in Indonesia, with production reaching 617,719 tons in 2024. In addition to abundant corn production, the selling price of corn in Gorontalo is also relatively cheap, ranging from IDR 4,000-IDR 5,000 per kilogram (BSIP Gorontalo, 2024).

This study applied corn flour substitution into cookie formulation at the levels of 10%, 20%, and 30% to determine the optimal composition based on nutrient content and sensory characteristics. The substitution limit is set at a maximum of 30% because the substitution rate of 40% will result in a harder cookie texture so that it can reduce the acceptance rate of panelists organolepically. This is in line with research conducted by Adnan et al (2025) and Dewi et al (2022) which stated that corn flour substitution of more than 30% can result in a harder cookie texture and decreased sensory acceptance, so it is not recommended for the application of products with high sensory quality. Both studies stated that a 30% cornmeal substitution was considered the maximum sensory acceptable threshold.

The substitution of other ingredients into certain products can have an impact on the nutritional value and acceptance rate of the product produced, as well as the substitution of cornstarch in the manufacture of F100-based cookies so that it is necessary to know how the nutritional value and reception of the panelists on cookies are The results of this study are expected to contribute to the development of nutritious food products for children, as well as provide scientific information about the nutritional content of proteins, fats and carbohydrates in F100-based cookies with corn flour substitution.

Based on the above background, the researcher is interested in conducting a research entitled "Analysis of Protein, Fat and Carbohydrate Nutrients in F100-Based Processed Cookies with Corn Flour Substitution for Malnutrition Toddlers".

RESEARCH METHODS
Research Location and Time

This research was conducted at the Laboratory of Chemical Analysis and Microbiology, Department of Food Science and Technology, Faculty of Agriculture, Gorontalo State University to analyze protein, fat, and carbohydrate levels and was carried out at the Department of Public Health, Faculty of Sports and Health, Gorontalo State University for organoleptic tests. This research was conducted for 1 month, from September to October 2025.

Research Design

This study is a quantitative study using laboratory experiments to analyze protein, fat, and carbohydrate levels, and using a factorial Complete Random Design (RAL) 1 pattern with 3 treatments (10%, 20%, and 30%).

Research Variables

The variables studied in this study were protein, fat and carbohydrate levels and organoleptic tests (aroma, taste, color and texture).

Research Panelists

The panelists in this study consisted of 20 nutrition specialization students from the Department of Public Health, Faculty of Sports and Health, Gorontalo State University. Panelists were selected based on basic knowledge and experience in food technology regarding the sensory characteristics of food and the importance of organoleptic qualities in nutritious food products. Nutrition students are considered to be somewhat trained panelists who are able to provide assessments objectively and relevant to the research objectives.

Research Instruments

This research instrument is in the form of laboratory tests using the Kjeldahl method to analyze protein levels, the Soxhlet method to analyze fat levels, and the By Difference method to calculate carbohydrate levels, as well as organoleptic tests to assess panelists' acceptance of aroma, texture, color and taste parameters.

Data Analysis Techniques

The data analysis technique in this study uses univariate analysis which aims to provide an in-depth understanding of the characteristics and distribution of single variables, which is very important to describe the nutritional profile of F100-based cookies with corn flour substitution.

RESEARCH RESULTS

Physical appearance of 10%, 20% and 30% cornstarch substitution cookies

Based on the results of the research conducted, F100-based cookies with corn flour substitution produced have differences in physical appearance, especially in the appearance of the color of the cookies seen in each treatment. The physical appearance of the cookies in each treatment can be seen in the following figure 1:

Figure 1 Physical Appearance of 10%, 20%, 30% Cornstarch Substitution Cookies.

Laboratory test results for protein, fat, and carbohydrate levels
Laboratory test results for protein content

Table 1 Results of Laboratory Test Protein Levels in Corn Flour Substitution Cookies

Treatment	Protein Levels (%)			Average (%)	SNI (%)	Classification
	P1	P2	P3			
10%	8,29	8,31	8,27	8,29	Min. 5	Eligible
20%	9,13	9,11	9,14	9,12	Min. 5	Eligible
30%	9,57	9,55	9,62	9,58	Min. 5	Eligible

Source: Primary Data, 2025

Based on table 1, the results of laboratory tests on protein content in F100-based cookies with corn flour substitution in all treatments were classified as meeting the cookie quality requirements based on SNI, which is at

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least 5%, where in the 10% treatment the protein content per repeat 1, 2 and 3 in order was 8.29%, 8.31% and 8.27% with an average value of 8.29%, in the 20% treatment the protein content per repeat in order was 9.13%, 9.11% and 9.14% with an average value of 9.12%, and in the 30% treatment the protein content in cookies per repeat was respectively 9.57%, 9.55% and 9.62% with an average value of 9.58%.

Laboratory test results for fat content

Table 2 Laboratory Test Results of Fat Content in Corn Flour Substitute Cookies

Treatment	Fat Content (%)			verage (%)	SNI (%)	Classification
	P1	P2	P3			
10%	10,12	10,10	10,09	10,10	Min. 9.5	Eligible
20%	11,17	11,14	11,16	11,15	Min. 9.5	Eligible
30%	12,28	12,21	12,26	12,25	Min. 9.5	Eligible

Source: Primary Data, 2025

Based on table 2 of the results of laboratory tests on F100-based cookies with corn flour substitution, it was found that all treatments met the cookie quality requirements based on SNI, which was at least 9.5%, where in the 10% treatment the fat content per repeat 1, 2 and 3 in order was 10.12%, 10.10% and 10.09% with an average value of 10.10%, in the treatment 20% the fat content per repeat in order was 11.17%, 11.14% and 11.16% with an average value of 11.15%, and in the 30% treatment the fat content in cookies per repeat was respectively 12.28%, 12.21% and 12.26% with an average value of 12.25%.

Results of carbohydrate content calculation

Table 3. Results of Carbohydrate Content Calculation in Cornmeal Substitution Cookies

Treatment	Carbohydrate Content (%)			erage (%)	SNI (%)	Classification
	P1	P2	P3			
10%	76,15	76,14	76,08	76,12	Min. 70	Eligible
20%	73,86	73,82	73,78	73,82	Min. 70	Eligible
30%	71,79	71,85	71,87	71,83	Min. 70	Eligible

Source: Primary Data, 2025

Based on table 3, the results of the calculation of the carbohydrate content in F100-based cookies with corn flour substitution are classified as meeting the cookie quality requirements based on SNI, which is at least 70%, where in the 10% treatment the carbohydrate content per repeat 1, 2 and 3 in order is 76.15%, 76.14% and 76.08% with an average value of 76.12%, in the treatment of 20% the carbohydrate content per repeat in order is 73.86%, 73.82% and 73.78% with an average value of 73.82%, and in the 30% treatment the carbohydrate content in cookies per repeat in order was 71.79%, 71.85% and 71.87% with an average value of 71.83%.

Organoleptic test results

Distribution of aroma cookies

Table 4 Distribution of Panelists by Aroma of Cookies Corn Flour Substitution 10%, 20%, 30%

Aroma	10%		20%		30%	
	n	%	n	%	n	%
Not fragrant	0	0	0	0	0	0
Less fragrant	0	0	1	5	0	0
Slightly fragrant	3	15	3	15	5	25
Fragrance	10	50	13	65	12	60
Very fragrant	7	35	3	15	3	15
Quantity	**20**	**100**	**20**	**100**	**20**	**100**

Source: Primary Data, 2025

Based on the distribution of the aroma cookies in table 4, it shows that out of 20 panelists, there were 3 (15.0%) panelists who chose the somewhat fragrant category, 10 (50.0%) panelists chose the fragrant category, and 7 (35.0%) panelists chose the very fragrant category. This shows that the majority of panelists rated the aroma of 10% cornstarch substitution cookies in the fragrant category.

For the substitution of 20%, it showed that out of 20 panelists, there was 1 (5.0%) panelists who chose the category of not very fragrant, 3 (15.0%) panelists chose the somewhat fragrant category, 13 (65.0%) panelists chose the fragrant category and 3 (15.0%) panelists chose the very fragrant category. This shows that the majority of panelists rated the aroma of 20% cornstarch substitution cookies in the fragrant category.

As for the substitution of 30%, it shows that out of 20 panelists, there are 5 (25.0%) panelists who choose the somewhat fragrant category, 12 (60.0%) panelists choose the fragrant category, and 3 (15.0%) panelists choose the very fragrant category. This shows that the majority of panelists rated the aroma of 30% cornstarch substitution cookies as also in the fragrant category.

Distribution of texture cookies

Table 5 Distribution of Panelists by Texture of Cookies Corn Flour Substitution 10%, 20%, 30%

Texture	10%		20%		30%	
	n	%	n	%	n	%
Not crispy	0	0	0	0	0	0
Less crispy	1	5	0	0	1	5
Slightly crispy	6	30	4	20	5	25
Crispy	12	60	16	80	11	55
Very crispy	1	5	0	0	3	15
Quantity	**20**	**100**	**20**	**100**	**20**	**100**

Source: Primary Data, 2025

Based on the distribution of cookie textures in table 5, it shows that out of 20 panelists, 1 (5.0%) panelists chose the less crispy category, 6 (30.0%) panelists chose the slightly crispy category, 12 (60.0%) panelists chose the crunchy category and 1 (5.0%) panelists chose the very crispy category. The average panelist in this study assessed the texture of 10% cornstarch substitution cookies in the crispy category.

For the substitution of 20%, it shows that out of 20 panelists, there are 4 (20.0%) panelists who choose the slightly crispy category and 16 (80.0%) panelists choose the crispy category. The average panelist in this study assessed the texture of 20 % cornstarch substitution cookies in the crispy category.

Meanwhile, the substitution of 30% showed that out of 20 panelists, there were 1 (5.0%) panelists who chose the less crispy category, 5 (25.0%) panelists chose the slightly crispy category, 11 (55.0%) panelists chose the crispy category and 3 (15.0%) panelists chose the very crispy category. The average panelist in this study assessed the texture of 30 % corn flour substitution cookies in the crunchy category.

Color distribution of cookies

Table 6 Distribution of Panelists by Color of Cookies Corn Flour Substitution 10%, 20%, 30%

Color	10%		20%		30%	
	n	%	n	%	n	%
Not yellowish-brown	0	0,0	0	0,0	0	0,0
Less yellowish browning	4	20,0	4	20,0	0	0,0
Slightly yellowish brown	11	55,0	8	40,0	9	45,0
Yellowish brown	5	25,0	7	35,0	10	50,0
Very yellowish brown	0	0,0	1	5,0	1	5,0
Quantity	**20**	**100,0**	**20**	**100,0**	**20**	**100,0**

Source: Primary Data, 2025

Based on table 6, it shows that out of 20 panelists, 4 (20.0%) panelists chose the less yellowish-brown category, 11 (55.0%) panelists chose the slightly yellowish-brown category, and 5 (25.0%) panelists chose the yellow-browned category. The majority of panelists in this study assessed the color of cookies in the 10% cornstarch substitution in the slightly yellow-brown category.

For the 20% substitution, it showed that out of 20 panelists, 4 (20.0%) panelists chose the less yellowish-brown category, 8 (40.0%) panelists chose the slightly yellowish-brown category, 7 (35.0%) panelists chose the yellow-brown category, and 1 (5.0%) panelists chose the very yellow-brown category. The average panelist in this study assessed the color of cookies in the 20% corn flour substitution in the slightly yellow-brown category.

In the 30% corn flour substitution, 9 (45.0%) panelists chose the slightly yellowish-brown category, 10 (50.0%) panelists chose the yellow-browned category, and 1 (5.0%) panelists chose the very yellow-brown

category. The majority of panelists in this study assessed the color of cookies in the 30% corn flour substitution in the yellow-brown category.

Distribution of flavor cookies

Table 7 Distribution of Panelists by Taste of Cookies 10%, 20%, 30% Corn Flour Substitution

Taste	10%		20%		30%	
	n	**%**	**n**	**%**	**n**	**%**
Not savory	0	0,0	0	0,0	0	0,0
Less savory	1	5,0	1	5,0	2	10,0
Slightly savory	4	20,0	4	20,0	1	5,0
Savory	12	60,0	13	65,0	16	80,0
Very savory	3	15,0	2	10,0	1	5,0
Quantity	**20**	**100,0**	**20**	**100,0**	**20**	**100,0**

Source: Primary Data, 2025

Based on table 7 on the flavor distribution of cookies substitution of 10% cornstarch, it shows that out of 20 panelists, there are 1 (5.0%) panelists who choose the less savory category, 4 (20.0%) panelists choose the somewhat savory category, 12 (60.0%) panelists choose the savory category, and 3 (15.0%) panelists choose the very savory category. This shows that the average panelist in this study assesses the taste of cookies 10% in the savory category.

In the 20% corn flour substitution, it showed that out of 20 panelists, there were 1 (5.0%) panelists who chose the less savory category, 4 (20.0%) panelists chose the somewhat savory category, 13 (65.0%) panelists chose the savory category, and 2 (10.0%) panelists chose the very savory category. The average panelist in this study assessed the taste of cookies in the savory category.

Meanwhile, the 30% substitution showed that out of 20 panelists there were 2 (10.0%) panelists who chose the less savory category, 1 (5.0%) panelists chose the somewhat savory category, 16 (80.0%) panelists chose the savory category, and 1 (5.0%) panelists chose the very savory category. It can be seen that the majority of panelists in this study assessed the taste of 30 % corn flour substitution cookies in the savory category.

DISCUSSION
Protein content in F100-based cookies with 10%, 20% and 30% corn flour substitution
The results showed that the protein content in cookies showed an increase in each corn flour substitution, namely 8.29% (10%), 9.12% (20%), and 9.58% (30%). These results show that the increase in corn flour substitution in formulations contributes to an increase in the protein content of the final product.

The increase in protein content along with the increase in corn flour substitution is quite rational considering that corn flour has a protein content of around 9.20%. According to Sukirno (2021), corn flour has a relatively higher protein content than some other cereal flours that are often used as a substitute for wheat flour. The results of this study are in line with the study, where any increase in the concentration of cornstarch is directly proportional to the increase in protein content in cookies.

The basic formula of F100 itself is a therapeutic food formula that contains enough protein, so the combination of corn flour and F100 also contributes to increasing protein levels. Lapui et al (2021) also showed that the substitution of cereal flour such as corn, sorghum, and millet in cookie products can increase the total protein content because the characteristics of these flours have a higher protein content than wheat flour. The increase in protein levels produced in this study is due to the combination of the characteristics of corn flour and the nutritional content of F100 which is basically designed as a solid nutritious food.

The protein content in these cookies is higher when compared to the protein content of the standard F100 which has a protein content of 3.1%. This can happen because cookies go through the baking stage where it can increase the concentration of nutrients, one of which is protein. The protein content in these cookies is still within the SNI allowed limit, which is at least 5%. In addition, the protein content in corn flour substitution cookies can meet the nutritional adequacy of toddlers (0-59 months), which is 9-25 grams if consumed 4 pieces per day. This shows that the use of cornstarch can be an effective alternative to increase the protein content of cookies, meet the protein needs of toddlers per day, and can maintain its physical and organoleptic quality.

Fat content in F100-based cookies with 10%, 20% and 30% cornstarch substitution
The results showed that the fat content in cookies increased with the increase in corn flour substitution, namely 10.10% (10%), 11.15% (20%), and 12.25% (30%). This increase can occur due to several factors, among which corn flour has a natural fat content of around 3.90%. Although the fat content is relatively small, it still has an effect when the corn flour in the formulation is increased. This is in accordance with Hadiyanti (2020) research which states that corn flour tends to bind more fat during the baking process than wheat flour.

In addition, the physical characteristics of gluten-free cornstarch cause the dough structure to become more fragile and more easily absorb butter or added fat. Muliani & Yulianto (2023) explained that low-gluten or gluten-free raw materials cause oil to be more easily absorbed during baking due to the absence of elastic protein structures that bind fats. Therefore, the higher the substitution of cornstarch, the greater the ability of the dough to absorb fat, so that the total fat content also increases. The results of this study are in line with research conducted by Natara (2019) which stated that the substitution of cornstarch in cookies can increase fat content even though the addition is not too significant.

Overall, this increase in fat content does not interfere with product quality standards because all fat content is within the SNI permissible limit for cookie products , which is at least 9.5%. In addition, the fat content in corn flour substitution cookies is comparable to even higher than the standard F100, which is 6.0%. Apart from being caused by the baking process, this is due to the characteristics of cornstarch which can bind large amounts of fat. The fat content in these cookies can meet the nutritional adequacy of toddlers (0-59 months), which is 31-50 grams if consumed 5 pieces per day. The fat content in cookies can play a role in increasing the savory taste and crunchy texture that the panelists like, thus adding value to the product.

Carbohydrate content in F100-based cookies with 10%, 20% and 30% cornstarch substitution

The results showed that carbohydrate content decreased with each increase in cornmeal, namely 76.12% (10%), 73.82% (20%) and 71.83% (30%). This decrease in carbohydrates is a consequence of increasing the level of protein and fat in the formulation, considering that the calculation of carbohydrates is carried out by the by difference method where the substitution of high-protein and fatty ingredients will reduce the value of carbohydrates in the calculation.

According to Ndumuye et al (2022), any increase in protein and fat content will directly decrease the percentage of carbohydrates as a result. Corn flour itself has a lower carbohydrate content than wheat flour, which is 73.70 grams for corn flour and 77.2 grams for wheat flour, therefore the less wheat flour and the more corn flour added to the formulation, it will result in a decrease in carbohydrate levels. This is in accordance with research conducted by Sukirno (2021) which states that the decrease in carbohydrate content in cornmeal-based cookies is caused by an increase in other components such as wheat flour and tapioca flour.

This decrease in carbohydrate content does not have a negative impact on the quality of cookies because it still meets the SNI requirements, which is at least 70%. In addition, the carbohydrate content in corn flour substitution cookies has a much higher content than carbohydrates in the standard F100 which amounted to 9.1%. The carbohydrate content in corn flour substitution cookies can meet the nutritional adequacy figure of toddlers (0-59 months), which is 59-220 grams if consumed 4 pieces per day. This can be interpreted that cookies with corn flour substitution can be an alternative food for malnourished toddlers.

Panelist acceptance based on organoleptic tests on F100-based cookies with 10%, 20% and 30% corn flour substitutions
Aroma

The results of the panelist assessment research on aroma parameters based on frequency distribution showed that the majority of panelists chose the "fragrant" category in the three corn flour substitution treatments, namely 10 panelists (50%) at 10% substitution, 13 panelists (65%) at 20% substitution, and 12 panelists (60%) at 30% substitution. Hadju et al (2025) stated that the addition of different corn compositions will produce a different aroma in each treatment. The decrease in the acceptance rate of the aroma of cookies at a higher substitution percentage despite having only a 5% difference from the 20% to 30% substitution can be attributed to the increased typical aroma of corn in line with the increase in the substitution of corn starch in cookies.

Adnan et al (2025) explained that an increase in the percentage of cornstarch leads to a more dominant distinctive aroma and can reduce the liking of some panelists. Nevertheless, the overall results showed that the aroma of cookies was still well received, so that cornstarch did not have a significant negative effect on the acceptance of the product's aroma despite an increase in the percentage of cornstarch substitution.

Texture

The results of the panelist assessment research on texture parameters based on frequency distribution showed that the majority of panelists assessed the texture of cookies to be in the "crispy" category, namely 12 panelists (60%) for 10% substitution, 16 panelists (80%) for 20% substitution, and 11 panelists (55%) for 30% substitution. Despite the decline in the panelists' assessment of the highest substitution, the corn flour substitution of up to 30% can still maintain the crispy texture characteristics expected in cookies products.

The crunchy texture of cookies is greatly influenced by the moisture content, type of starch, and gluten content in the dough. The cornstarch used in this study does not contain gluten so that it causes cookies to have a crispy texture. This is in accordance with the research of Muliani & Yulianto (2023) who stated that corn flour produces a crispier cookie structure because the starch particles do not form elastic tissues like gluten in wheat flour. Thus, the use of cornstarch as a substitute ingredient still contributes positively to creating a light cookie texture that is liked by the panelists.

Color

The results of the panelist assessment research on color parameters based on frequency distribution, the majority of panelists chose the "slightly yellowish-brown" category, namely 11 panelists (55%) for 10% substitution and 8 panelists (40%) for 20% substitution, while 10 panelists (50%) for 30% substitution chose the "yellow-brown" category. This suggests that the increase in cornstarch may contribute to the color of the cookies.

Corn flour has a more dominant yellow base color than wheat flour, so the higher the substitution rate will produce a more concentrated product color, this is in accordance with the statement of Hadju et al (2025) where products that use a larger corn formula can provide a bright yellow color compared to a lower corn formula. The change in the color of these cookies is also influenced by the carotenoid pigments (lutein and zeaxanthin) in cornmeal, in this case the Maillard reaction plays a role between proteins and reducing sugars that produce a brown color when baked and is also influenced by the increased protein content at higher substitutions, so that the browning color will be more visible.

This is in line with research by Adnan et al (2025) who said that the color of cookies can change to more yellowish-brown along with the addition of cornstarch. This shows that the color of the cookies in this study is not only influenced by the baking process but also by the characteristics of the raw materials, but overall cookies still show a good level of color acceptance by the panelists.

Taste

The results of the panelist assessment research based on the distribution of cookie flavor the majority of panelists chose the "savory" category in each substitution, namely 12 panelists (60%) for 10% substitution, 13 panelists (65%) for 20% substitution, and 16 panelists (80%) for 30% substitution. This shows that the increase in corn flour substitution does not decrease the rate of panelists' acceptance of cookie flavor, and even tends to increase panelists' acceptance of the highest substitution.

The dominant savory taste can be attributed to increased fat content and the savory flavor character of corn. Dewi et al (2022) stated that cornstarch can give a more savory taste to baked goods. This stable taste acceptance suggests that cornstarch is a substitute ingredient that can naturally enhance the taste of cookies. Thus, corn flour substitution cookies in this study have the potential to accept good taste and deserve further development.

CONCLUSION

Based on the results of the research and discussion on the Analysis of Protein, Fat, and Carbohydrate Nutrients in F100-Based Processed Cookies with Corn Flour Substitution for Malnutrition Toddlers, the following conclusions can be drawn:

The protein content of F100-based cookies with 10%, 20% and 30% corn flour substitution respectively was 8.29%, 9.12%, and 9.58%.

The fat content of F100-based cookies with 10%, 20%, and 30% corn flour substitution is 10.10%, 11.15%, and 12.25%, respectively.

The carbohydrate content of F100-based cookies with 10%, 20%, and 30% corn flour substitution respectively was 76.12%, 73.82%, and 71.83%.

The panelists' assessment based on organoleptic tests with aroma, texture, color and taste parameters on F100-based cookies with 10% corn flour substitution in order was 4.20%, 3.65%, 3.05% and 3.85%. The 20% substitution is 3.90%, 3.80%, 3.25% and 3.80% respectively. For 30% substitution in order are 3.90%, 3.80%, 3.60% and 3.80%.

Suggestions

Based on the above conclusions, the researcher provides the following suggestions:

For future researchers, it is recommended to conduct follow-up tests to determine the content of micronutrients, especially vitamins A, C, D and calcium.

For health workers, these cookies products can be considered as an alternative to snacks to avoid boredom in toddlers who are consume F100 in the form of condensed milk.

As a form of product development, the researcher recommends a 30% cornstarch substitution formulation because it shows a consistent balance of sensory reception across all test parameters compared to other formulations.

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