

Original Research

EFFECT OF SUPPLEMENTATION OF F100 BISCUITS MODIFIED WITH MORINGA OLEIFERA FLOUR SUBSTITUTION ON NUTRITIONAL STATUS OF UNDER-FIVE CHILDREN WITH MALNUTRITION IN KENDARI CITY INDONESIA

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Received: 13 December 2019 | Accepted: 7 March 2020

DOI: <http://dx.doi.org/10.36685/phi.v6i1.318>

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ABSTRACT

Background: Malnutrition is a condition of severe nutritional deficiency caused by an insufficient intake of energy and protein from daily food consumption. The most lethal impacts are declined IQ score, decreased cognitive development, and diminished sensory integration, which could harm the life of the children and resulted in the loss of the national youth generation. One effort to overcome this problem is to develop a diet alternative using F100 materials substituted from *kelor* (Moringa Oleifera) flour as the main ingredient and reform it into edible biscuits. *Kelor* leaves contain multiple micronutrient elements that are essential for children and have been proven to increase the nutritional status of children with malnutrition.

Objective: This research aims to identify the effect of the supplementation of F100 biscuits modified with *kelor* flour substitution on the nutritional status of under-five children with malnutrition.

Methods: This was a pre-experimental study conducted in Kendari city Indonesia from May-June 2019. Twenty children were included and given modified biscuits on a scale of 100 gm per day for six consecutive weeks. Data were analyzed using dependent and independent sample t-test.

Results: There was a significant effect of the supplementation of F100 modified biscuits on the nutritional status of under-five children with malnutrition ($p = 0.002$).

Conclusion: The F100 supplementation modified with *kelor* flour substitution biscuits has been proven to be effective in increasing the nutritional status of under-five children with malnutrition.

Keywords: biscuit, F100, *kelor*, malnutrition, children, moringa oleifera

BACKGROUND

Nutritional status is one of the factors determining the quality of human resources. Toddlers are one of the groups that are more susceptible to health problems, especially if their nutritional consumption are unbalanced with the standard their body needed. This situation potentially leads to nutritional complications ([Mardalena, 2017](#);

[Sahu et al., 2015](#); [Yisak, Gobena, & Mesfin, 2015](#)).

Malnutrition is a condition of severe nutritional deficiency caused by insufficient energy and protein intake from daily food consumption that happened in long terms. The short-term effect of

malnutrition includes apathy, speech disorder, and growth disorder in children. Furthermore, the long terms effects are including the decline in IQ score, a decrease of cognitive development, and diminish sensory integration which could harm the life of the children and resulted in the loss of the National young generation ([Almatsier, 2009](#); [Venables & Raine, 2016](#)).

The result of nutritional status assessment in 2016 using the weight/height index of children 0-59 months in Indonesia revealed the percentage of 3.4% for malnutrition in Indonesia ([Kementerian Kesehatan Republik Indonesia, 2017](#)). There is not a single area in Sulawesi Tenggara that is free from malnutrition. Most of the areas presented 20 incidents/area on average, including Kendari city ([Dinas Kesehatan Sultra, 2017](#)). To accelerate the malnutrition elimination program in Indonesia, apart from the food diversification program, it is also important to develop a formula for food supplementation contains standardized nutrients to increase child immunity, and also to generate a food processing technology that sustains the excellence of local food resources ([Osendarp et al., 2015](#); [Zakaria, Lestari, & Hartono, 2013](#)).

F100 is a food formula contains energy, fat, and high proteins recommended by WHO to treat children with malnutrition ([Bhandari, 2016](#); [Fekadu, Mesfin, Haile, & Stoecker, 2015](#); [Lanyero et al., 2017](#)). However, F100 supplementation to children with malnutrition still facing some obstacles, e.g. sanitation during food processing and hygiene of the tools that are being used ([Ambarwati, Setiadi, Tursilowati, & Rahmawati, 2018](#)). F100 supplementation in unhygienic conditions could give rise to bacterial pathogens to grow. Therefore, there needs to be a development of food materials that contain good nutrients, highly bioavailable, relatively procurable, and economically convenient. The potential alternative is the production of biscuits as a form of extra food using F100 substituted with *Kelor* flour as the main ingredient ([Kholidah, Prawirohartono, & Nisa, 2013](#)).

Biscuit is one type of food widely consumed in different forms by all ages, from babies to adults ([Sari, 2013](#)). Moreover, *kelor* is a type of plant commonly found in Kendari City. It is already

integrated into the culinary culture of Sulawesi Tenggara Province, and people often consume it as vegetables. *Kelor* leaves contain multiple micronutrients that are essential for babies and pregnant woman, such as beta carotene, thiamin (B1), riboflavin (B2), niacin (B3), calcium, iron, phosphor magnesium, zinc, dan vitamin C ([Daba, 2016](#); [Rudianto & Alharini, 2013](#); [ShM, Kassim, AbouRayya, & Abdalla, 2017](#)). *Kelor* is recommended to be transformed into flour because this form is more durable and easy to store ([Jerri, Adolfsen, McCullough, Velegol, & Velegol, 2012](#); [Kusharto & Damayanthi, 2017](#)). The nutritional content of *kelor* will be increased in quantity if it is consumed after being dried and made into flour ([Adwiyah, 2016](#); [Bolarinwa, Aruna, & Raji, 2019](#); [Singh & Prasad, 2013](#)). Another benefit of *kelor* is to increase the nutrient status of children with malnutrition ([Dhakar, Maurya, Pooniya, Bairwa, & Gupta, 2011](#); [Gopalakrishnan, Doriya, & Kumar, 2016](#); [Rahmawati & Adi, 2016](#)).

There has been a lot of precedent research that studies the effect of adding *kelor* leaves supplement formula into food products to increase the food nutritional value, for example in biscuits, soy meatballs, and yogurt ([Diantoro, Rohman, Budiarti, & Palupi, 2015](#); [Evivie, Ebabhamiegbho, Imaren, & Igene, 2015](#); [Kholis & Hadi, 2010](#)). Transforming the *kelor* leaves into biscuits will increase its likeability among people, which in turn is expected to increase the consumption of *kelor* leaves in society. Therefore, all the benefits contain by the *kelor* leaves will be absorbed by the body ([Rahmawati & Adi, 2016](#)). This study aimed to examine the effect of supplementation of F100 biscuits modified with *kelor* flour substitution on nutritional status of children with malnutrition in Kendari city Indonesia.

METHODS

Study Design and Participants

This was a pre-experimental study conducted in Kendari city Indonesia from May-June 2019. The participants in this study were 20 under-five children with malnutrition in Kendari city. The

exclusion criterion was children with malnutrition but experiencing medical complications.

Instrument

The instruments in this study included digital scales, microtoise, and biscuit intake recording form. WHO Anthro 2005 application was used to measure children's nutritional status, and Nutrisurvey 2007 was used to measure food and biscuits consumption.

Intervention

The supplementation of F100 biscuits modified with *kelor* flour substitution were explained in the following:

- a. *Tools and material.* The main ingredient used in this study was moringa flour of Southeast Sulawesi, while other supplementary ingredients included wheat flour, egg yolks, refined sugar, margarine, skimmed milk powder, vanilla, and salt. Tools included blenders, 80 mesh sieves, mixers, biscuit molds, ovens, wood rollers, basins, spoons, brushes, and food scales.
- b. *Making moringa flour.* The production of moringa leaf flour used a dry blender and was sieved using 80 mesh sieves to separate small stems that cannot be destroyed with a blender, then stored in an airtight plastic container ([Rudianto & Alharini, 2013](#); [Zakaria et al., 2013](#)).
- c. *Making biscuits.* Biscuits were made with mixing ingredients including flour (500 gr), sugar (250 gr), margarine (400 gr), egg yolks (3 grains), followed by mixing until they were fused, then added moringa flour to the ratio according to the treatment that was 5 g, 10 g, 15 g, and 20 g and powdered skim milk (70 gr), salt (2 gr) and vanilla (4 gr), then gradually stirred with a mixer for about 30 minutes until the mixture was mixed equally. The obtained dough was then molded into 4 shapes according to the number of treatments and baked in an oven at 160 °C for 20 minutes.
- d. *Organoleptic test* included texture, aroma, color, and taste of the modified F100 biscuit product in each treatment to determine the F100 modified biscuit product most preferred by the panelists. Assessment scores were given based on hedonic test criteria from selected 23 trained panelists. The results of this study

indicated that according to the level of preference of the F100 biscuit modification product panelists with the addition of moringa flour which was preferred by the panelists, was the formula R2 with the addition of 10 grams of moringa flour.

- e. *Nutrition content analysis* included protein content analyzed by the Kjeldahl method, fat by the Soxhlet method, carbohydrates by the difference method, water content by the oven method, ash content by the drying ash method. The results of the analysis of the nutritional content of biscuits based on panelist choices were biscuits with the addition of 10 grams of moringa flour showed that the calorie value was 429.6 kcal, protein 25.63 gr, fat 33, 71 gr, carbohydrate 101.56 gr, water content 3, 45%, and ash content 1.51%.
- f. *Giving biscuits to malnourished children.* The amount of modified F100 biscuits consumed daily for 6 weeks including how much was given, the amount consumed, and the remaining amount. Data on the amount of intake were recorded on the receipt form. Determination of the frequency of giving F100 modified biscuits to all samples was calculated based on body weight per individual, condition of the toddler at the time of examination and according to energy requirements, protein per individual for 6 weeks. Given after breastfeeding for infants who were still breastfed, or given before family feeding for children who received the main food.

Data Analysis

Data were analyzed using dependent and independent sample t-test using the SPSS program.

Ethical Consideration

This study was approved by the Research Ethics Committee of IAKMI Pengda Sultra with number: 003/ KEPK-IAKMI/ V/ 2019. An informed consent was signed by each participant in this study.

RESULTS

The majority of children were boys ($n = 11$, 55%) than girls ($n = 9$, 45%), with the average age of

46.50 months (SD = 7.008) with malnutrition status. Nutritional intake of children was obtained from daily food consumption in the sum of breakfast, lunch, dinner and snack. Table 1 shows that the average of energy intake of the participants before given biscuits was 854.21 calories, and after given biscuits was 1006.15 calories. The average protein intake before given biscuits was 9.72 grams, and after given biscuits was 15.09 gr. Statistical test results showed there were significant differences in the increase in energy and protein intake after consuming F100 biscuits modified with *kelor* flour substitution.

Table 1 The Average Energy and Protein Intake Before and After the Intervention

Nutrient	Pretest	Posttest	P-value
Energy (Kal)	854.21	1006.15	0.000
Protein (g)	9.72	15.09	0.000

Table 3 Effect of supplementation of F100 modified with *kelor* flour substitution biscuit on nutritional status of children

Consumption level	Final nutritional status		p-value
	Malnutrition	Undernutrition	
	%	%	
Insufficient	10	15	0.002
Sufficient	5	70	
Total	15	85	

Table 3 shows that there was a change in nutritional status in children. Before the intervention, all children were in malnutrition status, but after given the intervention, the status was changed from malnutrition to undernutrition specifically for the children who had sufficient consumption level of biscuits (70%). However, for those who had insufficient level of biscuit consumption, only 15% of children were changed from malnutrition to undernutrition. The statistical test showed that there was a significant effect of giving the supplementation of F100 biscuits modified with *kelor* flour substitution on the nutritional status of children under five with p-value of 0.002.

DISCUSSIONS

Nutrient contribution of F100 substituted with *kelor* biscuits to the nutrient sufficiency range of the children

The number of biscuits consumed by children was 6 pieces or equivalent to 100 g per day. On average, the contribution of energy from biscuits

Table 2 The Level of Biscuits Consumption

Consumption level	n	%
Insufficient (<50%)	5	25
Sufficient (>50%)	15	75
Total	20	100

The children's consumption level was observed from the number of biscuits that had been consumed for 6 weeks, which was divided into the number of biscuits supposed to be consumed (252 pieces). The level of consumption of children is categorized "sufficient" when spending biscuits as many as ≥ 126 pieces, while the level of consumption of children is categorized as "insufficient" if children consumes biscuits as < 126 pieces. Table 2 shows that 15 children (75%) had sufficient consumption level of biscuits, and 5 children (25%) had insufficient level of biscuit consumption.

was above 10% of nutrient range, which was 10.9% from the total. Meanwhile, the average proportion of protein contribution from biscuit consumption was 21.48% of nutrient range. According to BPOM, food is categorized as a good source of protein if it contains at least 20% of nutrient range recommended per serving ([Badan Pengawas Obat dan Makanan, 2014](#)). Additional food supplementation (AFS, or PMT in *Bahasa Indonesia*) for recovery purposes is one of the efforts to handle malnutrition problems. PMT is a diet capable of providing an extra beneficial effect for health besides the nutritional elements that naturally contained in food ([Chaix, Zarrinpar, Miu, & Panda, 2014](#)). PMT given to children with malnutrition intend to gradually provide a good and enough protein, vitamin, and mineral intake to achieve optimal nutritional status with sufficient nutritional composition.

Biscuit intake level

The children's consumption level could be observed from the number of biscuits taken in 6 weeks divided into the number of biscuits supposed to be consumed (252 pieces). In this

study, 75% of the children had enough level of consumption, and only 25% of the children had an insufficient level of consumption. Based on the interview with the mothers, the children enjoyed the biscuits for the good flavor. On the other hand, the children in category middle level of consumption became disinterested with the biscuits in weeks 4 and 5. This disinterest feeling resulted from the preference of the children who had to consume 6 pieces of biscuits with the same form and flavors for 6 weeks consecutively. As a result, the children who were initially able to finish 6 biscuits per day in the first weeks, eventually could only take 1-2 pieces of biscuits per day in week 4 to week 5.

Another potential explanation was that the condition of the children that were sick at the moment they were being assessed. During the study, 6 children experienced sickness with common types of symptoms like fever, cough, and flu. This condition could affect the appetite of the children which in turn affects the intake level of the biscuits

The effect of supplementation of F100 modified with *kelor* flour substitution biscuit on the nutritional status of children

F100 modified with *kelor* flour substitution biscuit is a type of snack made from several ingredients, including the main element of *kelor* flour with certain nutrient levels to achieve a high level of nutrition. *kelor* flour consumption is one of the alternatives to increase the weight of children with malnutrition. This study shows that there was an increase of nutritional status from malnutrition to undernutrition to those who had sufficient level of biscuit consumption. This result is in line with a study conducted an experiment of PMT-P supplementation in form of *Tempe* biscuits for 1 month to 17 children with tuberculosis aged 12-59 months ([Muslimah, Judiono, Suparman, Ichwannudin, & Diandini, 2019](#)).

The result of statistical analysis displayed the significant effect of supplementation of F100 modified with *kelor* flour substitution biscuit to the nutritional status of children. This means that the larger portion of children with enough intake of F100 modified biscuits had better nutritional

status (70%). On the other hand, the children with low intake of F100 modified biscuits had lower nutritional status (15%). This could indicate that biscuit consumption according to the recommendation could increase the nutritional status of the children. This result is due to the high level of energy contribution and protein from the biscuit intake resulted from the addition of *kelor* flour in the biscuits.

This is in line with the theory stated that the more *kelor* flour added, the higher the level of protein, iron, calcium, fiber content, and β -carotene in the food. This indicates the potential of *kelor* flour is used to increase the nutrient level in foods ([Dachana, Rajiv, Indrani, & Prakash, 2010](#)). The digestibility of amino acid and protein is up to 60%, increasing the ability of nutritional absorption contained in *kelor* flour ([Baptista et al., 2017](#)). This result is in line with previous study that the weight of the children administered with *kelor* flour intake was higher than the unadministered children (8.9 ± 4.30 g/kg/days compared to 5.7 ± 2.72 g/kg/days), and faster recovery rate with the average of 36 ± 16.54 days for administered children compared to 57 ± 19.20 days in unadministered children ([Zongo, Zoungrana, Savadogo, & Traoré, 2013](#))

CONCLUSION

The supplementation of F100 modified with *kelor* flour substitution biscuits increases the nutritional status of children with malnutrition. This study can be an input as an alternative treatment to increase the nutritional status of under-five children with malnutrition. Future studies with control groups were needed to see the effectiveness of this intervention on nutritional status of the children.

Declaration of Conflicting Interest

There is no conflict of interest in this study.

Acknowledgment

The authors delivered the deepest gratitude to all parties that helped this research.

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Cite this article as: Mayangsari, R., Rasmiati, K. (2020). Effect of supplementation of F100 biscuits modified with moringa oleifera flour substitution on nutritional status of under-five children with malnutrition in Kendari city Indonesia. *Public Health of Indonesia*. 6(1), 28-34. <http://dx.doi.org/10.36685/phi.v6i1.318>