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Effect of Substitution of Cowpea Sprouts Flour (*Vigna unguiculata L.*) and Sorghum Flour (*Sorghum bicolor L.*) of Chemical Quality and Organoleptic Quality on Biscuits as Supplementary Feeding Recovery for Protein Energy Malnutrition School Age Children

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Abstract: *Malnutrition status in school-age children (5 – 12 years) based on BMI/U nationally reaches 9.2% (very thin category 2.4% and thin 6.8%) while the prevalence of malnutrition in East Java Province is 8% and Malang city region is 7.69%. Overcoming PEM in school-age children by providing diet therapy in the form of Providing Supplementary Food to School Children (PMT-AS). Additional food based on local food ingredients using cowpea sprout flour (Vigna unguiculata L.) and sorghum flour (Sorghum bicolor L.). The aim of the research was to analyze the effect of substitution of cowpea sprout flour and sorghum flour on the chemical quality and organoleptic quality of biscuits as PMT for PEM school-age children. This type of experimental research with a RAL design consists of 4 treatment levels with 3 repetitions, namely* P_0 *(100:0:0),* P_1 *(40:55:5),* P_2 *(40:45:15),* P_3 *(40:35:25). The chemical quality results of biscuits using the calculated value method are carbohydrate content (59.27 – 62.27 g/100 g), protein content (7.31 – 10.56 g/100 g), fat content (16.16 – 16.64 g/100 g), and energy value (423.75 – 428.45 Kcal). The organoleptic quality of biscuits had a significant effect on the panelists' liking for color (p=0.000), taste (p=0.000), and aroma (p=0.000) but did not have a significant effect on texture (p=0.221). The best formulation of PMT biscuits with the substitution of cowpea sprout flour and sorghum flour for PEM school-aged children is treatment* P_2 *(40:45:15).*

Keywords: Biscuit, PMT-AS, Cowpea Sprout Flour, Sorghum Flour

INTRODUCTION

The nutritional problem experienced by school-aged children is Protein Energy Malnutrition (PEM). The results of the 2018 Riskesdas report that the malnutrition status of school age children (5 – 12 years) based on BMI/U in Indonesia is 9.2% with the very thin category being 2.4% and underweight 6.8%. Furthermore, the prevalence of undernutrition in East Java Province reached 8% (very thin category 2.2% and thin 5.8%). The incidence of malnutrition in the Malang city area is 7.69% (very thin category 1.83% and thin 5.86%) (Riskesdas, 2018). This shows that the prevalence of undernutrition nationally is higher than the prevalence of undernutrition in East Java and Malang city (7.69%).

The program to accelerate the prevention of PEM in school-age children is by providing additional food for school children (PMT-AS) (Kemenkes RI, 2016). Nora's research (2018) stated that giving PMT-AS to Solok city elementary school students was able to reduce the prevalence of underweight nutrition from 21.4% to 14.3%. In line with Chandradewi's (2021) research, the results of assisting parents of students in providing PMT-AS at SDN 1 Karang Bayan showed that there was an increase in the average knowledge and skills of parents of students (75%) and the nutritional status of children from malnutrition (20%) to normal nutrition (22%). Modified PMT using local food ingredients can be an alternative to modified PMT for PEM school-age children.

Cowpeas (*Vigna unguiculata L.*) contain relatively high levels of protein and iron, respectively 24.4 g and 13.9 mg per 10 grams of material (Kemenkes RI, 2019). Cowpeas are rich in essential amino acids such as lysine 68.32 mg/g, methionine 11.68 mg/g, cysteine 10.88 mg/g, threonine 36 mg/g, and tryptophan 10.88 mg/g protein (FAO, 2013). Cowpeas through the germination process for 12 hours at room temperature can reduce 30.5% phytic acid, 22.4% trypsin inhibitor, and 66.7% tannin (Mubarak, 2005). Cowpea sprouts are processed into flour which contains 65.2 g carbohydrates, 22 g protein, 2.5 g fat, and 358 Kcal energy per 100 g (Lestari and Murtini, 2017).

Sorghum flour (*Sorghum bicolor L.*) is an alternative to wheat. Sorghum flour contains 8.43 g of protein, relatively the same as 9 g of wheat flour, while the iron content of sorghum flour is 3.14 mg higher than that of wheat flour 1.3 mg per 100 grams of ingredients (USDA, 2018; Kemenkes RI, 2019). Sorghum flour is rich in essential amino acids such as lysine 20.16 mg/g, methionine 13.92 mg/g, cysteine 15.04 mg/g, threonine 30.24 mg/g, and tryptophan 12.16 mg/g protein (FAO, 2013). Sorghum contains starch consisting of amylopectin (70 – 80%) and amylose (20 – 30%) (Firmansyah and Suarni, 2005). The weakness of sorghum is that it contains phytic acid (0.3 – 1.0%) and tannin (0.2 – 48.0 mg) (Khalid et. al., 2022). Sorghum tannin levels can be reduced by carrying out the polishing process 2 – 3 times (Suarni, 2016).

METHODS

This type of experimental research with a Completely Randomized Design (RAL) uses 4 treatment levels with 3 repetitions. Determination of substitution uses a ratio of the proportions of Wheat Flour (WF) : Cowpea Sprout Flour (CSF) : Sorghum Flour (SF) namely P_0 (100:0:0), P_1 (40:55:5), P_2 (40:45:15), and P_3 (40:35:25). This research was carried out in July 2023, taking place at 1) Batu Materia Medica Laboratory for the process of making cowpea sprout flour, 2) Food Ingredient Science Laboratory (IBM) Department of Nutrition, Malang Health Polytechnic for the biscuit processing process, 3) Taste Testing Laboratory (UCR) Department of Nutrition, Malang Health Polytechnic for organoleptic test. The variables in this study used independent variables, namely the proportion of cowpea sprout flour and sorghum flour and the dependent variable, namely chemical quality (water content, ash, protein, fat, carbohydrate content), energy value, and organoleptic quality (color, taste, aroma, and texture).

The research procedure included processing cowpea sprout flour, namely sorting the cowpeas. The cowpeas that have ben sorted are then washed 5 times with running water. Soak the cowpeas in a cowpea : water ratio (1:4) for 12 hours. Next, the cowpeas are drained and placed in a closed container that has ben lined with banana leaves for the germination process for 12 hours at room temperature (25°C). after going through the germination process, the cowpea sprouts are steamed (steam blanching) at a temperature of 60°C for 5 minutes then placed on a baking sheet. The next process is that the cowpea sprouts are dried using a cabinet dryer at 60°C for 5.5 hours. The dried cowpea sprouts are separated from the epidermis. Cowpea sprouts are ground and sifted using a 90 mesh sieve to become cowpea sprout flour (Modification of Safitri, 2017). The final procedure for processing biscuits is to prepare the ingredients and weigh the ingredients according to the recipe. Add buter and powdered sugar then mixer on high speed for 5 minutes. Add the egg yolks and mix on high speed for 3 minutes until the mixture is pale yellow. Mix wheat flour, cornstarch, cowpea sprout flour, sorghum flour, milk powder, salt, and baking powder then sift (Mixture 1). Add mixture 1 and stir the mixture on low speed for 3 minutes until smooth. Once the dough is smooth, put the dough in the refrigerator for 15 minutes. The dough was weighed at 11 grams and flattened using a mold 0.5 cm thick, then baked in the oven at 120°C for 25 minutes (Modification Mardhiah, 2020).

Data analysis on organoleptic quality used the Hedonic Scale Test method with Kruskall Wallis statistical analysis at a 95% confidence level. If there was an influence then a further test was carried out using Mann-Whitney analysis at a 95% confidence level to determine treatment pairs that were significantly different, while chemical quality and the energy value was not subjected to statistical analysis because it only used calculated values. The calculated value of nutrients from each type of food ingredient used in a recipe is corrected by the loss or gain factor in the weight of the food ingredient (yield factor) and changes in nutrients (retention factor) due to the processing process. This value is a rough estimate because the processing conditions for each recipe vary greatly, such as varying temperatures and cooking duration, which significantly affect the yield and retention factor. Yield factor is obtained from the weight of cooked food while still hot (g) divided by the weight of raw food to be cooked (g) x 100%. Meanwhile, the retention factor is obtained from the nutritional content per gram of cooked food x weight of cooked food (g) divided by the nutritional content per gram of raw food x weight of raw food (g) x 100%.

The formula above shows that accurate food weight data is needed and you really have to do research to find out the weight of the food. So for this research, data was taken based on research results for yield factor, while for retention factor data, data was taken based on existing ones using tables in the cereal based flour, bake categories (Bognar, 2002).

The energy value is obtained using the Atwater factor, the energy value of food is determined by calculating the composition of carbohydrates, fats and proteins, as well as the energy value of the food.

The procedure for determining the best treatment is as follows:

a. The results of determining the best level of treatment for each respondent are tabulated to obtain the number of each variable and the average.
b. Variable ranking is determined based on the average value of each variable where the variable with the largest average is ranked 1st and the variable with the lowest average is ranked 10th.
c. Variable weights are determined by dividing the average value of each variable by the highest average. The variable with the greater the average value, the lowest average is the worst value and the highest average is the best value.
d. The normal weight of each variable is obtained from the variable divided by the total weight of the variable.
e. Each variable is then calculated for its effectiveness value (Ne) using the formula treatment value minus the worst value and divided by the best value minus the worst value.
f. The value used to determine the best treatment level is the total result value (Nh) where this value can be calculated by multiplying the normal weight of each variable by Ne and then adding it up.
g. The best level of treatment is the level of treatment that has the highest yield value.

Table 1. Completely Randomized Design

Proportion Treatment Level (%) Wheat Flour : Cowpea Sprout Flour : Sorghum Flour	Repetition		
	1	2	3
P_0 (100 : 0 : 0)	X_{01}	X_{02}	X_{03}
P_1 (40 : 55 : 5)	X_{11}	X_{12}	X_{13}
P_2 (40 : 45 : 15)	X_{21}	X_{22}	X_{23}
P_3 (40 : 35 : 25)	X_{31}	X_{32}	X_{33}

Information:
X_{01} : research unit at treatment level P_0 replication 1
X_{11} : research unit at treatment level P_1 replication 1
X_{21} : research unit at treatment level P_2 replication 1
….
X_{33} : research unit at treatment level P_3 replication 3

RESULTS AND DISCUSSION

Based on the research results, the empirical chemical quality results and organoleptic quality of biscuits are as follows:

Table 2. Results of Biscuit Chemical Quality Calculations at Each Treatment Level

Proportion Treatment Level (%) WF : CSF : SF	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (Kcal)	Water (g)	Ash (g)
P_0 (100 : 0 : 0)	62.27	7.31	16.16	423.75	10.74	1.73
P_1 (40 : 55 : 5)	59.27	10.56	16.56	428.39	9.68	2.11
P_2 (40 : 45 : 15)	59.79	9.94	16.60	428.31	9.80	2.05
P_3 (40 : 35 : 25)	60.31	9.32	16.64	428.24	9.92	2.00

Table 3. Average Organoleptic Quality of Biscuits at Each Treatment Level

Proportion Treatment Level (%) WF : CSF : SF	Color	Taste	Aroma	Texture
P_0 (100 : 0 : 0)	3.67^{a}	3.70^{a}	3.50^{a}	3.33^{a}
P_1 (40 : 55 : 5)	3.47^{a}	2.77^{b}	2.50^{bc}	3.20^{a}
P_2 (40 : 45 : 15)	3.00^{b}	3.00^{b}	2.83^{c}	3.30^{a}
P_3 (40 : 35 : 25)	2.60^{c}	3.07^{b}	2.97^{c}	3.00^{a}

A. Chemical Quality of Biscuits

1) Carbohydrate

The carbohydrate content of biscuits tends to increase with increasing substituion of sorghum flour. This is because the carbohydrate content of sorghum flour tends to be high at 76.6 g/100 g (USDA, 2018) compared to cowpea sprout flour at 65.2 g/100 g (Lestari and Murtini, 2017). Sorghum contains high starch (82.5%) in the endosperm. Starch is a water-insoluble complex carbohydrate (polysaccharide) consisting of two glucose polymer compounds, namely amylopectin and amylose. Sorghum starch consists of amylopectin (70 – 80%) and amylose (20 – 30%) (Firmansyah and Suarni, 2005). The amylose found in sorghum flour is in the medium category (20 – 25%) so it can be an alternative substitute for wheat flour (Suarni, 2016). This is because the amylose content of sorghum flour is not much different from the amylose (28%) and amylopectin (72%) found in wheat flour (Pradipta and Widya, 2015). Supported by research by Rahmawati and Anggray (2021), the carbohydrate content of cookies with 40% sorghum flour substitution is 68.2%. The carbohydrate content of biscuits is also influenced by temperature factors and the length of drying time during the flouring process. The higher the drying temperature and the longer the drying time, the carbohydrate content of the flour will increase which is caused by the reduced water content during drying (high temperature) thereby increasing the carbohydrate content (Erni et. al., 2018; Mahmuddin, 2021).

The carbohydrate content based on the standard nutritional supplementation product for additional food for PEM school-age children according to Minister of Health Regulation Number 51 of 2016 is a maximum of 38 g, so the biscuit formulation with the substitution of cowpea sprout flour and sorghum flour in P_1, P_2, and P_3 has met the PMT standard of Minister of Health Regulation Number 51 of 2016.

2) Protein

Biscuit protein content increased along with increasing substitution of cowpea sprout flour. This is caused by the relatively high protein content of cowpea sprout flour 22 g/100 g (Lestari and Murtini, 2017) compared to sorghum flour 8.4 g/100 g (USDA, 2018). In line with Winata et. al. (2018) stated that the protein content of cookies with 50% substitution of cowpea sprout flour was 14.79%. Supported by research by Tunjungsari and Fathonah (2019) explained that protein levels increased along with the addition of cowpea sprout flour. Furthermore, biscuits with the addition of 30% cowpea sprout flour contain 6.44% protein.

The protein content based on the quality requirements for SNI 2973-2011 biscuits is a minimum of 5% and the PMT standard for PEM school-age children according to Minister of Health Regulation Number 51 of 2016 is a minimum of 11 g, so the biscuit formulation substituted for cowpea sprout flour and sorghum flour in P_1, P_2, and P_3 has met biscuit quality standards SNI 2973-2011 and PMT standards of Minister of Health Regulation Number 51 of 2016.

3) Fat

The fat content of biscuits tends to increase with increasing sorghum flour substitution. This is caused by the relatively high fat content of sorghum flour 3.3 g/100 g (USDA, 2018) compared to cowpea sprout flour 2.5 g/100 g (Lestari and Murtini, 2017). The higher the substitution for sorghum flour, the higher the fat content in the resulting product (Ashfiyah, 2019; Ramadhani, 2022). In line with research by Farrah et. al. (2022), the fat content of cookies with 50% sorghum flour substitution was 25.2%. Supported by research by Rahmawati and Anggray (2021), cookies with a 40% substitution of sorghum flour contain 19.72% fat. It was further explained that the fat content of cookies tends to increase along with increasing substitution of sorghum flour.

The fat content based on the standard nutritional supplementation product for additional food for PEM school-age children according to Minister of Health Regulation Number 51 of 2016 is a minimum of 14 g, so the biscuit formulation substituted for cowpea sprout flour and sorghum flour in P_1, P_2, and P_3 has met biscuit quality standards SNI 2973-2011 and PMT standards of Minister of Health Regulation Number 51 of 2016.

4) Energy

Energy value is determined based on the protein, fat, and carbohydrate content, namely 4 Kcal, 9 Kcal, and 4 Kcal per gram respectively (Almatsier, 2010). Fat is a macronutrient that is the biggest energy contributor. The fat in cowpea sprout flour (2.5 g) and sorghum flour (3.3 g) was higher than the fat in wheat flour (1 g). The energy value of biscuits decreased with decreasing substitution of cowpea sprout flour and increasing substitution of sorghum flour. Cowpea sprout flour is known to contain higher protein (22 g) than sorghum flour (8.4 g). In line with research by Winata et. al. (2018) which states that the addition of 50% cowpea sprout flour produces cookies with the highest protein content (14.79 g) compared to cookies without cowpea sprout flour substitution (9.18 g). The higher the substitution of cowpea sprout flour, the higher the protein content, which affects the energy value of the biscuits.

Consumption of biscuits substituted for cowpea sprout flour and sorghum flour for PEM school-aged children contributes energy of 423.75 – 428.45 Kcal per 100 g. This shows that all levels of treatment have met the requirements according to Minister of Health Regulation Number 51 of 2016 concerning standards for nutritional supplementation products for school-age children with a minimum amount of energy of 400 Kcal in 100 grams of biscuits.

5) Water Content

The water content of biscuits tends to increase with increasing sorghum flour substitution. This is caused by the relatively high starch content of sorghum flour 80% compared to wheat flour 78.8% (Alfiana, 2016). When gelatinization occurs, starch binds with water so that the dough expands. The water in the dough evaporates during the baking process and creates voids in the biscuits. The increase in biscuit water content was also influenced by the addition of cowpea sprout flour which is high in protein. The protein content of cowpea sprout flour is hydrophilic so it has more water absorption capacity. Apart from protein, the fiber content in cowpea sprout flour can also bind water and takes longer to evaporate during the roasting process (Asfi et. al., 2017). In line with Lestari and Murtini (2017), the water content of cookies with the substitution of cowpea sprout flour is around 2.43 – 3.79%. Supported by research by Permatasari et. al. (2020), the addition of 24% cowpea flour can increase the water content of biscuits from 4.01% (F1) to 4.95% (F3). The higher the substitution of cowpea sprout flour, the higher the water content of the cookies (Lestari and Murtini, 2017; Permatasari et. al., 2020). The water content of biscuits substituted for cowpea sprout flour and sorghum flour for PEM school-age children is 9.68 – 10.74 g per 100 g. This shows that all treatment levels do not meet the requirements according to SNI 2973-2011, a maximum of 5.0%.

6) Ash Content

The ash content of biscuits tends to increase with increasing substitution of cowpea sprout flour. This is caused by the formation of minerals during the germination process so that the ash content of 2.5 g cowpea sprout flour is higher than 1 g wheat flour (Lestari and Murtini, 2017; Kemenkes RI, 2019). In line with Winata et. al. (2018), the ash content of cookies with the addition of 50% cowpea sprout flour was 1.48%. Furthermore, the higher the proportion of cowpea sprout flour added, the higher the ash content of the cookies (Lestari and Murtini, 2017; Winata et. al., 2018). The increase in biscuit ash content was also caused by the substitution of sorghum flour. Sorghum flour per 100 g contains minerals such as 12 mg calcium, 278 mg phosphorus, 3.14 mg iron, 3 mg sodium, and 324 mg potassium (USDA, 2018). Supported by research by Rahmawati and Anggray (2021), the highest ash content is found in cookies with 60% and 80% sorghum flour substitution, namely 1.34%.

B. Organoleptic Quality of Biscuits

1) Color

Color is the first assessment that plays an important role in detemining the quality and acceptability of food. Development of substitute biscuits for cowpea sprout flour and sorghum flour as PMT for PEM school-age children produces a brownish yellow color. Based on the color palette, P_0 biscuits are mustard brownish yellow, P_1 biscuits are medallion brownish yellow, P_2 biscuits are dijon brownish yellow, and P_3 biscuits are flaxen brownish yellow. The results of the research showed that the average level of panelists' liking for the color of biscuits substituted with cowpea sprout flour and sorghum flour ranged from 2.60 – 3.67 in the like to very like category.

The results of Kruskall Wallis statistical analysis at the 95% confidence level showed that the substitution of cowpea sprout flour and sorghum flour had a significant effect ($p=0.000$) on the panelists' preference for color. Further analysis using the Mann-Whitney test showed that there was a significant difference in the level of color preference in groups P_0 with P_2, P_0 with P_3, P_1 with P_2, P_1 with P_3, and P_2 with P_3.

As the substitution for cowpea sprout flour decreases and the substitution for sorghum flour increases, the level of panelists' preference for the color of biscuits substituted for cowpea sprouts and sorghum flour for PEM school-age children tends to decrease. This is caused by increasing the proportion of sorghum flour which results in the color of the biscuits becoming browner and tending to be pale. In line with Farrah et. al. (2022) stated that cookies with 50% sorghum flour substitution produce brown cookies. As the substitution for sorghum flour increases, the level of panelists' preference for color will decrease and the resulting biscuit color will become darker due to the presence of tannin compounds in sorghum flour (Syafitri et. al., 2019; Farrah et. al., 2022).

The color of biscuits substituted for cowpea sprout flour and sorghum flour is also influenced by the Maillard reaction during the baking process. The Maillard reaction occurs due to the reaction of reducing sugars in sorghum flour and cowpea sprout flour with free amine groups from amino acids. The Maillard reaction produces melanoidin pigment which plays an important role in changing the color of biscuits to brown (Kusnandar, 2019).

2) Taste

The development of substitute biscuits for cowpea sprout flour and sorghum flour as PMT for PEM school-age children produces a savory biscuit taste (nutty) and a slightly bitter aftertaste. The results of the research showed that the average level of panelists' liking for the taste of biscuits substituted with cowpea sprout flour and sorghum flour ranged from 2.77 – 3.70 in the like to very like category.

The results of the Kruskall Wallis statistical analysis at the 95% confidence level showed that the substitution of cowpea sprout flour and sorghum flour had a significant effect ($p=0.000$) on the panelists' level of preference for taste. Further analysis using the Mann-Whitney test showed that there was a significant difference in the level of taste preference between groups P_0 and P_1, P_0 and P_2, and P_0 and P_3.

The less the substitution of cowpea sprout flour and the increase of the substitution of sorghum flour, the level of panelists' preference for the taste of biscuits substituted for cowpea sprout and sorghum flour for PEM school-age children tends to increase. The taste of biscuits tends to have a bitter aftertaste which becomes more intense as the substitution of cowpea sprout flour increases. The bitter taste (off flavor) and chalky taste in biscuits is caused by the presence of glycoside compounds in the form of soyasaponin and sapogenol which are found in cowpeas (Situmorang et. al., 2017). Supported by research by Tunjungsari and Fathonah (2019), it is explained that the high substitution of cowpea flour causes an unpleasant, astringent, chalky, and bitter taste in biscuits. Bean flavor is influenced by the activity of the lipoxygenase enzyme and the presence of volatile compounds such as aldehydes, ketones, and alcohol (Kanetro, 2017). The taste of the biscuits is also influenced by the substitution of sorghum flour. Sorghum flour contains tannin compounds which produce a bitter (astringent) biscuit aftertaste. To reduce the bitter (astringent) taste, the polishing process can be carried out 2 – 3 times when processing sorghum flour (Suarni, 2016).

3) Aroma

Development of substitute biscuits for cowpea sprout flour and sorghum flour as PMT for school-age children. PEM has a distinctive aroma of cowpeas and a slightly nutty flavor. The research results showed that the average level of panelists' liking for the aroma of biscuits ranged from 2.50 – 3.50 in the like to very like category. The results of Kruskall Wallis statistical analysis at the 95% confidence level showed that the substitution of cowpea sprout flour and sorghum flour had a significant effect (p=0.000) on the panelists' level of preference for aroma. Further analysis using the Mann-Whitney test showed that there were significant differences in the level of aroma preference between groups P_0 and P_1, P_0 and P_2, and P_0 and P_3.

The lower the substitution for cowpea sprouts flour and the higher the substitution for sorghum flour, the level of panelists' liking for the aroma of biscuits substituted for cowpea sprouts and sorghum flour for PEM school-age children tends to increase. This is because cowpea sprout flour gives off a pleasant aroma (beany flavor or off flavor) due to the activity of lipoxygenase enzymes and volatile compounds. The lower the substitution of cowpea sprout flour, the less pleasant the aroma of the biscuits will be. Supported by research by Winata et. al. (2018) which states that the higher the substitution of cowpea sprout flour, the stronger the cowpea aroma will be in the cookies so that the panelists' liking for the aroma will decrease.

4) Texture

The development of substitute biscuits for cowpea sprout flour and sorghum flour as PMT for PEM school-age children produces a biscuit texture that is crunchy, easy to bite, and slightly rough. The research results showed that the average level of panelists' liking for the biscuit texture ranged from 3.00 – 3.33 in the like category. The results of the Kruskall Wallis statistical analysis at the 95% confidence level showed that the substitution of cowpea sprout flour and sorghum flour did not have a significant effect (p=0.221) on the panelists' preference for texture.

As the substitution of cowpea sprout flour and sorghum flour decreases, the level of panelists' preference for the biscuit texture substituted with cowpea sprout flour and sorghum flour for PEM school-age children tends to increase from P_1 to P_2, but decreases from P_2 to P_3. The level of crispiness of the biscuits is influenced by the substitution of sorghum flour in the biscuit formulation. In line with Farrah et. al. (2022) who explained that the addition of sorghum flour substitution had an effect on the level of crispiness of the cookies produced, the higher the sorghum flour substitution, the lower the level of crispiness of the cookies and the level of panelists' liking for the texture tended to decrease. This is caused by the starch content of sorghum flour (80%) being higher than that of wheat flour (78.8%) (Alfiana, 2016). Sorghum starch consists of amylopectin (70 – 80%) which produces a hard texture, and amylose (20 – 30%) which produces a sticky texture in biscuits (Firmansyah and Suarni, 2005). Starch binds with water during gelatinization, causing the dough to rise. During the baking process, the water in the dough evaporates and creates voids so that the biscuit texture becomes crispy.

C. The Best Level of Treatment

Determining the best level of treatment in this research uses the effectiveness index method. Based on the results of determining the best treatment level, it shows that the most important variable that ranks first in processing biscuits for PEM school-age children is the protein content which is presented in Table 4.

Table 4. Variable Ranking in Determining the Best Level of Treatment

Ranking	Average	Variable
1	7,80	Protein
2	7,67	Energy
3	7,37	Taste
4	6,10	Color
5	5,50	Texture
6	5,23	Fat
7	5,10	Aroma
8	4,87	Carbohydrate
9	3,07	Water content
10	1,80	Ash content

Protein is a macronutrient consisting of a series of amino acids needed by the body. Proteins act as building blocks, forming tissue during growth and development, maintaining and replacing damaged tissue, forming antibodies (Adriani and Wijatmadi, 2012). Protein also functions as a transport to transport nutrients from the digestive tract through the walls of the digestive tract into the blood, from the blood to the tissues, and through the cell membrane into the cells (Almatsier, 2010).

The results of calculating the best treatment level with the highest yield value (Nh) were at P_2 (40:45:15) with a total value of 0.58. substitution biscuits for cowpea sprout flour and sorghum flour for KEP school-age children at the best treatment level P_2 (40:45:15) have met the standards of Minister of Health Regulation Number 51 of 2016, namely 107% energy adequacy, 90% protein, 118.5% fat, and 157.1% carbohydrates.

Table 5. Fulfillment of Product Standards at the Best Treatment Level for Substitute Biscuits for Cowpea Sprout Flour and Sorghum Flour

Characteristics	Substitution Biscuits for Cowpea Sprout Flour and Sorghum Flour (P_2) (40 : 45 : 15)	Ministry of Health Number 51 of 2016	
		Standard	% Fulfillment
Energy (Kcal)	428	400 – 600	107
Protein (g)	9.9	11 – 16	90
Fat (g)	16.6	14 – 21	118,5
Carbohydrate (g)	59.7	Maks. 38	157,1
Water content (g)	10	Maks. 5	-
Ash content (g)	2.05	-	-
Color	3.00 (like)	-	-
Taste	3.00 (like)	-	-
Aroma	2.83 (like)	-	-
Texture	3.30 (like)	-	-

Table 6. Energy and Nutrient Value of Biscuits for PEM School-age Children

NUTRITION FACTS				
Serving size	40 grams			
Serving per container	4 pieces			
Amount per serving				
		% Daily Value*		
		Age 7 – 9 years	Age 10 – 12 years Male	Female
Calories (Kkal)	171	103,7	85,5	90
Protein (g)	3,9	97,5	78	70,9
Fat (g)	6,6	120	101,5	101,5
Carbohydrate (g)	23,8	95,2	79,3	85

Information: *Percent Daily Value based on 10% of school children's energy needs

CONCLUSIONS

Substitution biscuits for cowpea sprout flour and sorghum flour as PMT for PEM school-age children at treatment level P2 (40:45:15) were determined as the best treatment level. The chemical quality at the P2 treatment level (40:45:15) has met the requirements of Minister of Health Regulation Number 51 of 2016 concerning standards for nutritional supplementation products for additional food for PEM school-age children with a carbohydrate content of 59.79 g/100 g, protein 9.94 g/100 g, fat 16.60 g/100 g, energy 428.31 Kcal/100 g, water content 9.80 g/100 g, and ash content 2.05 g/100 g. Substitution biscuits for cowpea sprout flour and sorghum flour as PMT for PEM school-age children had a significant influence on organoleptic quality (color, taste, and aroma). Suggestions for further research include improvements in the organoleptic quality (texture) of slightly rough biscuits, it is recommended to use a sieve with a higher mesh.

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