Research Article
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Acceptability and energy protein content of sago cookies with mackerel substitution as an additional food for the malnourished toddlers

Abstract

Background: Providing additional food in the form of cookies is one of the efforts to reduce the problem of malnutrition in toddlers. Sago is one of Indonesia's local foods as a raw material for cookies, which is containing high carbohydrates but low in protein. It is necessary to substitute sago with mackerel, which is containing high protein and linolenic acid. This study aims to determine the effect of mackerel flour subtitution on the acceptability and energy protein content of sago cookies.

Methods: This was an experimental study with a completely randomized design. There were four variations of mackerel flour substitution, namely 0% (A) as control, 5% (B), 10% (C), 15% (D). The substitution of mackerel flour as independent variable, while the dependent variables were an acceptability, energy content, protein content. Data were statistically analyzed using ANOVA.

Results: Statistical test to determine the difference in sago cookies showed p-value = 0,860 for the acceptability, p-value = 0,001 for the energy content, p-value = 0,000 for the protein content.

Conclusion: The substitution of mackerel flour has a significant effect on the energy and protein content, but it has no effect on the acceptability of sago cookies.

Keywords: acceptability, energy content, mackerel, protein content, sago cookies

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Analia Mayasari, Fery Lusviana Widiany, Kuntari Astriana
Department of Nutrition, Universitas Respati Yogyakarta, Yogyakarta, Indonesia

Correspondence: Fery Lusviana Widiany, Department of Nutrition, Universitas Respati Yogyakarta, Yogyakarta, Indonesia, Email fery_lusviana@respati.ac.id

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Introduction

Malnutrition is still being one of the health problems in Indonesia.[1] Data from the basic health research in Indonesia in 2018 showed that the prevalence of malnutrition in toddler in Indonesia was 13,8%, while in Papua Province was 11,44%. Yapen Islands is one of the regencies in Papua Province with cases of malnutrition of 15.26% and is included in the top 10 highest cases in Papua Province.[2] Based on the profile of the Yapen Islands Regency Health Office in 2021, it is known that there are 8.7% of toddlers suffering from malnutrition or 818 cases out of 9.366 toddlers who are weighed. The high prevalence of undernutrition is feared to have implications for poor nutritional status in the following period.[3] Malnutrition in toddlers causes disturbances in the process of growth, energy production, body defense, behavior and brain structure and function.[4] Inadequate energy intake is the dominant factor in the incidence of malnutrition in toddlers aged 12-59 months. Toddlers with deficit energy intake have a 1,92 times the risk of experiencing malnutrition.[5] Deficiency in energy consumption and protein consumption plays an important role as a risk factor for undernutrition in toddlers.[1]

Lack of energy and protein intake in toddlers needs to be addressed by providing energy- and protein-dense additional food so that the nutritional needs of toddlers who experience malnutrition are fulfilled.[6] Providing additional food in the form of biscuits made from local food is one of the efforts that can be made to reduce nutritional problems in toddlers in Indonesia.[7] Cookies are a type of biscuit made of soft, crunchy dough and when broken, the texture looks less dense.[8] Cookies are practical food because they can be eaten at any time and good packaging, cookies have a relatively long shelf life. Cookies can be seen as a good medium as a type of food that can meet special human needs.[9] Cookies can be made from one of Indonesia's local foods, namely sago. Sago is easy to get in the Yapen Islands. Data from the Department of Agriculture of the Yapen Islands Regency shows that the sago plantation area in the Yapen Islands in 2021 covers 44.520 ha with a total production of 533.886 tons. The use of sago is not too much developed by the people of the Yapen Islands. They only use sago as the main food ingredient, which is usually processed into papeda and sinole.[10] As a food source, sago contains high carbohydrate, reaching 84, 7 grams per 100 grams. This content is higher than rice (80 grams per 100 grams) and wheat flour 77,3 (grams per 100 grams). Apart from its nutritional composition, one of the important components in sago which can be of added value is its starch which does not contain gluten so it is very good for consumers with special needs. Sago starch also functions as a nutraceutical, which is a product that contains natural bioactive chemical compounds that are useful for increasing endurance and disease prevention.[11]

Sago starch when viewed from its chemical composition consists mostly of carbohydrates, the same as tapioca, flour, rice flour, cornstarch and others. This shows that sago starch can be used to make bread, pastries, biscuits, noodles, vermicelli, crackers, vermicelli and so on, either as a substitute or as a main ingredient.[12] Based on the nutritional content of sago starch which is dominated by carbohydrates, the content of other nutrients, namely protein, can be increased by adding food sources of protein, one of which is by adding mackerel. Mackerel is a fish that is commonly found in Indonesian waters and is generally very popular among the public, because it has an economical price and is relatively simple to process.[13] Based on the profile of the Yapen Islands Regency Fisheries Service, mackerel production in 2021 will reach 415 tons. In addition to the abundant production of mackerel, the nutritional content of mackerel is also high. The nutritional content of mackerel per 100 grams is 125 cal energy, 21,3 grams protein, 3,4 grams fat and 2,2 grams carbohydrates.2 In addition, the omega 3 fat

content in mackerel is more than salmon, which is 2,2 in 100 grams of mackerel. The protein found in fish is of high quality and easily digested and absorbed.[13]

Mackerel is a perishable commodity that requires good handling and management, one of which is by processing it into flour. Fish meal has the advantages of having a long shelf life at room temperature without undergoing much change, being easy to use as a raw material in the manufacture of food products and being a good source of protein.[14] The use of mackerel flour as a substitution ingredient in making cookies made from sago flour is expected to increase the protein content of cookies so that energy and protein-dense products are produced and can be an alternative food supplement for undernourished toddlers. Based on the preliminary research conducted by researchers, with a substitution percentage of mackerel flour of 20%, cookies were obtained with a slightly brownish yellow color, slightly crumbly texture, slightly fishy aroma typical of fish and fish and savory taste. Previous research also showed the same results.[15] Based on this preliminary research, a range (difference in substitution of mackerel flour) was made of 5%, namely 5%, 10% and 15%. This research was conducted to analyze the acceptability and energy content analysis of protein sago cookies substituted mackerel flour as additional food for undernourished toddlers.

Materials and methods

This was a true experimental study, namely making sago cookies substituted with mackerel flour and will examine its effect on acceptability, energy content and protein content. The design used was completely randomized design, with four different treatments (0%, 5%, 10% and 15%), two replications and three experimental units. The research was carried out in July 2022 at the Dietetics and Culinary Laboratory of Universitas Respati Yogyakarta, Indonesia, and testing for energy and protein content was carried out at the Food Technology and Agricultural Products Laboratory of Gadjah Mada University. The acceptance test was carried out at the Dahlia Posyandu, Mutihan Hamlet, Srimartani Village. Acceptance testing by 25 toddler subjects aged 1–5 years by weighing the remaining uneaten cookies. Protein content was analyzed using the Micro Kjeldahl method. The results of the calculation of the energy content and protein content test were statistically analyzed using the ANOVA test, then followed by a post-hoc test if there were differences between groups. Acceptability test results were analyzed with the Kruskal Wallis test. This research has obtained the ethical clearance from the Health Research Ethics Commission at Universitas Respati Yogyakarta No: 082.3/FIKES/PL/VI/2022.

Results

The process of making sago cookies as a substitute for mackerel flour consists of two stages, namely the preparation stage and the stage of making cookies. The sago flour used by researchers in making cookies is sago flour made by a local community living in Mariadei Village, Anotaurei District, Yapen Islands. Meanwhile, the mackerel used is fresh mackerel with the characteristics of bright shiny skin, the eyes are still protruding and look clear and the flesh is dense and elastic.

Acceptability of sago cookies substitute Mackerel flour

Acceptability is the level of preference of panelists for sago cookies products substituted for mackerel flour which is assessed based on the remaining uneaten cookies through a weighing process using a digital food scale. The remaining cookies that were not eaten were converted into 2 scales, namely 1 = likes (1-3 grams of remaining cookies), 2 = dislikes (4-6 grams of remaining cookies). The subjects in this study were toddlers aged 1-5 years at Posyandu Dahlia, Mutihan Hamlet, totaling 25 people. Of the 25 toddlers who were the subject of the study, 1 toddler was undernourished while the other 24 toddlers had good nutritional status. The characteristics of the subjects in this study are shown in Table 1. Based on Table 1, most of the subjects were female, namely 16 toddlers (64%), aged 1-3 years, namely 15 toddlers (60%), and with good nutritional status, namely 24 people (96%). The data obtained from the acceptability test results were then analyzed using the Kruskal Wallis test because based on the results of the data normality test performed, the data from the acceptability test for sago cookies substituted with mackerel flour were not normally distributed ($p<0,05$). The results of the acceptance test for each treatment of mackerel substitution sago cookies can be seen in Table 2. Based on Table 2, the average acceptance of sago cookies substituted for mackerel flour ranges from 1,40 to 1,52. Statistical test results using the Kruskal Wallis test at a significance level of 5%, showed that there was no significant difference in the acceptability of sago cookies with the four types of mackerel flour substitution treatment, indicated by p-value = 0,860 ($p>0,05$). This means that the substitution treatment for mackerel flour has no effect on the acceptability of sago cookies.

Table 1 Characteristics of subjects acceptance test of sago cookies substitute Mackerel flour

Characteristics of Subjects	Number of subjects (n)	%
Gender		
Man	9	36%
Woman	16	64%
Total	**25**	**100%**
Age		
1–3 years old	15	60%
4–5 years old	10	40%
Total	**25**	**100%**
Nutritional Status		
Normal	24	96%
Malnutrition	1	4%
Total	25	100%

Table 2 Acceptability of sago cookies substitute Mackerel flour

Experimental Group	n	Results				
		Min	Max	Mean	Deviation Standard	*p-value*
A	25	1	2	1,40	0,500	
B	25	100%	2	1,48	0,510	0,860*
C	25	100%	2	1,48	0,510	
D	25	100%	2	1,52	0,510	

Note:

The sign notation (*) indicates testing with the Kruskal Wallis test.

A: Sago cookies without mackerel flour substitution

B: Sago cookies with 5% mackerel flour substitution

C: Sago cookies with 10% mackerel flour substitution

D: Sago cookies with 15% mackerel flour substitution

Energy content of sago cookies substitute Mackerel flour

Energy content is the amount of energy contained in sago cookies substituted for mackerel flour which is obtained through empirical

calculations, namely by converting the amount of protein content, fat content and carbohydrate content into the amount of energy. The results of the analysis of the energy content of sago cookies with the four substitution treatments of mackerel flour is shown in Table 3. Based on Table 3, the energy content of sago cookies substituted for mackerel flour is in the range of 492,22 – 504,29 kcal. The highest energy content was found in sago cookies without mackerel flour substitution (treatment A) with an average value of 504,29, while the lowest was found in sago cookies with 15% mackerel flour substitution (treatment D) with an average value 492,22 kcal. These results indicate that the higher the mackerel flour substitution, the lower the energy content of sago cookies. Based on the results of statistical tests using the ANOVA test at a significance level of 5%, it shows that there is a significant difference in the energy content of sago cookies substitution of mackerel flour with four different treatments, indicated by p-value = 0,001 (p<0,05). This means that the mackerel flour substitution treatment affects the energy content of sago cookies. Because there is an influence, it is continued with the Post-Hoc test. From the results of the Post-Hoc test it can be seen that the energy content of sago cookies substitution of mackerel flour in treatment A was significantly different from treatments C and D. However, it was not significantly different from the energy content of sago cookies substitution of mackerel flour in treatment B. The energy content of sago cookies substitution of mackerel flour treatment D was significantly different from treatments A, B and C.

Table 3 Results of analysis of the average energy content of sago cookies substitute Mackerel flour

Experimental Group	Mean (kcal)	p-value
A	504,29±1,633^{c}	0,001*
B	502,12±0,233^{bc}	
C	499,27±0,183^{b}	
D	492,22±0,183^{a}	

Note: Numbers followed by the same lowercase letter show no significant difference according to Tukey's test. The sign (*) indicates testing with the ANOVA test.

A: Sago cookies without mackerel flour substitution

B: Sago cookies with 5% mackerel flour substitution

C: Sago cookies with 10% mackerel flour substitution

D: Sago cookies with 15% mackerel flour substitution

Protein content of sago cookies substitute Mackerel flour

Protein content is the amount of protein contained in mackerel flour substitution sago cookies as measured by the micro-kjeldahl method. The Kjeldahl method is used to measure protein content in solid materials by indirectly analyzing the protein content in the food body, because what is analyzed is the nitrogen content.[15] The results of the protein content in each treatment of sago cookies substitution of mackerel flour are shown in Table 4.

Table 4 Results of analysis of average protein content of sago cookies substitute Mackerel flour

Experimental Group	Mean (%) ± Deviation Standard	*p-value*
A	2,17±0,028^{a}	0,000*
B	4,83±0,141^{b}	
C	6,72±0,035^{c}	
D	10,75±0,063^{d}	

Based on Table 4, it can be seen that the protein content of sago cookies substituted for mackerel flour is in the range of 2,17 – 10,75%. The highest protein content was found in sago cookies with 15% mackerel flour substitution (treatment D) with an average value of 10,75%, while the lowest was found in sago cookies without mackerel flour substitution (treatment A) with an average value of 2,17%. These results indicate that the higher mackerel flour substituted into sago cookies, the protein content of sago cookies increases.

Based on statistical tests using the ANOVA test at a significance level of 5%, it shows that there is a significant difference in the protein content of sago cookies with four different treatments, indicated by p-value = 0,000. This means that the substitution treatment for mackerel flour affects the protein content of sago cookies. Because there is an influence, it is continued with the Post-Hoc Test.

From the results of the Post-Hoc Test it can be seen that there is a significant difference between each treatment. Protein content of sago cookies substituted mackerel flour treatment A was significantly different from treatments B, C and D. Protein content of sago cookies substituted mackerel flour treatment B was significantly different from treatments A, C and D. Protein content of sago cookies substituted mackerel flour treatment C significantly different from treatments A, B and D. The protein content of sago cookies substituted mackerel flour in treatment D was significantly different from treatments A, B and C.

Discussion

Acceptability of sago cookies substitute Mackerel flour

Acceptance or food preference can be interpreted as the level of individual liking or disliking of a type of food. The level of this preference varies greatly for each individual which affects food consumption.[16] Acceptability of food is influenced by several factors including the appearance of food when it is served and the taste of food.[17]

Based on the results of statistical tests using the Kruskal Wallis test on the acceptability of mackerel substitution of sago cookies, it was obtained p = 0,860 (p>0,05), meaning that the mackerel flour substitution treatment did not have a significant effect on the acceptability of sago cookies. This is because in terms of the appearance of the sago cookies that were tested on the panelists, namely in terms of shape and portion size, the sago cookies for each treatment were made uniformly, namely in the form of a flower with a weight of 6 grams each cookie. An attractive and harmonious form of food has its own charm for people who eat it.[18] In addition to the uniform shape and portion size, in this study the color of the cookies produced from the four different treatments did not differ much, ranging from light brown to dark brown. The more mackerel flour substituted into the cookie formulation, the darker the color of the cookies. Fish meal causes the color of the biscuit to darken due to the Maillard reaction, which is a non-enzymatic browning reaction due to a reaction between reducing sugars and free amine groups from amino acids or proteins.[19] The product results were not significantly different physically, both in shape and color, causing the panelists' preference level for sago cookies substituted for mackerel flour was also not significantly different. The sago cookies given to the panelists during the acceptability test were not in accordance with the predetermined serving size, which was only 1 piece (6 grams). This is with the consideration that toddlers as panelists are not used to consuming fish-flavored biscuits because the biscuits circulating in society in general are biscuits made from wheat flour without any additions with a sweet or savory taste, so there is a need to introduce these cookies

first. Statistical test results showed that mackerel flour substitution treatment did not have a significant effect on the acceptability of sago cookies. That is, sago cookies with mackerel flour substitution of 5%, 10% and 15% can be liked by panelists as panelists like sago cookies without mackerel flour substitution. Therefore, sago cookies with 15% mackerel flour substitution can be developed as additional food for undernourished toddlers who are dense in nutrients because the energy and protein content of cookies is quite high and meets PMT_P requirements according to Indonesian Minister of Health Regulation No. 51 of 2016.

Energy content of sago cookies substitute Mackerel flour

Energy is a nutrient that is useful for moving the body and metabolic processes in the body. Nutrients that function to provide energy are carbohydrates, fats and proteins.[20] The total energy of food ingredients is usually expressed in kilocalories (kcal). Determination of the number of calories in sago cookies substituted for mackerel flour is obtained from the sum of the calories of protein content, fat content and carbohydrate content. Fat content provides energy of 9 kcal/gram, while protein and carbohydrates provide energy of 4 kcal.[7]

Based on the results of statistical tests using the ANOVA test, the value of p = 0,001 (p<0,05) was obtained, meaning that the mackerel fish flour substitution treatment had a significant effect on the energy content of sago cookies.

From the calculation results, it can be seen that the total energy obtained in each treatment was treatment A of 504,29 kcal, treatment B of 502,12 kcal, treatment C of 499,27 kcal and treatment D of 492,22 kcal. These results indicate that as the substitution of mackerel flour increases, the total energy decreases. The results of this study are in line with previous studies, that the higher the proportion of substitution of bran flour and tuna fish flour, the lower the total energy of cookies.[21]

Sago cookies without mackerel flour substitution (treatment A) had a higher energy content than sago cookies substituted for mackerel flour. This is because sago cookies without mackerel flour substitution have the highest carbohydrate content, namely 68,90%. The high carbohydrate content of the product comes from the main component of the product which is a source of carbohydrates, namely sago flour. In 100 g of sago flour it is known to have a high carbohydrate content of 89,22 g, so the more sago flour used, the higher the carbohydrate content of cookies. The most influential factor on the energy content is the content of protein, fat and carbohydrates, where the energy value is directly proportional to the content of protein, fat and carbohydrates in the product. The greater the protein, fat and carbohydrate content, the greater the energy produced.[22] Carbohydrates are the biggest contributor to energy content.[23]

Based on the quality requirements for PMT-P for toddlers according to Permenkes No. 51 of 2016 where the specified energy content is at least 400 kcal, the energy content of all treatments is in accordance with the specified quality requirements.

Protein content of sago cookies substitute Mackerel flour

Protein is a very important nutrient because it is most closely related to life processes. Protein functions for the growth and maintenance of tissues, replacing cells that die and wear out as well as anti-bodies. In addition, protein also functions as a building and regulatory substance as well as a source of energy.[24]

Protein deficiency in severe stages causes kwashiorkor in children under 5 years. Protein deficiency is often found together with energy deficiency which is called maramus.[25] Based on the results of statistical tests using the ANOVA test, it was obtained a value of p = 0,000 (p<0,05), meaning that the substitution treatment for mackerel flour had a significant effect on the protein content of sago cookies. Based on the results of the proximate analysis, it can be seen that the value of the protein content of sago cookies shows an increase in results as the mackerel fish flour substitution is added. The protein content of sago cookies obtained in each treatment was treatment A of 2,17%, treatment B of 4,83%, treatment C of 6,72%, and treatment D of 10,75%. Sago cookies without mackerel (treatment A) had the lowest protein content and sago cookies with 15% mackerel flour substitution had the highest protein content. This is because the protein content of mackerel meal is higher than the protein content of sago flour. Deep mackerel flour per 100 g has a high protein content of 55,02 g (2). Meanwhile, sago flour protein per 100 g of ingredients is 0,18 g. The more use of fish meal, the higher the protein content of the biscuits.[16,26] Based on the quality requirements for PMT-P for toddlers according to Permenkes No. 51 of 2016 where the specified protein content is in the range of 8-12 g, then those that meet the requirements are sago cookies with 15% mackerel flour substitution (Treatment D).

Serving size

The serving size according to BPOM in 2019 is the amount of food that must be consumed at one meal, which is expressed in metric units and household size. Determination of the PMT-P serving size is based on fulfilling 1/3 of the adequacy of protein for toddlers in a day.[6] The protein requirement for toddlers aged 1-3 years is 20 g, while toddlers aged 4-6 years is 25 g.[27] As much as one third of the protein requirement for toddlers aged 1-3 years is 6,7 grams and children aged 4-6 years is 8,3 g.

The contribution per serving of sago cookies substituted for mackerel flour is determined based on the results of an analysis of the nutritional content of cookies that meet PMT-P requirements according to the Indonesian Minister of Health Regulation No. 51 of 2016 and good acceptability compared to the 2019 Nutrition Adequacy Rate. The formula that meets the requirements of the Indonesian Minister of Health Regulation No. 51 of 2016 and has good acceptability is treatment D with 15% mackerel flour substitution.

Sago cookies with 15% mackerel flour substitution, based on the nutritional content test per 100 grams of cookies contain 492,22 kcal of energy and 10,75 g of protein. Based on this, the serving size of sago cookies with 15% mackerel flour substitution to be able to meet 1/3 of the protein needs of toddlers aged 1-3 years, the cookies consumed per day are 10 pieces (62,3 g). Meanwhile for toddlers aged 4-5 years, to meet the target, cookies are consumed as many as 13 pieces (77,2 g).

The serving size of sago cookies with 15% mackerel flour substitution as PMT-P is 10 pieces (62,4 g) for children aged 1-3 years and 13 pieces (77,2 g) for children aged 4-5 years which can meet 22,7–27,1% of Recommended Dietary Allowance of energy and 26,8–41,5% Recommended Dietary Allowance of protein. Toddlers should consume 10-13 pieces of cookies a day, where cookies are used as a morning, afternoon and evening distraction of 3–5 pieces each time they are consumed.

Conclusion

There is no effect of mackerel fish flour substitution on the acceptability of sago cookies. Sago cookies with mackerel flour

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substitution of 5%, 10%, and 15% were liked by the panelists as the panelists liked sago cookies without mackerel flour substitution. There is an effect of substitution of mackerel flour on the energy content of sago cookies. The higher the mackerel flour substitution, the lower the energy content of sago cookies. There is an effect of substitution of mackerel flour on the protein content of sago cookies. The higher the substitution of mackerel flour, the higher the protein content of sago cookies. Sago cookies with 15% mackerel flour substitution is the chosen formula based on the nutritional content of cookies that meets PMT_P requirements according to the Indonesian Minister of Health Regulation No. 51 of 2016 and good acceptability. Sago cookies with 15% mackerel flour substitution have an energy content of 492,22 kcal and a protein content of 10,75% which meet the PMT-P requirements. Based on these conclusions, it was suggested to the community health center that sago cookies can be used as an alternative to providing additional food for undernourished toddlers. It is necessary to carry out further research regarding the effect of the intervention of sago cookies substitution of mackerel flour on the nutritional status of undernourished toddlers and in future research, it is hoped that researchers will use mackerel flour as an addition so that the energy content of the cookies produced does not decrease.

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Conflicts of interest

The author declares that there is no conflicts of interest.

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