ORIGINAL RESEARCH ARTICLE

Effectiveness of moringa biscuit (*Moringa oleifera*) and snakehead fish (*Channa striata*) in improving the nutritional status of pregnant women with chronic energy deficiency

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Abstract

The objective of this study was to analyse the effectiveness of moringa biscuits and snakehead fish in improving the nutritional status of pregnant women with chronic energy deficiency (CED). The study was a randomized control trial carried out in two stages. The first stage was carried out in 2020, while the second stage was implemented in 2021 in Sigi Regency, Central Sulawesi Province, Indonesia. Thirty pregnant women with CED were divided into two groups. Five pieces of biscuits (60g) were given every day for three months to women in the intervention group while the control group were given biscuits without moringa and snakehead fish. The analysis consisted of paired t-test statistics. The results showed that giving biscuits significantly improved the nutritional status of pregnant women with CED, with the mean body mass index Centre (BMI) having a value of (P 0.000). In contrast, the upper arm circumference did not differ between the intervention and control groups. (P 0.247). We conclude that the consumption of moringa and snakehead fish biscuits provides a higher average contribution of energy and nutrients in pregnant women with CED. *(Afr J Reprod Health 2024; 28 [10s]: 41-49).*

Keywords: Biscuits; moringa; nutrition; pregnant women CED; snakehead fish

Résumé

L'objectif de cette étude était d'analyser l'efficacité des biscuits au moringa et de la tête de serpent pour améliorer l'état nutritionnel des femmes enceintes souffrant de carence énergétique chronique (DEC). L'étude était un essai contrôlé randomisé réalisé en deux étapes. La première étape a été réalisée en 2020, tandis que la deuxième étape a été mise en œuvre en 2021 dans la régence de Sigi, dans la province centrale de Sulawesi, en Indonésie. Trente femmes enceintes atteintes de DEC ont été divisées en deux groupes. Cinq morceaux de biscuits (60 g) ont été donnés chaque jour pendant trois mois aux femmes du groupe d'intervention tandis que le groupe témoin a reçu des biscuits sans moringa ni poisson à tête de serpent. L'analyse consistait en des statistiques de test t appariées. Les résultats ont montré que donner des biscuits améliorait significativement l'état nutritionnel des femmes enceintes atteintes de DEC, l'indice de masse corporelle (IMC) moyen ayant une valeur de (P 0,000). En revanche, la circonférence du haut du bras ne différait pas entre les groupes d'intervention et témoin. (P0,247). Nous avons conclu que la consommation de biscuits au moringa et au poisson à tête de serpent apporte un apport moyen plus élevé en énergie et en nutriments chez les femmes enceintes atteintes de DEC. *(Afr J Reprod Health 2024; 28 [10s]: 41-49).*

Mots-clés: Biscuits; moringa, nutrition; femmes enceintes DEC; poisson tête de serpent

Introduction

One of the benchmarks for the success of development in the health sector is the maternal mortality rate (MMR) and infant mortality rate (IMR), therefore health services for mothers and pregnant women need to receive special attention from all sectors[1]. Complications from pregnancy and childbirth are the leading causes of death in girls aged 15–19 years with a disproportionately higher number occurring in developing countries, particularly in sub-Saharan Africa. There is also an increased risk of neonatal deaths in adolescent mothers, with the risk being highest among adolescents younger than 16 years[2]. The 2020 population census from the Central Bureau of

Statistics of the Republic of Indonesia showed that the maternal mortality rate in Indonesia was 189 per 100.000 livebirths[3]. This condition is different when compared to Malaysia, where the MMR figure is 21 per 100,000 births[4]. Based on this data, it shows that the MMR in Indonesia is still far from the Sustainable Development Goals' (SDGs) target to reduce the risk of maternal mortality to less than 70/100,000 births by 2030[5]. The MMR in Central Sulawesi Province is still quite high, and Sigi Regency is a district that has a greater percentage of additional cases of maternal death than in 2021[6], namely 54%. Bleeding (28%), anemia and Chronic Energy Deficiency (CED) are the biggest causes of death [7].

CED for pregnant women can inhibit fetal growth and cause abortion, stillbirth, birth defects, asphyxia, low birth weight and stunting[8]. Based on the results of the 2018 Basic Health Research, the prevalence of CED in pregnant women aged 15-19 years was 33.5%. This number exceeds that of non-pregnant women in the same age group, which was 36.3%[9]. This means that since the number of CEDs is quite high at pre-marital age, there is a chance that they will suffer from CEDs during pregnancy [10]. The prevalence of CED risk in pregnant women was 32.6% and Sigi Regency was in third place in the Central Sulawesi province in 2020 at 46.4%[11].

The risks and complications experienced by pregnant women during pregnancy due to the impact of malnutrition include quality of life problems and adverse outcomes of pregnancy, such as low birth weight, impaired physical development of the fetus, and a high risk of death in the baby[12]. The risks that occur not only during pregnancy, but during the birth process can include difficult and prolonged labour, premature labour, post-partum hemorrhage, and the impact on the fetus, namely low birth weight, abortion, neonatal death, and congenital defects[13].

The body's immune response will weaken due to a lack of energy and protein, making it easier for infectious diseases including COVID 19 to occur. Thus, increasing nutritional intake for pregnant women is of critical importance[14]. One way to improve the nutritional status of pregnant women with CED is through the provision of additional recovery food (PMT-P)[15]. The commercial PMT-P that is being developed is in the form of biscuits which are easy to prepare in a short time and can be made from local food ingredients found in Central Sulawesi, namely Moringa and Snakehead Fish.

The objective of this study was to determine the effectiveness of functional biscuits with moringa flour and snakehead fish flour in improving the nutritional status of pregnant women with CED.

Methods

Study design and subjects

This research design used a randomized controlled trial (RCT) with a Simple Random Sampling method. The subjects of this research were pregnant women who suffered from chronic energy deficiency (CED) at the Dolo Health Center, Sigi Regency, Central Sulawesi Province, Indonesia, from August to October 2021. The sample size was 30 respondents, which was calculated based on the significance level of the α value, which was set at 0.05, the power of the 1-β test was 0.80, and the effect size was medium (d = 0.5). The image below is a sample size calculation graph using the Gpower-Plot application. Figure 1

Pregnant women suffering from CED are identified from an upper arm circumference of less than 23.5 cm and mass index measurements. Body mass before pregnancy (BMI) or Trimester I (gestational age ≤12 weeks) is below 18.5 kg/m^2. Of the 30 participants recruited, they were screened and met the criteria. The criteria include CED pregnant women who do not suffer from infectious or non-infectious diseases and are in the first and second trimesters of pregnancy. All participants provided informed consent and indicated willingness to be subjects in the research. Then, random assignment was carried out, including a treatment group and a control group, a treatment group (15 participants), and a control group (15 participants). The intervention group was given functional biscuits with the biscuit formula described at the research stage, five pieces per day (weighing 60 g). The control group was given biscuits from the government without moringa flour and snakehead fish; they were also given five pieces per day (weight 60 g). The daily consumption patterns of both groups were controlled through food recalls. Figure 2

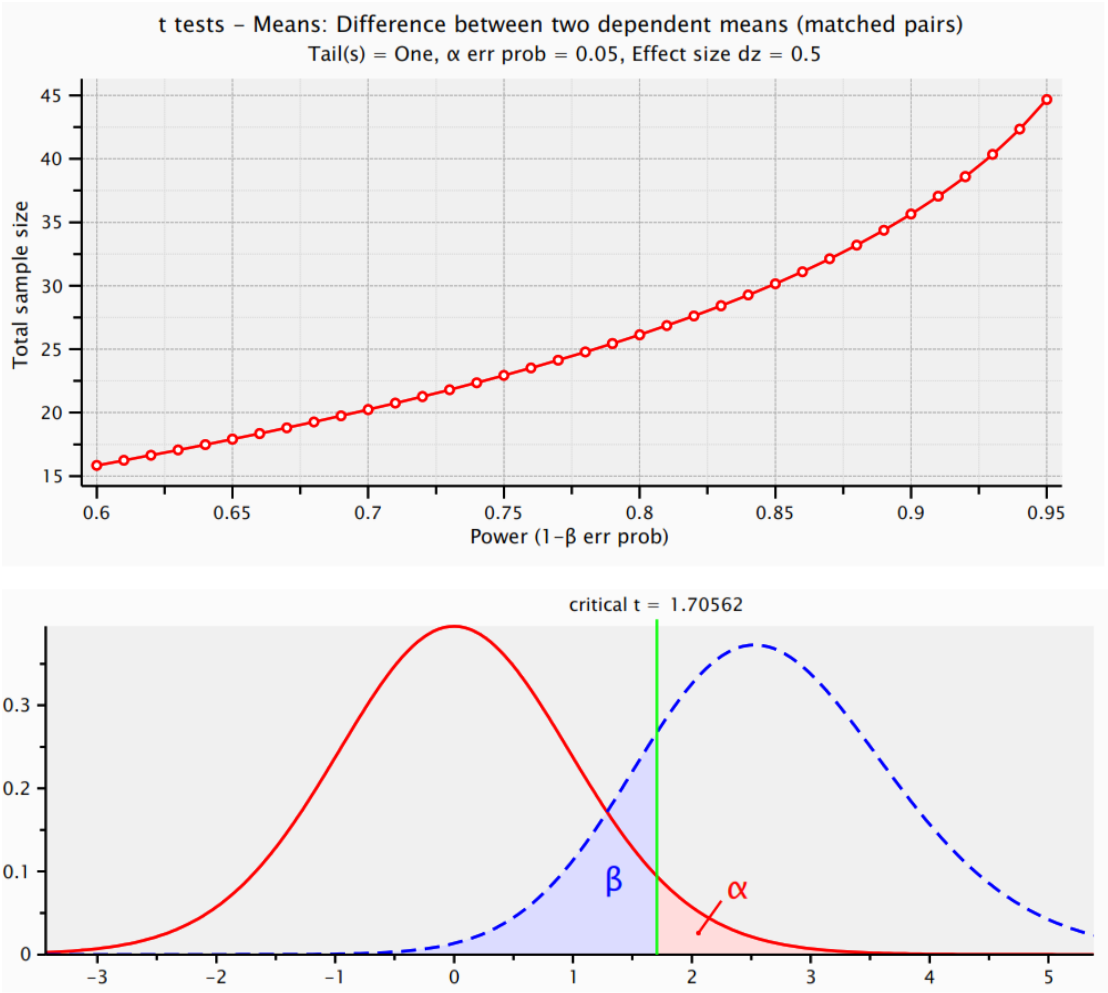

Figure 1: Sample size calculation graph

Research stages

Stage 1. Making biscuit product formula

1. Making biscuit products
   The manufacture of biscuit products was carried out in previous research which received funding grant from the Ministry of Research and Technology which was carried out in June - July 2020 at the Widya Nusantara College of Health Sciences Laboratory, Palu[16].
2. Organoleptic test
   This test was carried out in August 2020 at the Central Sulawesi Province Food and Drug Management Agency (BPOM) Laboratory. The biscuit formula chosen was the F5 formula, namely the substitution ratio between wheat flour, moringa leaf flour and snakehead fish flour, namely 80% wheat flour, 10% moringa leaf flour and 10% snakehead fish flour of the total weight of the biscuit dough.
3. Test the macro and micro nutritional content of F5 biscuits
   This test was carried out at the MIPA Laboratory and Chemistry Laboratory, FKIP, Tadulako University. Macro nutrient content: water content 0.6929%, ash content 1.862%, protein 26.69%, carbohydrates 57.432% and fat 31.422%. Micronutrient content: micronutrient content: vit. A 10.22 µg/100 gr, vit. 5 mg/100gr, Sodium 361.339 mg/100gr[16].
4. Based on the macro and micro nutritional content, the selected biscuit formula meets the Indonesian National Standard (SNI) for biscuits as additional food for pregnant women and meets the specifications for additional food for pregnant women with chronic energy

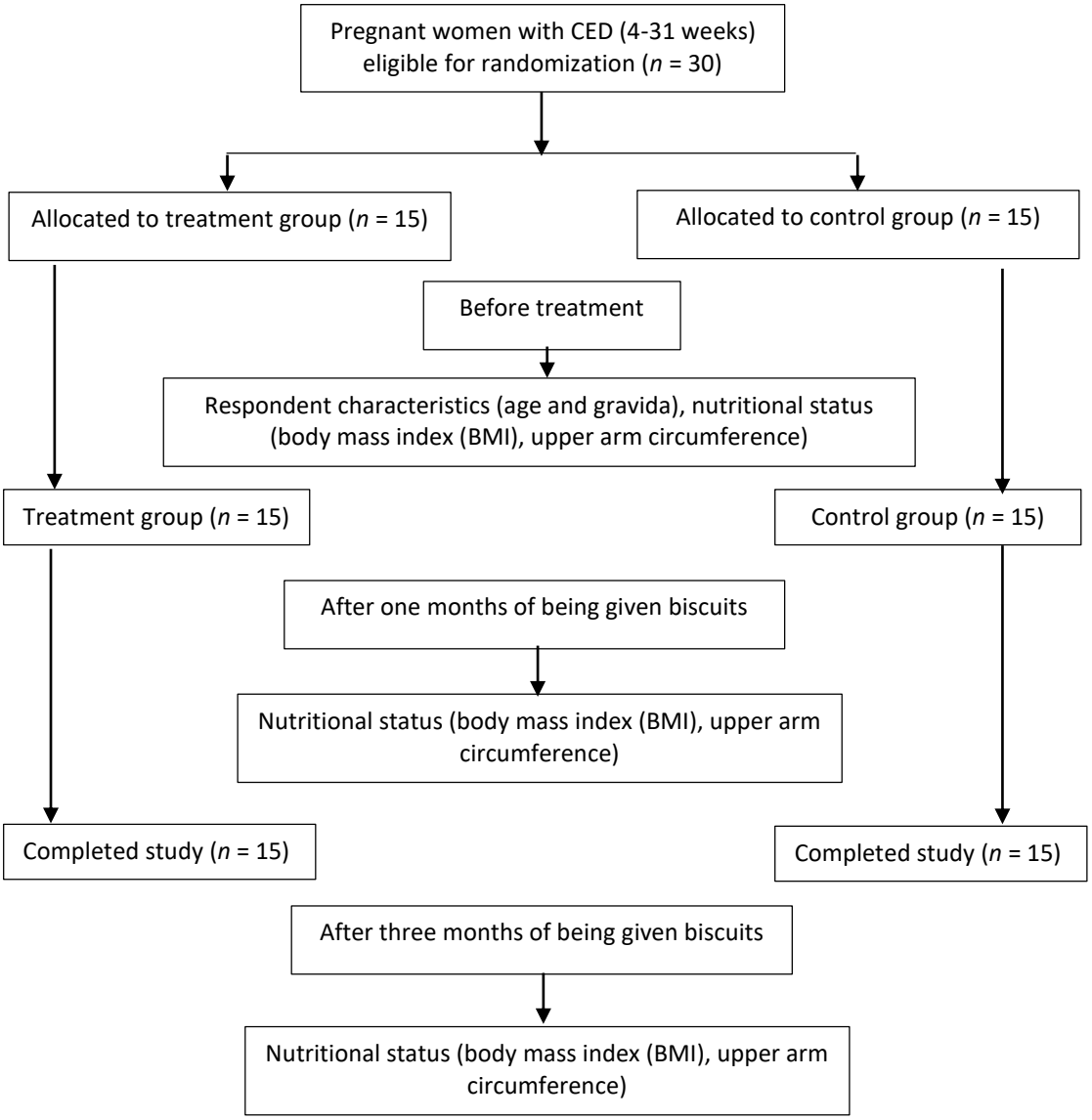

Figure 2: Flow chart of study participants

deficiency (CED) according to the Indonesian Ministry of Health in 2020[17].

Stage 2. Intervention stage providing functional biscuits

1. Consent Ethical clearance
   This research has obtained Ethical Clearance from the Health Research Ethics Commission, Faculty of Medicine, Tadulako University with Ethical Clearance number: 1550/UN.28.1.30/KL/2020. This ethical clearance arrangement was carried out during the first phase of research in 2020.
2. Biscuit Making
   Production of functional biscuits and control biscuits was carried out in April – May 2021.
3. Data collection before intervention
   Includes age, weight before pregnancy and during pregnancy, height, arm circumference, and consumption patterns of respondents. This stage was carried out in June 2021.
4. Selection of respondents using purposive sampling technique
   This stage was carried out to determine respondents who received control biscuits and functional biscuits. This stage was carried out in June 2021.

5. Measure the nutritional status of respondents before being given biscuits
   Measurements were carried out by calculating body mass index (BMI) and measuring upper arm circumference (UAC) before the intervention. This stage was carried out in June 2021.
6. Providing functional biscuits and biscuits
   Biscuits were given for 3 months (August-October 2021) and respondents continued to control consumption patterns through food recall. Biscuits are given 5 pieces.
7. Measurement of the nutritional status of respondents after being given biscuits
   Measurements were carried out by calculating body mass index (BMI) and measuring upper arm circumference (UAC) before and after the intervention. This stage was carried out in October 2021 after the biscuits had been given.

Variables and data collection

The dependent variable in this study is the nutritional status of pregnant women (body mass index and upper arm circumference). The Independent Variables are consumption of functional biscuits (yes/no), characteristics of pregnant women (age, parity). The data collected consisted of the characteristics of the respondents, namely age and pregnancy data. Data on the nutritional status of respondents were measured anthropometrically including body weight, height, and respondents' upper arm circumference (UAC) before and after intervention. Intervention biscuit consumption data was obtained from a monitoring form containing the number of biscuits distributed to respondents. Food consumption data was collected using the recall method 2 times 24 hours in a row, which was carried out before the intervention and during the intervention activities.

Data analysis

The sample was selected as many as 30 with a standard deviation (SD) effect of 10% (= 0.05 and 1 = 0.8). Data analysis was carried out descriptively and inferentially. Descriptive analysis to determine the average value of each variable and its distribution based on classification. Inferential analysis to assess the effect of providing functional moringa biscuits and snakehead fish on improving the nutritional status and arm circumference of CED pregnant women. The data obtained were normally distributed with a significant value of more than 0.05.

Results

This research was conducted in Sigi Regency with a total of 30 respondents divided into 2 groups. The following is the distribution of respondent data based on age characteristics and data on gravida and height of respondents.

Based on Table 1. above, it can be seen that the majority of respondents were aged 21-35 years, amounting to 56,6%. However, there were also respondents aged ≤ 20 years, namely 20%. Women who are ready to get pregnant based on age category are 21-35 years.

Table 2 explains the calculation of BMI and UAC in the control group and treatment group before being given biscuits. Based on the information from the table, it shows that most of those with a BMI of 17-18 are in the control group, namely 60%, and those with a BMI of less than 17 are primarily in the treatment group, 46.6%. Meanwhile, the UAC data shows that the majority of those with a UAC of 22-23 are in the control group, namely 60%, and those with a UAC of less than 22 are primarily in the treatment group, 60%.

Table 3 shows that there the group that experienced an increase in nutritional status based on BMI and upper arm circumference calculations were the group given functional biscuits.

Based on Table 4, it shows that there was a significant effect of increasing the BMI of respondents in both the control group and the functional group before and after being given biscuits with a P value <0.05. Meanwhile, for the upper arm circumference measurement variable, there was no significant effect before and after the intervention in the two groups, namely the control group and the functional group with a P value > 0.05.

The results show that among the intervention group, no pregnant woman experienced anaemia or weight loss. Biscuits given to pregnant women as PMT-P were made with the addition of food ingredients that are fortified using vitamins and minerals and contain energy, protein, fat, carbohydrates, vitamins and minerals, with or

Table 1: Characteristics of respondents

Characteristics	F0		F1	
	n	%	n	%
Age				
≤ 20 years old	3	10.0	3	10.0
21-35 years old	7	23.3	10	33.3
>35 years old	4	13.4	3	10.0
Gravid				
Primigravida (Pregnant =1 time)	5	16.6	6	20.0
Multigravida (Pregnant 2-5 time)	6	20.0	9	30.0
Grandemultigravida (Pregnant > 6 time)	2	6.7	2	6.7

F0 = Control Biscuits; F1= Functional Biscuits

Table 2: Data on nutritional status of respondents' mothers based on BMI and upper arm circumference (UAC) calculation before intervention

Variable	F0		F1	
	n	%	n	%
BMI				
≥ 18.5	0	0	0	0
17-18	9	60	8	53.4
< 17	6	40	7	46.6
UAC				
≥ 23.5	0	0	0	0
22-23	9	60	6	40
< 22	6	40	9	60

F0 = Control Biscuits; F1= Functional Biscuits

Table 3: Data on nutritional status of respondents' mothers based on bmi and upper arm circumference (uac) calculations after intervention

Variable	F0		F1	
	n	%	n	%
BMI				
≥ 18.5	8	53.4	10	66.6
17-18	7	46.6	5	33.4
< 17				
UAC				
≥ 23.5	9	60	10	66.6
22-23	6	40	5	33.4
< 22				

F0 = Control Biscuits; F1= Functional Biscuits

Table 4: Effect of effectiveness before and after giving functional biscuits and control biscuits on increasing BMI and UAC of pregnant women with CED

Paired Samples Correlations		N	Correlation	P
Pair 1	BMI PRE & BMI POST	30	0.740	0.000
Pair 2	UAC PRE & UAC POST	30	-.272	0.247

without the addition of bioactive components or permitted food additives.

Table 5 shows that there was a significant difference in the Body Mass Index (BMI) of pregnant women before and after being given functional biscuits in the intervention group, and there was also a difference in the BMI of pregnant women in the control group after being given functional biscuits in the control group with a P value <0.05. The table also shows that there is a difference in the Upper Arm Circumference (UAC) of pregnant women before and after being given functional biscuits in the intervention group and a difference in UAC of pregnant women before and after being given functional biscuits in the control group with a P value <0.05.

Discussion

The study's results on the characteristics of respondents with age variables showed that most respondents were aged 21 to 35. According to the Marriage Law in Indonesia No. 16 of 2019, the minimum age for marriage is 21[18]. A mother who becomes pregnant at a young age will significantly impact the nutritional needs of the fetus she is carrying. This is in line with research conducted by Siti Fatimah in 2019, which shows that a maternal age of less than 20 increases the risk of experiencing chronic energy deficiency (CED) during pregnancy[19]. Young pregnant women need many additional nutrients because, in addition to being used for their own growth and development, they also have to share them with the fetus they are carrying.

Meanwhile, old age requires a lot of energy because the body's organ functions have weakened and are required to work optimally, including sufficient additional energy to support ongoing pregnancy. Thus, the best age for pregnancy is more than 20 and less than 35, with the hope that pregnant women will be better nourished at these ages[20.]

The following measured response characteristic was gravida data. The results showed that most of the participants were multigravida, as many as 15%. From the gravida factor, according to the results of research conducted by Zahidatul Rizak in 2017, it is known that multigravida mothers have a 1.021 times greater chance of experiencing CED than primigravida mothers. Similarly, grande multigravida mothers are 3.200

Table 5: Differences in the treatment of giving functional biscuits and control biscuits on increasing BMI and UAC of pregnant women with CED

Paired Samples Test Treat		Mean	95% Confidence Interval of the Difference		T	df	P
			Lower	Upper			
Pair 1	BMI PRE - BMI POST	-1.2250	-1.4587	-0.9913	-10.971	19	0.000
Pair 2	UAC PRE - UAC POST	-90.5000	-161.6966	-19.3034	-2.661	19	0.015

times more likely to experience CED compared to primigravida mothers. This suggests that the more often a mother experiences pregnancy, the more likely she is to experience CED. Grande multiparous mothers have a greater risk of complications during pregnancy and labor. Complications in pregnancy are miscarriage, anemia in pregnancy, placenta previa, placental abruption, abnormality, preeclampsia, and severe bleeding, while in labor are uterine inertia and complications in the postpartum period are Uterine atony, placental retention, and subinvolution.

According to Ahluwalia (2004), serum ferritin values are greatly influenced by nutritional intake, whether obtained through food or food supplements. An increase in ferritin synthesis in the intestine and other tissues will cause iron absorption to increase, whereas in conditions of low ferritin synthesis it will cause iron absorption to decrease. Albumin is a laboratory indicator that can be used to test the sensitivity of an individual's nutritional status and is specific for nutritional intake. Albumin has a fairly long halflife, namely 14–20 days, so it can be used as a marker of chronic nutritional status.

Based on the results of research by Dewi, it shows that one source of very high albumin comes from snakehead fish. To increase the body's resistance to disease attacks, especially in conditions of malnutrition, food intake with macronutrient content, namely high protein, is required. Likewise, research conducted by Dewi (2014) shows that the efficacy of providing functional biscuits with a substitution of 15% snakehead fish meal fortified with zin and iron microcapsules as much as 50% of the Nutritional Adequacy Rate (NAR) during 8 weeks of intervention can improve micronutrient status. (haemoglobin, zinc, ferritin and albumin) and humoral immunity (IgG)[21].

The results of the analysis showed that the mean difference at the end and at the beginning of the intervention for pregnant women who received functional biscuits and control biscuits was not significantly different between treatments, but consumption of biscuits could increase the weight of pregnant women. Based on Zuriati Muhamad's research in 2018 that Pregnant women should be provided with nutritional education and micronutrient supplementation in order to improve their nutritional status[22].

The implication of this research for policy is that it becomes a source of reference for the government in making regulations for handling CED for pregnant women by including moringa and snakehead fish in the food fortification program, especially for pregnant women. These findings can also support the development or expansion of community-based nutrition programs that supplement pregnant women with these biscuits. In addition, healthcare providers can use this research to educate pregnant women about the benefits of consuming moringa and snakehead fish and recommend these biscuits as a food supplement. Public health workers can be trained to distribute and monitor the consumption of these biscuits among pregnant women, ensuring compliance with recommended consumption.

The strength of this research is the use of a randomized controlled trial (RCT) design with a control group, which is the gold standard method in intervention research. This allows researchers to make more robust causal conclusions between the intervention (functional biscuits) and the outcome of improving nutritional status. Researchers divided the sample into two groups randomly. Although this sample size is small, efforts were made to minimize selection bias. The intervention provided is functional biscuits with measured doses, and control of daily consumption patterns through food recall offers a clear picture of the intervention provided. This research has received ethical approval, ensuring that research subjects' rights are protected. This research also has limitations, including the relatively small sample size due to the

research being conducted during the COVID-19 pandemic. Even though randomization has been carried out, there is still the potential for bias that could influence the research results, such as dropout bias (subjects who leave the study) or measurement bias. This research has not considered all confounding variables that can influence the nutritional status of pregnant women, such as socio-economic status, education level, and other living habits. The research was only conducted for three months, so the long-term effects of consuming functional biscuits have yet to be discovered.

Conclusion

Consumption of functional biscuits made from moringa flour and snakehead fish, which are local food sources, provides a higher average difference in intake and contribution of energy and nutrients to pregnant women compared to control biscuits. Therefore, providing additional food made from local food is one strategy for dealing with nutritional problems in pregnant women. Additional feeding activities need to be accompanied by nutrition and health education for behaviour change, for example with support for breastfeeding, education and counselling on feeding, hygiene and sanitation for families. It is hoped that providing additional food based on local food can encourage family food and nutritional independence in a sustainable manner. This research is the first step in exploring the potential of functional biscuits to improve the nutritional status of pregnant women. However, further research needs to be conducted with a stronger design and a larger sample size to strengthen the findings.

Contribution of Authors

Evi Setyawati: research topic, analysis data, writing original draft preparation, writing-review and editing and project administration
Nurasmi: concept, method, analysis data and editing the paper
Sri Sumarmi: reviewed empirical studies, discussion and conclusion
Irnawati collected and analysed the data
Iin Octaviana Hutagaol: collected and analysed the data

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