Amerta Nutrition
e-ISSN: 2580-1163 (Online)
p-ISSN: 2580-9776 (Print)
Helmizar et al. | Amerta Nutrition Vol. 9 Issue 2 (June 2025). 340-349

RESEARCH STUDY
English Version

OPEN ACCESS

The Impact of *Dadih* Functional Bread on Gestational Weight Gain for Pregnant Women in Padang, Indonesia: a Randomized Controlled Trial

Pengaruh Roti Fungsional Dadih terhadap Kenaikan Berat Badan Ibu Hamil di Padang, Indonesia: a Randomized Controlled Trial

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ARTICLE INFO

Received: *07-03-2024*
Accepted: *10-02-2025*
Published online: *20-06-2025*

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DOI:
10.20473/amnt.v9i2.2025.340-349

Available online at:
https://e-journal.unair.ac.id/AMNT

Keywords:
Dadih, Functional Bread, Gestational Weight Gain, Pregnant Women

ABSTRACT

Background: Gestational Weight Gain (GWG) is correlated to the growth and development of foetus and pregnancy outcomes. Probiotics have a positive effect on gestational weight gain. Dadih is a traditional West Sumatra food containing 10^8 CFU/ml of probiotics.
Objectives: This research aimed to investigate the effect of dadih functional bread on gestational weight gain.
Methods: This research is a Randomised Controlled Trials (RCT) design with double blinds with a gestational age of 12-20 weeks belonging to 88 pregnant women. The tests for weight balancing scales were used. The data were examined using Independent T-test for difference test and General Liniar Model (GLM) repeated measures, and *Analysis of Covariance* (ANCOVA).
Results: The average GWG was significantly 2 kg greater for the intervention group related to the control group (7.3±2.6 kg *vs* 5.4±3.8 kg). The GWG in the intervention group exceeded the recommended GWG per month. The results indicated that weight gain was difference across the four-time measurements in both groups. There was a significant different in the average GWG among the intervention control and the control group (p-value<0.001).
Conclusions: Dadih functional bread supplementation for three months significantly effect the gestational weight gain. Thus, the consumption of the dadih products can be considered when planning the nutrition to advance the nutritional status of pregnant women.

INTRODUCTION

Indonesia has experienced tremendous socio-economic development over the past few decades with the natural consequences of nutritional transitions and demographic changes[1]. The GWG can describe the nutritional status of a mother before and during pregnancy. The growth and development of the fetus can be predicted using this indicator[2]. Malnutrition during pregnancy correlates with maternal mortality, neonatal mortality, and pregnancy outcome. Malnutrition during pregnancy affects the health of both mothers and infants[3]. One of the main risk factors for poor pregnancy outcomes is malnutrition status previous to pregnancy and inadequate or high GWG status during pregnancy[2].

According to the Indonesia Basic Health Survey conducted by the National Institute of Health Research and Development, Ministry of Health, Republic of Indonesia, the prevalence of Chronic Energy Deficiency (CED) among pregnant women in 2018 was 17.3%[4]. This number decreased in 2013 which found out that the prevalence of CED in pregnant women was 24.2%[5]. Another nutritional problem that is prevalent among pregnant women in Indonesia is anaemia. Indonesia has a 48.9% anemia prevalence rate among expectant mothers. Malnutrition in the form of obesity (Body Mass Index (BMI) ≥27 kg/m^2) among women gained from 9.7% to 19.6% in the same period[6]. The high prevalence of CED in pregnant women requires nutritional intervention to provide additional food to pregnant women[7]. According to IOM guidelines, a study by Soltani et al. in 2017 discovered that the majority acquire insufficient weight[8]. Clinicians, researchers, and policymakers must develop and modify targeted interventions to address the high prevalence of inadequate GWG as these malnutrinition are known to have considerable influence on infants weight and wellbeing[9].

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Supplementing with probiotics during pregnancy may have a beneficial impact on GWG[10]. When consumed in the right amount or concentration, probiotics which are live organisms offer a variety of health benefits[11]. The composition of the gut microbiome plays an essential part in the utilisation of nutrients[12]. This also applies during pregnancy, and a good gut microbiome seems to be related with comparatively improved health results for pregnant women and pregnancy outcomes[13]. Several studies showed that gut microbiota composition is associated with body weight, weight gain, and metabolic biomarkers during pregnancy[14]. The study conducted by Santacruz et al. (2010) showed that differences in the intestinal microbiota of pregnant women who were normal weight compared to women who were overweight, this were linked to changes in body weight and GWG indicated that the gut microbiome is an important focus for weight management in pregnancy[15]. In addition, GWG are inversely related with some bacterial groupings.

Dadih is a typical Minangkabau dairy product of buffalo milk, naturally fermented in bamboo cylinders. *Dadih* is under facultative anaerobic conditions because the banana leaf functions as a packaging cover. It is producted as a traditional product in several areas of West Sumatera Province, such as Agam, Solok, Limapuluh Kota, and Tanah Datar[16]. In general, *dadih* is used as a complementary food, as well as herbal food[17]. Lactic Acid Bacteria (LAB) of *dadih* offers more advantages than the average diet, the common food. *Dadih* contains 36 isolated LAB strains, among them are probiotics. Lactic acid bacteria found in *dadih* amounting to 10^8 CFU are probiotics, with several therapeutic purposes such as, enhancing the digestive tract's microbial balance and improving the immune system[18].

The current research only focuses on the effect of probiotics on GWG in obese pregnant women. No research has focused on the potential role of probiotics in the absorption of nutrients that are beneficial for weight gain in general pregnant women. The study aims to investigate the effect of *dadih* functional bread on the GWG of pregnant women in Padang, West Sumatera, Indonesia.

METHODS

This research was carried out in the City of Padang, Indonesia, between March 2022 and December 2022 (for three months). The research permit No. 891/4379/DKK/2022, was issued on May 31, 2022. The study protocol has been approved by the Medical Faculty Ethics Committee of Universitas Andalas No. 945/UN.16.2/KEP-FK/2022 on September 8, 2022. . All selected pregnant women, the subjects of the research, were asked to voluntary sign a written informed consent prior to data collection. The research locations were in the three working areas of the public health centers being chosen based on the data as areas prone to stunting. This research has received approval and has been added to ClinicalTrials.gov (No. NCT05712629).

The working areas included the Andalas Health Centre, Kuranji Health Centre, and Nanggalo Health Centre. The sample consisted of 88 pregnant women divided into two groups: “the intervention group” and “the control group”. Employing a double-blind, RCT with a randomized block design, the participants were assigned to either the intervention group receiving functional bread with *dadih* vla or the control group receiving functional bread with vla without *dadih* (considered a placebo). Neither the researchers nor participants were aware of the group assignments. The flow diagram of recruitment for pregnant women can be seen in Figure 1.

Pregnant women who consumed one piece of *dadih* functional bread (50 g) received 4 g of total fat, 5 g of protein, 23.8 g of carbohydrates, 2 mg of iron, and 153 kcal of energy. Meanwhile, a cup of vla *dadih* (30 g) provided 1.2 g of protein, 2.6 g of total fat, 9.75 g of carbohydrates, and 67.1 kcal of energy (Figure 2-7). The intervention spanned 12 weeks, during which the modified *dadih* functional bread aimed to fulfill daily protein and energy requirements, along with meeting the nutritional needs of pregnant women. Enumerators in the study gave *dadih* functional bread every day for 3 months. They also checked for food waste using the comstock method.

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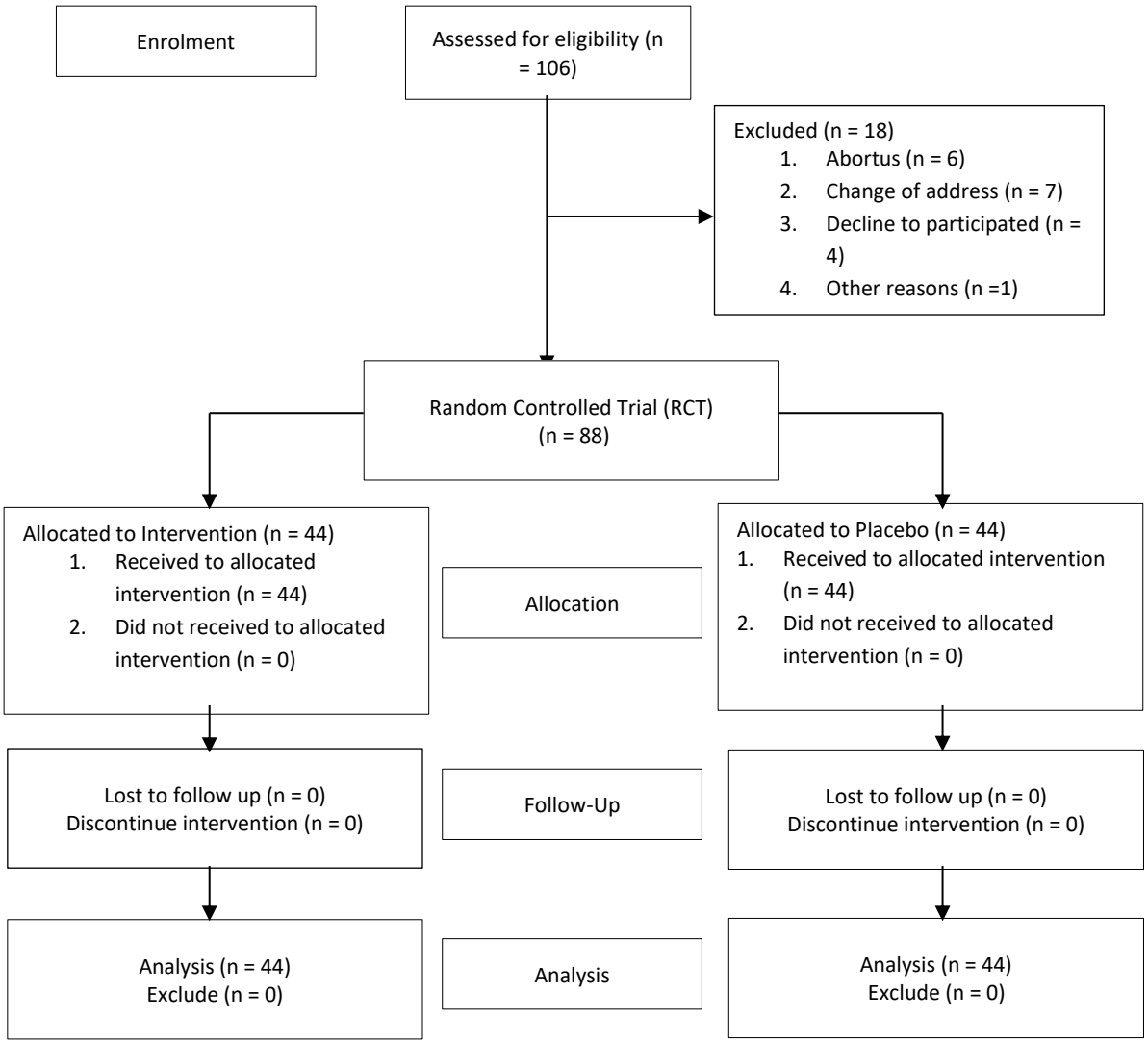

Figure 1. Consort Flow Diagram

(a) Digital Scale (b) Bowl (c) Mixer (d) Bread Proofer (e) Oven

Figure 2. Bread Making Tools

(a) Digital Scale (b) Bowl (c) Sieve (d) Pan (e) Wooden Spatula

Figure 3. Tools for Making *Dadih* Vla

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(a) Composite Flour (b) Wheat Flour (c) Milk Flour (d) Granulated Sugar (e) Salt

(f) Yeast (g) Margarine (h) Eggs (i) UHT Milk

Figure 4. Ingredients for Making Bread

(a) Cornstarch (b) Salt (c) UHT Milk (d) Sugar (e) Eggs (f) Vanilla (g) *Dadih*

Figure 5. Ingredients for Making *Dadih* Vla

(a) Weighing Raw Materials (b) Mixing (c) Weighing Dough (d) Rounding (e) Waiting for the Dough to Rise (f) Baking Bread

g) Cooked Bread

Figure 6. Functional Bread Making Process

(a) Weighing Ingredients (b) Mixing Ingredients (c) Filtering *Dadih* (d) Cooking Ingredients other than Curd (e) Mixing *Dadih* into Custard

Figure 7. VLa Making Process

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This type of clinical study research serves as the gold standard for validating treatment interventions. The 12-20 week gestational period was the beginning of the sample criterion, and it ended right before birth. In order to support optimal child development, maintain nutritional status, and exclusive breastfeeding, the study participants received information on healthy food choices, nursing techniques, and child development throughout the third trimester. The inclusion criteria were as follows: 1) residing in the city, 2) willingness to adhere to the entire study process (including follow-up) by signing the informed consent, 3) being pregnant between 12 and 20 weeks of gestation at the time of recruitment, and 4) having a normal fetus. The exclusion criteria included pregnant women with preeclampsia, miscarriage, stillbirth, or chronic conditions such as metabolic syndrome. Some participants dropped out due to miscarriages, relocation, or refusal to continue with the interventions.

In the next step, two nutritionists were recruited to interview and measure the participants using standard protocols and perform anthropometric measurements. In this study, gestational age at birth was calculated by ultrasonography. Weight measurements were done using a digital scale to the nearest 0.1 kg using an electronic scale, and height measurements were done using a microtoise to the nearest 0.1 cm. The questionnaire served as the primary data collection tool, accompanied by informed consent for respondents to sign. Enumerators assisted in administering and completing the questionnaire. The assessment of functional bread and *dadih* vla involved proximate tests, hedonic tests, and hedonic quality evaluations, while weight balancing scales were utilized.

The hedonic test was carried out with the participation of 30 semi-trained panelists. The *Dadih* functional bread samples were assessed individually, with each sample being repeated three times to minimize errors and calculate the average. Panelists were informed about the study's objectives, and their personal information was handled accordingly. An informed consent form was provided, explaining the voluntary nature of participation, the right to withdraw at any time, and ensuring confidentiality. The hedonic scoring criteria were: extremely dislike (score 1), dislike (score 2), neutral (score 3), like (score 4), and extremely like (score 5). Score sheets, data collection, and processing were conducted using computer software.

The experimental units of bread were randomly divided into groups with three treatments and two replications. F0 represented the standard formula, while treatments were applied to F1, F2, and F3 with additions of 10%, 20%, and 30% composite flour, respectively. The study began with the analysis of biochemical and nutritional values at the Food Technology Laboratory of Andalas University. The nutritional content of the *dadih* functional bread was tested through a proximate analysis, including moisture content using thermogravimetric or oven methods, ash content using the oven method, fat content through Soxhlet extraction, and protein content using total nitrogen or the Kjeldahl method. Carbohydrate content was determined by difference.

Similarly, the experimental units of *dadih*'s vla were randomly assigned to three treatments with two replications. F0 represented the standard formula, while treatments F1, F2, and F3 involved 10%, 20%, and 30% additions, respectively. The *dadih*'s vla product underwent testing for nutritional content, with proximate analysis including moisture, ash, and fat content through Soxhlet extraction, protein content via total nitrogen or the Kjeldahl method, and carbohydrate content by difference.

To conduct statistical analysis, SPSS version 26.0 (IBM Corp, Armonk, NY, USA) was performed to analysis mean±SD for continuous variables and percentages for categorical variables. A GLM test, with a 5% level of significance (p-value<0.05), was used to assess the difference in weight gain. The difference in weight increase between the intervention and control groups was evaluated using an independent T-test, with a 5% level of significance (p-value<0.05). Adjusted ANCOVA was used to determine the effect of the intervention on GWG by adjusting the covariate variables.

RESULTS AND DISCUSSIONS

Based on the results of this study (Table 1), almost all pregnant women were from Minangkabau ethnic group. They had graduated from high schools and universities. Most were housewives aged between 20-35 years old. The mean age of the pregnant women in the intervention group wasis 28.5±4.79 years old, which was younger than compared to those in who the control group, 29.6±5.63 years old. Table 1 shows that almost half of the pregnant women had moderate knowledge in terms of health, while the majority of them had moderate finances and most of the family members were smokers. The The sociodemographic characteristics of pregnant women and their frequency distribution can be seen in Table 1.

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Table 1. Frequency distribution of sociod-emographic characteristics of pregnant women in the intervention and control groups in Padang, Indonesia

Characteristics of Respondents	Intervention Group (N=44)		Control Group (N=44)	
	n	%	n	%
Mother Tribe (%)[a]				
Minang	40	90.9	42	95.5
Java	1	2.3	2	4.5
Others	3	6.8	0	0
Mother's Level Education (%)[a]				
Low	3	6.8	5	11.3
High	41	93.2	39	88.7
Mother's Job (%)[a]				
Housewives	32	72.7	30	68.2
Civil Servant	6	13.6	2	4.5
Entrepreneur	2	4.5	6	13.6
Others	4	9.1	6	13.6
Mother Knowledge (%)[a]				
Less	6	13.6	11	25.0
Moderate	32	72.7	28	63.6
Good	6	13.6	5	11.4
Family Income (%)[a]				
35.63 to 71.26 USD[c]	1	2.3	1	2.3
71.26 to 142.54 USD[c]	8	18.2	6	13.6
142.54 to 213.78 USD[c]	24	54.5	24	54.5
Others	11	25.0	13	29.5
Smoking Family Members (%)[a]				
Yes	31	70.5	27	61.4
No	13	29.5	17	38.6
Maternal Age (Years) (mean±SD)[b]	28.7±4.11		29.3±5.07	
Gestational (Week) (mean±SD)[b]	14.6±4.41		14.1±3.85	

[a]) Data are presented as n (%), [b]) Data are presentes as mean±SD, [c]) USD 1=IDR 14,033, SD: Standard Deviation

Food intake in both groups is presented in Table 2. The average energy, protein, fat, and carbohydrate content of the intervention group were greater than those of the control group, but there was no statistically significant. Thus, in order to fulfill both their own and their offspring' nutritional demands, pregnant women are advised to abide by dietary guidelines[19].

Table 2. Analysis of respondents' daily nutrient consumption of pregnant women in the intervention and control groups in Padang, Indonesia

Nutrients	Intervention (n=44)		Control (n=44)		p-value[a]
	Mean±SD	%RDA	Mean±SD	%RDA	
Energy (kcal)	1745.6±270.1	68.5	1666.1±226.0	68.0	0.073
Protein (g)	62.9±21.3	89.9	57.7±13.4	82.4	0.096
Fat (g)	65.3±19.4	96.3	60.2±17.3	96.7	0.135
Carbohydrate (g)	253.7±34.1	63.4	250.0±42.5	65.8	0.098

SD: Standard Deviation, RDA: Recommended Dietary Allowance, kcal: kilocalories, g: gram, [a]) Mann Whitney test, significant

The results of weight measurement of pre-intervention and intervention can be seen in Figure 7. The mean maternal weight gain in the intervention was 7.3 ± 2.6 kg and it 5.4 ± 3.8 kg in the control group was (Table 3). The results of the GLM Repeated Measures indicated that weight gain differed across the four-time measurements in both groups (Table 3). The result of analysis showed that there was a significant difference in GWG in both groups (p-value<0.001). Compared to the control group, the intervention group observed an average weight increase of around 2 kg more.

Maternal nutritional status during pregnancy can affect foetal growth and development[18]. Weight gain is an indicator of the maternal nutritional status. This research found significant increase and difference in GWG between in both groups (p-value<0.001). The management of body weight both before and throughout pregnancy has a big impact on how things work out during pregnancy[20]. Many unfavorable pregnancy outcomes are linked to suboptimal GWG. Thus, according to Moli et al., GWG significantly affects birth weight[21,22].

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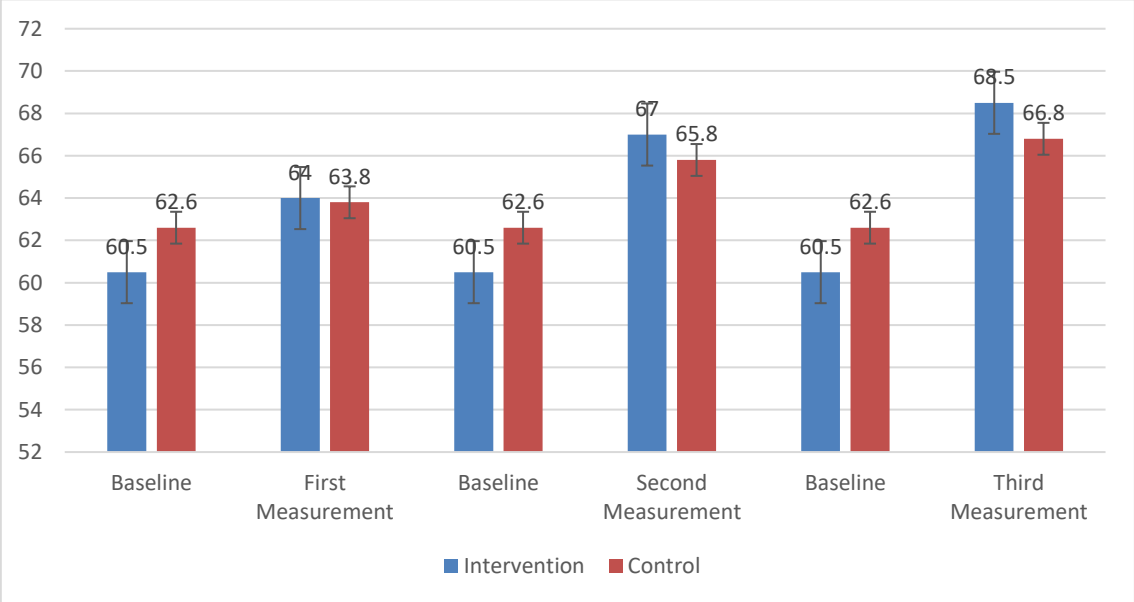

Figure 7. Weight (kg) of mothers at four points of measurement

Tabel 3. Effect of *dadih* functional bread on the GWG in the intervention and control groups pregnant women in Padang, Indonesia

Variable	Group		Δ	p-value
	Intervention (n=44)	Control (n=44)		
Body Weight (kg)[1]				
Pre-Intervention	62.0±13.0	61.2±15.0		
First Measurement (Baseline)	65.2±13.0	62.7±15.0	3.2	
Second Measurement (Midline)	67.7±12.8	64.8±14.7	2.6	
Third Measurement (Endline)	69.3±13.2	66.5±14.3	1.5	
p-value[a]	<0.001*	<0.001*		
GWG (kg)[b,1] (Endline - Baseline)	7.3±2.6	5.4±3.8		<0.001*
Adjusted Ancova[c]	(71.0)	(64.8)		<0.001*

Kg: kilogram, [1]) Value are expressed as mean±SD, [a]) General Linear Model Repeated Measure, [b]) Independent t-test, [c]) ANCOVA, *) Significantly different between treatment and control group

The GWG on pregnancy is an major factor of maternal and foetal nutrition[21]. Based on these results, the average body weight in the intervention group was 2 kg greater than that in the control group. *Dadih* functional bread delivery proved the presence of probiotics in early pregnancy. *Dadih* has been shown to have a number of probiotic microorganisms that improve their nutritional status[23]. *Dadih* products can serve as food supplements that are useful for pregnancy outcomes[24]. *Dadih* supplementation may improve in the number of L. fermentum in the digestive tract of pregnant women[25].

Studies on probiotics in relation to GWG in pregnant women are limited. However, this may be related to the beneficial effects of probiotics. Consumption of probiotics affects the microbial environment of the small intestine[26–28]. In addition to a healthy diet that will boost microbial diversity and the quantity of important species to support effective nutrient absorption, microbes may enable the most potential absorption and use of dietary nutrients[29]. The process of nutrient utilisation is the key physiological foundation for optimal health. Malnutrition happens when sufficient nutrients cannot enter the body adequately or are imbalanced[29].

This study found that the average body weight of the intervention group was 2 kg greater than that of the control group. This could be due to the very good acceptability of *dadih* functional bread. The findings of this study are consistent with those of Soltani et al. (2017), who discovered that *dadih* supplementation is appropriate for women and that applying it is feasible[30]. Thus, the *dadih* functional bread has been modified to meet the daily protein and energy needs as well as the nutritional needs of pregnant women.

After controlling maternal age, pre-pregnancy BMI, and fat intake, GWG was significantly related to functional bread intervention. There are 6.2 kg mean differences between the mean gestational age of the intervention group and the average gestational age of the control group. The differences is statistically significant (p<0.001) (Table 3). Maternal age, pre-pregnancy BMI, and fat intake were the main factors affecting gestational weight gain. Another study also found that the primary determinants of GWG were maternal body weight, age, and food intake[31,32].

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The average GWG in the intervention group over three months was 7.3±2.6 kg. This weight gain exceeded the recommended weight gain per week or per month. For underweight and normal weight women, the IOM suggests a GWG of 4 pounds, and for overweight and obese women, a GWG of 2 pounds[33]. The GWG, an important indicator for pregnancy outcomes, was determined based on pre-pregnancy BMI[8,34]. The gestational weight gain (GWG) in pregnant women is determined based on pre-pregnancy BMI. Pre-pregnancy BMI and GWG during pregnancy are indicators of foetal growth and maternal nutritional status[8]. GWG is also a controllable risk factor for poor pregnancy outcomes[35]. Meanwhile, According to Soltani et al. (2017), the majority of pregnant women in West Sumatra acquired less weight throughout their pregnancy than what the IOM recommended, particularly those with normal BMI. Therefore, in communities where maternal and infant mortality rates are known to be high, it is crucial to create culturally relevant treatments that will improve the nutritional status and health of mothers and newborns[8].

This study supports the recommendation. *Dadih*, a local Minangkabau food containing probiotics, can support and maintain the nutritional status of pregnant women during pregnancy which will further affect pregnancy outcomes. In addition, *dadih* utilisation has a positive economic impact and provides sustainable solutions to the challenges faced by mothers and infants. One of the study's limitations is that the probiotic profiles of the pregnant women were not measured. Further studies are recommended to assess the probiotic profiles to estimate the potential effects of probiotics on pregnant women and pregnancy outcomes.

CONCLUSIONS

The *dadih* functional bread supplementation for three months significantly affected GWG. Maternal age, pre-pregnancy BMI, and fat intake are the primary determinants of the GWG. Thus, consumption of the *dadih* products can improve the nutritional status of pregnant women.

ACKNOWLEDGEMENT

This research was supported financially by Lembaga Penelitian dan Pengabdian Masyarakat, Universitas Andalas with a grant for research T/6/UN.16.17/PP.Pangan-PTU-KRP2GB-Unand/2022.
This acknowledgement also goes to those who participated in this research, so that the research has achieved the completion stage of this journal.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors have no conflict of interest in this article. This research was funded by Lembaga Penelitian dan Pengabdian Masyarakat, Universitas Andalas with a grant for research T/6/UN.16.17/PP.Pangan-PTU-KRP2GB-Unand/2022.

AUTHOR CONTRIBUTIONS

HH: conceptualization, investigation, methodology, supervision, writing–review and editing; AA: methodology, writing–original draft; FYR: methodology; formal analysis, writing–original draft; AA: formal analysis, resources; FF: writing–original draft, writing–review and editing.

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