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The Effect of Addition of Various Food Ingredients on Acceptance and Protein Content of Cookies as PMT for Stunting Toddlers

Pengaruh Penambahan Berbagai Bahan Makanan terhadap Daya Terima dan Kadar Protein Cookies Sebagai PMT untuk Balita Stunting

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ABSTRACT

Background: Stunting is a developmental failure that occurs due to poor nutrition in the past, and almost 25% of children under five worldwide experience it. The World Health Organization determined that stunting in the world was <20% in 2018, while it was 30.8% in Indonesia. Cookies are meals liked by people of all ages and can be given to eradicate stunting. They can be processed from various food ingredients that have rich protein content.
Objectives: This study aimed to determine cookie acceptance for protein content for stunted children
Methods: The experimental research used a completely randomized design (CRD) for five treatments: formulations A, B, C, D, and E, with three repetitions. The acceptance test was also carried out on 15 stunted toddlers using the Comstock test (food scraps). The selected cookie formulations were tested for protein content using the Kjehdal method. Data analysis was continued using the variance analysis (ANOVA) test, followed by the Duncan method.
Results: The results of the ANOVA test showed that cookies significantly influenced the level of aromatic aspect (p=0.011) and contained 12.91 grams of protein. Duncan's test showed significant differences in cookies' taste and aroma (treatments C and A).
Conclusions: Treatment A, which has certain cookies' formulation and sensory characteristics, i.e., color, texture, taste, and aroma, contains higher protein and contributes to the adequacy of nutrition in children aged 3-5 years by 57.37%.

INTRODUCTION

Stunting is a growth and development failure that occurred due to poor nutrition in the past, and almost 25% of children under five worldwide are stunted. The World Health Organization (WHO) determined that the incidence of stunting was <20% worldwide in 2018, while the percentage of stunting cases in children under five in Indonesia was 30.8%[1]. To alleviate stunting in children under five, it is necessary to provide additional food rich in amino acids, such as nuggets, waffles, stick bars, and cookies developed by Irwan (2020) to improve the nutritional status of stunting toddlers[2]. Cookies contain high energy and fat to meet nutritional needs and alleviate stunting. They can be processed from various food ingredients that are rich in nutrients, including proteins that affect insulin growth factor (IGF-1) and zinc, which helps regulate albumin and iron, which not only becomes a growth motor but also prevents stunting children from getting sick quickly, as well as calcium in the bone matrix[3-4].

Cookies are dry cakes containing wheat flour, skim milk, and butter as the essential ingredients. They had a crunchy texture and were quickly broken[5]. Wheat flour usually makes noodles and bakery products, including bread, cakes, and biscuits. Cookie processing can also be added to flour substitutes for wheat, including red bean flour, catfish flour, and tempeh formula flour, which are easy to obtain, affordable, and quite familiar to the community. Taro flour originating from American taro is usually given as animal feed. They are rarely used in human commodities. Red bean flour had a high protein content of 22.3 grams/100 grams. Taro flour is gluten-free and has higher calcium and phosphorus content than rice. Catfish flour also has a high calcium content of 285 g, while tempeh formula flour contains 41.5 grams of protein, effectively improving the nutrition of children under five[6].

Red beans (*Phaseolus Vulgaris L.*) can be used as a food additive and substitute for various food products to increase the nutritional value and fortify food ingredients. Red bean seeds can be utilized and processed into various food ingredients after drying into flour. Red beans contain various nutrients, such as carbohydrates, proteins, fibers, B complex vitamins,

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minerals, calcium, phosphorus, and iron. The protein content in red beans was comparable to that in green beans. The fat content was lower than that in peanuts and soybeans. Red beans contain more fiber than corn, sorghum, rice, and wheat[7]. Red beans contain high protein, and thus, they are very good, especially for people with stunting, given the lack of albumin levels in the blood. Low intake of albumin levels can lead to albumin deficiency[8].

Taro (*Colocasia Esculenta (L.) Schott*) is a less preferred and rarely used food commodity because it is slightly itchy after the taste on the tongue. However, taro can be processed into food with a high economic value if it is produced and packaged correctly. Taro contains carbohydrates, proteins, minerals, vitamins, and fiber. Taro contains proteins, such as histidine, tryptophan, isoleucine, lysine, and methionine, which are vital for supporting body health. Taro has a higher protein content than other tubers, such as sweet potatoes and cassava. Taro contains 1.9 grams of protein per 100 g, cassava contains 1.2 grams, and sweet potatoes contain 1.8 grams of protein[9-10]. Taro can be used as a source of carbohydrates to meet energy requirements. This could replace the need for proteins as an energy source. Taro also contains amino acids vital for the growth and development of children under five[11].

Protein in catfish (*Clarias Batrachus*) is a source of animal protein that is affordable and easy to obtain. Catfish contains essential amino acids like leucine and lysine, which are beneficial for child growth and development, maintaining nitrogen balance in the body, absorbing calcium more efficiently, and sustaining adipose tissue to prevent obesity. The proteins obtained from catfish can produce antibodies, enzyme hormones, and collagen to replace damaged cells and body tissues. Protein intake that does not meet children's needs will cause height growth failure; thus, amino acids, especially methionine and cysteine, are building blocks of protein needed to build the bone matrix and affect children's growth[12]. The fat in catfish is a source of essential fatty acids as an omega, which can help form brain cells in children under five[13].

Tempe is a traditional food made by fermenting soybeans, which are high in vegetable protein, readily available, and inexpensive[14]. Tempe can be made into flour (forte) with supporting ingredients, such as flour, sugar, oil, and baking powder. Forte can be used as an ingredient for making snacks that are high in nutritional content, such as cakes, snack bars, and puddings, which can help overcome nutritional problems in children under five[10]. Based on Suhartini et al. (2018), forte can be formulated as an effective food additive to improve nutrition in children under five[6].

Based on the above issues, the researcher expects to develop a nutrient-rich product to eradicate stunting cases in Indonesia. The products in question are cookies made from high-protein ingredients, which children like and people make quickly. Based on previous studies, cookies are still made from vegetable sources that are low in protein, such as those developed by Jannah (2019), Damayanti (2020), and Prihapsari (2021). With the addition of catfish flour, the protein value is hoped to increase, especially the amino acids required for growth and development[4,15-16]. Cookies with the formulation of these four ingredients follow the mathematical Formula $Yij = \mu + \alpha i + \varepsilon ij$ in Suharjo's (2019) and Kristanti's (2020) research[11,17-18]. Mixing various ingredients for cookies is expected to make them tasty, slightly sweet, and nutrient-rich. This study aimed to determine cookie acceptance for protein content to reduce nutritional problems, such as malnutrition and stunting.

METHODS

This was an experimental study using a completely randomized design (CRD). The chemical characteristics of the cookies were tested at the M. Brio Food Laboratory, Bogor. The panelist test was conducted at the Food Technology Laboratory, Department of Nutrition, Lubuk Pakam (Student Panelist).

In this study, the substitution of ingredients for cookies was carried out using five treatments of red bean flour (35, 20, 25, 30, and 35 g), five treatments of taro flour (15, 25, 20, 15, and 10 g), five treatments of catfish flour (40, 35, 30, 25, and 20 G), and five treatments of tempe formula flour (10, 20, 25, 30, and 35 g)[11,17-18]. The research sample consisted of cookies with red bean, taro, catfish, and tempeh formula flours (Table 1). Cookie sampling was carried out randomly for each treatment using 25 semi-trained panelists (students who had graduated from food technology) for 20 min. Panelist students then completed a hedonic test questionnaire including color, texture, aroma, and taste on a 5 Likert scale (1: strongly unpreferred, 2: unpreferred, 3: neutral, 4: preferred, and 5: strongly preferred). This was followed by a direct acceptance test on 15 stunted toddlers using the Comstock (food waste) test. The research was approved by the ethics committee of Poltekkes Kemenkes Medan (01.0145/KEPK Poltekkes Kemenkes Medan).

Tools

This study used many tools, such as scales, basins, knives, 80 mesh sieves, cabinet dryers, millers, and plastic jars. Meanwhile, cookie-making included tools such as cookie cutters, tins, basins, mixers, and ovens.

Materials

Red beans, taro, catfish, and forte are ingredients for making flour, while milk flour, sugar flour, margarine, butter, baking powder, salt, egg yolks, and cornstarch are ingredients for making cookies.

Research Stages

Making Red Bean Flour

Sorted red beans were selected to obtain whole red beans. The red beans were washed with clean water and soaked for 24 h in water before being washed with running water and drained. Red beans were boiled and dried at 50^0C for 1-2 hours. After drying, they were ground until smooth and then sifted to produce red bean flour[19].

Making Taro Flour

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American taro was sorted and peeled off. The American taro was then washed using running water, sliced to 0.20 cm thick, and soaked in a solution of table salt at a ratio of 1:4 for two hours. Subsequently, the American taro was washed with water and drained. Then, they were dried with a cabinet dryer at 60^{0}C for ± 48 h and ground into flour. They were then sifted using a 100-mesh sieve to obtain the flour. The prepared American taro flour was placed in a closed plastic container[10].

Making Catfish Flour

The catfish were washed and cleaned. The guts and heads of the catfish were discarded and soaked in lime juice for 30 min. The catfish was steamed until tender and yellowish for 30 min; then, they were placed in a blender, dried in an oven at 60^{0}C for six hours, blended, and filtered through a 60-mesh sieve[17].

Making Tempeh Formula Flour (Forte)

The tempeh was chopped into small pieces and boiled for 10 minutes. The boiled tempeh was drained and crushed. Sifted flour, powdered sugar, and salt were added and stirred with the tempeh thoroughly. All ingredients were sprinkled with salt, baking powder, and novelette. They were then stirred until they became doughed. The dough was then placed in a pan that was previously greased with oil with a thickness of 1 cm. The dough was then baked in an oven until it was cooked. Drying was performed using a cabinet dryer at a temperature of 60^{0}C to produce a tempeh formula with a longer shelf life. Finally, the tempeh formula was placed in the mill until it became flour[20].

Making Cookies

The recipe used for making cookies includes various modifications. The dough was made with 80 g of refined sugar, 35 g of margarine, 20 g of butter, 15 g of milk flour, and one egg yolk. The mixture was then placed in a mixer for ± 5-10 minutes. Red bean, taro, catfish, and tempeh formula flours were added to the mixture slightly according to a predetermined amount. Next, 15 g of cornstarch, 1.4 grams of baking soda, and 2.4 grams of salt were added to the mixture. After the dough was formed, it was baked in an oven for ± 20-25 minutes at a temperature of ± 100^{0}C. Cookies made from red bean, taro, catfish, and forte flours were prepared based on the cookie recipe by Kristanti et al. (2020)[11], as shown in Table 1.

Table 1. Distribution of ingredients and grams in the manufacture of cookies

Materials	Unit	Treatment				
		A	B	C	D	E
Red bean flour	gram	35	20	25	30	35
Taro flour	gram	15	25	20	15	10
Catfish flour	gram	40	35	30	25	20
Tempeh formula flour	gram	10	20	25	30	35
Milk flour	gram	15	15	15	15	15
Sugar flour	gram	80	80	80	80	80
Margarin	gram	35	35	35	35	35
Butter	gram	20	20	20	20	20
Baking powder	gram	1.4	1.4	1.4	1.4	1.4
Salt	gram	2.4	2.4	2.4	2.4	2.4
Egg yolk	gram	30	30	30	30	30
Cornstarch	gram	15	15	15	15	15

Testing of Protein Content of Cookies with the Kjeldahl Method

The sample (1 g) was placed in a Kjedhal flask containing 5 grams of Na_2SO_4, 15 mL of concentrated H_2SO_4, and 0.3 grams of $CuSO_4$. Subsequently, the sample in the fume hood was heated at a medium temperature until it became colorless. After the smoke disappeared, the temperature was increased. The same procedure was performed with the blank solution until the Kjeldahl flask was cold, followed by 200 mL of distilled water, 1 g of Zn, and 45% NaOH solution. The sample was distilled until the ammonia evaporated. The distillate was collected in an Erlenmeyer flask containing 100 mL of 0.1 N HCl, which was given a 1% PP indicator. The distillation was stopped when 150 mL volume was reached in the Erlenmeyer flask or after the distillate that came out was no longer alkaline. The excess of 0.1 N) in the distillate was titrated with a 0.1 N NaOH solution.

$$\text{Protein content } (\%\ ^{b}/_{b)} = \frac{V\ pentiter\ (blank\ sample)\ x\ N\ HCL\ x\ 14.008\ x\ 6.25}{\text{sample weight x } 1000} \text{ x } 100\%$$

Processing and Analysis of Data

Data processing and analysis went through several stages, namely, editing by checking the contents of the questionnaire, data entry, coding, and cleaning the data by re-checking whether there were errors in the data entry. The data were then collected and analyzed using the Analysis of Variance (ANOVA) test followed by Duncan's advanced test with a degree of significance (a) of 5%. If p ≤ 5%, it means that there were formulations and characteristics of various types of food ingredients that have the potential to be used as additional food for stunted children from the most preferred analysis.

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Research Flow

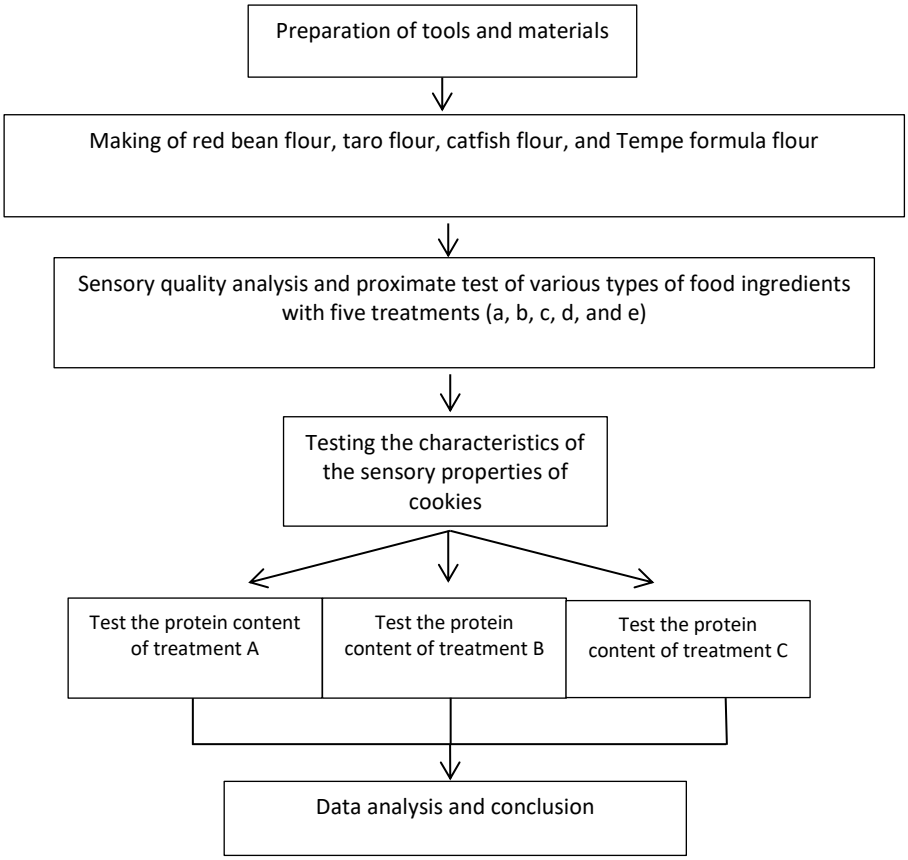

Figure 1. Organoleptic test flow scheme and protein content

The selection of treatments for examining protein content was based on the taste component and the four domains of the organoleptic test (color, texture, taste, and aroma). This term is because treatments A, B, and C had the highest average scores based on the organoleptic test and also had more significant animal protein, which is needed for stunted children. In terms of taste, treatments A, C, and D had the highest average scores, and this study aimed to develop a cookie formula to overcome the problem of stunting, which requires a higher animal protein content. The less savory taste and unpleasant smell caused by adding catfish flour and red bean flour were overcome by adding spices, such as lime leaves, coriander, cinnamon, and garlic[17-21].

RESULTS AND DISCUSSION

Organoleptic Test

The results of the cookie organoleptic test based on the hedonic scale with various formulations suggested that the lowest treatment value was found in treatment B (3.34), which was neutral and had a rather dark brown color, hard texture, sweet taste, and slightly unpleasant aroma. The highest treatment value was found in treatment A (3.72), which was strongly preferred and had a light brown color, crunchy texture, sweeter taste, and distinctive cookie aroma, and was not unpleasant. Based on these results, the sensory quality test for acceptance of cookies is shown in Table 2.

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Table 2. Distribution of organoleptic test results by various treatments

Organoleptic Properties	Treatment					
	A	B	C	D	E	p-value
Color	3.60	3.32	3.56	3.40	3.34	0.137
Texture	3.52	3.36	3.40	3.26	3.36	0.479
Taste	3.70	3.36	3.48	3.44	3.36	0.112
Aroma	3.72	3.34	3.52	3.36	3.38	0.011*
Average	3.63	3.34	3.49	3.36	3.36	

ANOVA test; *) Significant if p-value <0.05

Table 2 shows the organoleptic results, including the cookies' color, aroma, taste, and texture. The panelists preferred treatment A the most, with an average value of 3.63. The selected cookie formulation with formula A consisted of 35 g of red bean flour, 15 g of taro flour, 40 g of catfish flour, and 10 g of forte flour in the strongly preferred category, especially in terms of taste, with an average value of 3.70. This form was light brown, with a crunchy texture and distinctive aroma.

Color

The color of a food product is influenced by the ingredients consumers prefer. The bright dark brown color of the cookies was thought to originate from the raw materials of red beans and catfish, which produced a dark brown color. The colors of these cookies appeared increasingly brighter after being mixed with forte flour and taro flour, which are light gray. The brown color of the cookies was due to roasting in the oven. Another factor that causes the dark brown color of cookies is the reaction between the sugar and amino group in the protein, which produces the Maillard reaction and caramelization[22].

Adding catfish flour to the cookies made the color brown but still bright. This is because of the high protein content in catfish, which can affect color during roasting[23]. Burning cookies in an oven at high temperatures produces melanoidin compounds, which are reactions between groups of amino acids and carbohydrate-reducing sugars[24]. The increase in the intensity of the Maillard reaction could be due to the increase in reduced sugar and protein content in the dough obtained from taro, red bean, catfish, and forte[25].

Texture

The texture is a quality parameter that is essential in determining product characteristics. The texture is the sensation of pressing a product, which can be felt by biting, chewing, swallowing, or touching the ring finger[26]. The acceptability results of treatment A were in the neutral category, with a crunchy texture[27]. The crunchy texture of the cookies was produced from the high addition of red beans, which contain gluten, which makes the texture intact, challenging, and not easily broken. A crunchy and crumbly texture could also result from roasting. After the cookies are cooled, retrogradation occurs (starch granules rebind the amylose molecules that have come out owing to a decrease in temperature)[28]. According to Jannah (2020), the texture of cookies is influenced by taro amylopectin, which causes the puffing process. This causes the cookies made from starch with a high amylopectin content to be porous and crunchy. Starch with a high amylose content tends to produce hard cookies because the development process occurs in a limited manner[15].

Taste

Taste is the senses' response to determine whether a food product is accepted or rejected[26]. The taste of cookies originates from the glutamic acid present in red beans. Glutamic acid in proteins can lead to a delicious taste. The fat content of red beans and catfish can also impart a savory taste[29]. Moreover, red bean processing, carried out with the correct procedure, will reduce the unpleasant taste of red beans[30]. Cookies also have a sweet taste because of the addition of taro flour, which contains starch and makes cookies sweet [31].

Aroma

Aroma is a response to the sense of smell that originates from volatile compounds and is influenced by the main elements of the ingredients and procedures. The lipoxygenase enzyme in red beans, which produces an unpleasant aroma and high protein content, gives off a distinctive aroma. Nataliningsih (2007) found that the dominant aroma in instant BMC comes from red beans, which have a slightly unpleasant smell because red beans contain lipoxygenase enzymes, which produce a beany flavor or unpleasant aroma[32]. However, the unpleasant odor produced by lipoxygenase from red beans mixed with the aroma of catfish reduces the odor, causing a more fragrant flour because it is the first roast[17]. The caramelization process during the roasting of the taro flour mixture also enhanced the distinctive aroma of the cookie. Aromas generated from steam during food processing are produced by volatile compounds and are influenced by the main components and processing methods. The aroma of a food can be a benchmark for liking or liking a food product[7].

Overall Satisfaction

The most preferred cookies were cookies in treatment A, with a composition of 35 grams of red bean flour, 15 grams of taro flour, 40 grams of catfish flour, and 10 grams of forte flour, with an average of 3.63 (strongly preferred). Meanwhile, the least desirable were cookies in treatment B with a composition of 20 g of red bean, 25 g of taro flour, 35 g of catfish flour, and 20 g of forte flour, with an average of 3.34 (unpreferred). Cookies in treatment A were categorized as bright brown, crunchy, sweet and savory, distinctively aromatic, and not unpleasant. Overall preferences based on product acceptance can be assessed in terms of color, taste, aroma, and texture. The results of the statistical analysis

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using the ANOVA test showed that the formulations of red bean flour, taro flour, catfish flour, and tempeh formula only significantly affected the level of aroma preference (p=0.011). Duncan's test was used to observe differences in taste and aroma produced in treatments A, B, C, D, and E (treatments C and A have distinct aromas).

Chemical Test of Cookies

Chemical quality analysis of the food product was carried out to determine the levels of nutrients, especially proteins. The examination for treatment A was selected because the animal protein source was higher than treatments B, C, D, and E. Other fundamental things were that animal protein's viability value was higher than vegetable protein's, and the amino acid content was more complete[31]. Formula A had a bright brown color, crunchy texture, sweet and savory taste, distinctive cookie aroma, and no unpleasant smell. The selection of treatment A (35 g of red bean flour, 40 g of catfish flour, 15 g of taro flour, and 10 g of forte flour) was then repeated three times to obtain cookie formulas A1, A2, and A3. The analysis and contribution of cookies based on the 2019 Nutrition Adequacy Figures are shown in Table 3.

Table 3. Distribution of protein content of cookies and contribution to Recommended Daily Allowance (RDA) 2019

Cookies Formula	Chemical Protein	% NAF
A1	12.81	56.93
A2	13.27	58.97
A3	12.66	56.26
Average	12.91	57.37

Table 3 shows that the average protein content of cookies formula A is 12.91 grams, giving a protein adequacy of 57.37% for toddlers aged 3-5 years. The high protein content in Formula A cookies was due to the protein content in each cookie-making ingredient. Red beans contain 22.1 grams of protein in 100 grams (100 grams of catfish flour contains 56 grams of protein[17], and 100 grams of forte contains 8.3 grams of protein[33]). The cookies with the highest protein content were in treatment A, with a composition of 35 grams of red bean flour, 15 grams of taro flour, 40 grams of catfish flour, and 10 grams of forte flour, with an average of 12.91.

Protein is a macronutrient required by humans. The primary function of proteins in stunting toddlers is as a growth and development substance for body structure. Therefore, protein plays an essential role in the life cycle of humans, especially toddlers. Thus, it must be consumed daily. The protein content of catfish can produce an excellent immune response and form several hormones, enzymes, and collagen, which are required to form structures in toddlers. Proteins function to transport Insulin Growth Factor (IGF-1) and can also increase the potential of peak bone mass. Hormone Insulin Growth Factor (IGF-1) can help the growth hormone proliferation and differentiation process and activate osteoblasts to increase the height of toddlers and overcome stunting incidents[30].

CONCLUSIONS

The results of the preference level analysis by panelists for cookies made of red bean flour, catfish flour, taro flour, and forte showed no significant differences in color, texture, or taste in each sample. However, there was a real difference in the aroma of each cookie made of different flours. Formula A is the cookie selected and preferred based on color, taste, aroma, and texture, with an average value of 3.63 (strongly preferred). The results of the protein content test in Formula A found that the average protein content was 12.91 grams, contributing 57.37% to the nutritional adequacy in children under five.

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