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Research Article
Impact of Date-tempeh Biscuit on the Nutritional Status of Stunted and Wasted Toddlers

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Abstract

Background and Objective: The nutritional problems in stunted and wasted toddlers decrease cognitive development and child productivity. This study aimed to evaluate the effect of date-tempeh biscuit consumption on the change in nutritional status of stunted and wasted toddlers. **Methodology:** A quasi-experimental design was used in a study conducted on 70 toddlers who consumed 50 g of biscuits for 90 days. Weight and height measurement done at pre-post study and bi-weekly. Nutrition education undertaken by research team in collaboration with integrated service post for under-five children cadres bi-weekly. **Results:** The nutritional status of children under five was stunted (31.4%), wasted (24.3%), normal (24.3%) and stunted-wasted (20%). Mean height per age (H/A) of stunted toddlers was -3.2±1.2, weight per height (W/H) of wasted toddlers was -3.1±1.7 and H/A and W/H of stunted-wasted toddlers were 3.3 for each measure. Wasted toddlers had a mean weight change of 1.9 kg and the highest increase in mean height of wasted toddlers was 2.5 cm. Wasted toddlers had the highest percentage of date-tempeh biscuit consumption (29%). Adherence to the recommendations for date-tempeh biscuit consumption affected the nutritional status of children under five in all groups ($p = 0.015$). Carbohydrate intake difference was correlated positively with weight changes ($r = 0.26$, $p = 0.03$). There was a significant relationship between the difference in fat intake with final weight ($r = 0.254$, $p = 0.034$). **Conclusion:** Date-tempeh biscuits can increase weight and height in wasted, stunted and wasted-stunted toddlers during 3 months of intervention.

Key words: Date-tempeh biscuit, stunted, wasted, stunted-wasted, toddlers

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Wasting and stunting problems at an early age cause bodily vulnerability to the development of degenerative diseases in adulthood and have an impact on long-term cognitive development and child productivity. The immediate causes are inadequate nutritional intake and infectious diseases. This situation is closely related to low levels of education and income, poverty, lack of knowledge of nutrition or the ability to apply information in everyday life[1].

Although the prevalence of stunting in toddlers in Indonesia has decreased from 36.8% in 2007 to 35.6% in 2010, this problem is still a public health concern because it has exceeded the minimum criteria of 20% for a stunting problem established by the Ministry of Health[2]. The main factor in the direct cause of stunting in toddlers is the low level of nutritional intake in toddlers[1,3]. Several studies have reported that low protein intake is associated with stunting in children[4,5]. Inadequate energy intake is significantly associated with the occurrence of stunting in infants[3,6].

The basic determination of public health problems in underweight children is measured from a wasting prevalence of over 5%. It is considered a serious public health problem when the wasting prevalence is between 10.1 and 15.0% and is considered critical if the wasting prevalence is above 15.0%[7]. Nationally, the prevalence of wasting in toddlers is 13.6%, which means that the wasting problem in toddlers in Indonesia is still a serious public health problem.

Efforts to improve child nutrition is conducted through Supplementary Feeding (PMT) of date-tempeh biscuit. The reason for choosing biscuits made of date-tempeh from tempeh flour and date palm fruit is based on the high protein content in tempeh, while dates are high in glucose, vitamins A and C and Ferrous to increase appetite. This has been proven by one study of underweight children under the age of five in Depok in 2010 and two studies of toddlers with TBC in Depok and East Jakarta in 2012 for 4-6 weeks of intervention. The increases in weight and height in those 3 studies were 1.3 kg and 0.7 cm, 0.7 kg and 1.7 cm and 0.4 kg and 2.4 cm, respectively[8-10].

However, efforts by the government and private sector/NGOs to improve family nutrition through posyandu are often only aimed at toddlers with less nutrition and malnutrition. Such efforts are rarely focused on stunted and wasted toddlers. Therefore, it is necessary to conduct a study of nutritional intervention for stunted and wasted toddlers from poor families to save the children from being stunted. Changes in height at stunted toddlers may not be as substantial as changes in weight in wasted toddlers, considering that within 3 months, the increase in height is not as fast as that in weight, but at least this intervention activity can be alternative empirical evidence of PMT recovery of underweight and short toddlers for the government in the future. The study finds out the possible beneficial effect of dates jam and tempeh flour in the biscuit formulation that may gain weight and height of stunted and wasted children. This study will assist the researcher to un-cover the area of nutritional status of children that many researchers were not able to explore. Thus, a new theory on these macro-micronutrients contained inside dates and tempeh, may be arrived at.

MATERIALS AND METHODS

Study design and study site: The study employed a quasi-experimental design that assessed the effect of consumption of 50 g of date-tempeh biscuits every day for 90 days. The baseline data collection includes socio-demographic characteristics of mothers (age, employment status, final education) and toddlers (age, gender), maternal level of knowledge of nutrition of stunting and wasting in toddlers, data on the last 24 h of food consumption at the beginning and end of the study. Ethical clearance was obtained from the Research Ethics of Health Research Development Committee Board, The Indonesian Ministry of Health. The research was conducted in the two selected sub-districts of Depok City, namely, Pancoran Mas and Bojongsari Sub-districts. The selection of this location was based on the acute chronic nutrition problem due to the numbers of wasted toddlers (>5%), stunted toddlers (>20%) and underweight toddlers (10%). The prevalence of very stunted toddlers was high in Pancoran Mas (5.72%), while the prevalence of stunted toddlers was high in Bojongsari (13.16%). The prevalence of both wasted and very wasted toddlers were high in Pancoran Mas (28.71 and 0.19%, respectively). The prevalence of wasted toddlers in Pancoran Mas was 28.90% and that in Bojongsari was 14.14%[11].

Subject and data collection: The inclusion criteria for children under-five who participated in the study were as follows: Age between 12-57 months, male and female gender, Z score for weight/height <-2 SD (W/H) for wasted toddler and height/age <-2 SD (H/A) for stunted toddlers[12], as well as not following a supplementation programme for toddlers with under nutrition. The materials and tools used in the study were weighing scales with 0.1 kg accuracy to assess weight, a

microtoise with 0.1 cm accuracy to measure height and survey questionnaires. The consumption history of toddlers was assessed by 24 h food recall instrument during the 90 days of the study. The study group was divided into the intervention group (consisting of stunted, wasted and stunted-wasted toddlers) and the control group (consisting of toddlers with healthy nutritional/normal status). Screening of the 70 stunted and wasted toddlers was conducted by a research team based at community health centres at the sub-district level and the use of data from local integrated service posts. We took the whole samples from 70 undernourished children because we used purposive sampling. Home visits by the research team in collaboration with local integrated service post cadres were conducted once every 2 days to monitor the obedience rate of the toddlers' mothers and to distribute a 2 day supply of date-tempeh biscuit at home and record the daily consumption of toddlers in the 2 days before each home visit. Every 2 weeks, the nutritional status of toddlers who received the date-tempeh biscuit was measured and the health status was recorded by the enumerator. Education and counselling on balanced nutrition in toddlers by using print media was also conducted at the same time by integrated service post cadres. In the 12th week, at the end of the intervention, validation of the toddlers' nutritional status was conducted in order to assess the extent of the weight and height changes and maternal nutritional knowledge changes since the beginning of the study. Complete research scheme is presented in Fig. 1.

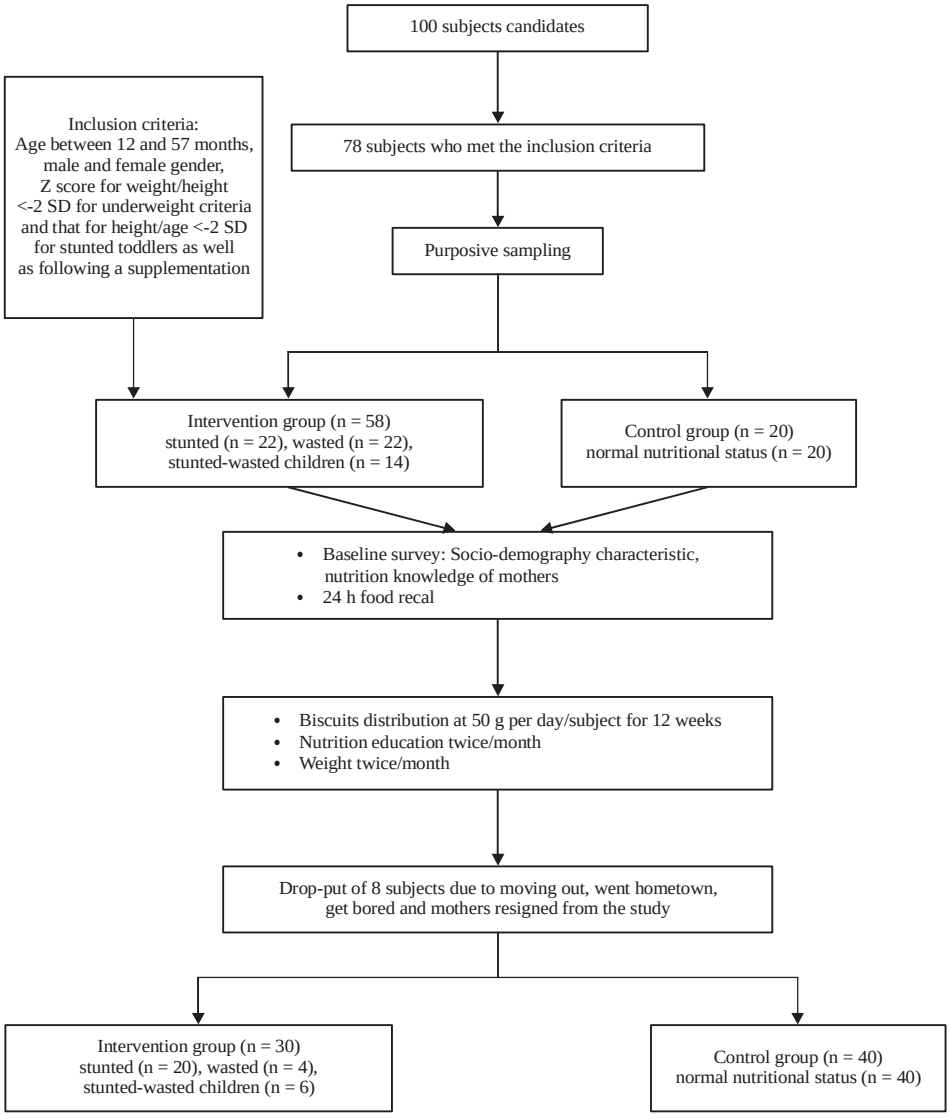

Fig. 1: Research scheme

Data analysis: Primary data analysis included calculation of the mean, standard deviation (SD), minimum value, maximum value and percentages. Anthropometric weight loss data were analysed using the WHO 2007 standard with WHO Anthro-Plus Version 02/2009 based on H/A and W/H indicators. Univariate data analysis was conducted by using SPSS version 13. Food consumption data to assess the adequacy of macro-nutrient intake (energy, carbohydrate, protein and fat) and micro-nutrients (vitamin A, B1, calcium, iron) were analysed by Nutri-Survey. Independent t-test were used to assess changes in macro- and micro-nutrient intake. One-way ANOVA was performed to assess the mean macro- and micro-nutrient intake, the socio-demographic characteristics of mothers and toddlers and maternal knowledge of stunted and wasted toddler nutrition between groups based on nutritional status.

RESULTS

Based on the results of screening for nutritional status at the beginning of the study, it was found that the percentage of stunted toddlers (31.4%) was greater than those of the wasted toddlers (24.3%) and stunted-wasted toddlers (20%). Toddlers with normal nutrition (24.3%) were selected for comparison to assess changes in nutritional status of malnourished toddlers who received biscuits. At the end of the study, it was found that of the 17 underweight toddlers, many of them changed to normal nutrition (11 toddlers) and some remained lean (6 toddlers). From the 22 stunted toddlers at the beginning of the programme, 3 toddlers were shifted to normal and of the rest, 16 toddlers remained stunted, 1 toddler was wasted, 2 toddlers were stunted-wasted and 3 toddlers achieved normal nutrition. Of the 14 stunted-wasted toddlers at the beginning of the programme, there were 3 normal toddlers, 4 stunted toddlers, 3 underweight toddlers, 4 stunted-wasted toddlers and 3 toddlers with normal nutrition after 3 months on the programme.

One noteworthy observation was the change from 17 normal-nutrition toddlers to 5 underweight toddlers and 12 toddlers who remained in normal-nutritional status. This might be due to their habit of eating the biscuits at lunch or dinner. As a result, they feel full and lose their appetite because the biscuits were consumed during the main meal (meals). The date tempeh biscuits should be consumed during the morning or afternoon snack because it is a daily interlude food.

Table 1 illustrates the difference in mean weight gained, height, Z-score weight/height, Z-score weight/age and Z-score of H/A in all toddler groups. Underweight toddlers had the greatest weight gain compared to others at 1.9 kg, but the stunted toddler group did not change. The highest mean height change was found in the stunted-wasted toddler group (2.5 cm), followed by that of the stunted toddler group (2.2 cm). There was a significant difference in the final weight and weight mean in each group ($p<0.05$). The mean Z-score of the toddlers with wasted nutritional status changed to normal. The mean Z-scores of stunted-wasted toddlers changed to the normal direction, but this change was not found in stunted toddlers, although there was a change in the mean Z-score. There was no difference in height before or after the intervention ($p>0.05$).

Table 2 illustrates changes in nutritional status based on the indicators weight/height, height/age and weight/age, intake of macro-nutrients and mother's knowledge of nutrition of stunted and wasted toddlers. At the end of the study, many of the toddlers in the stunted-wasted group shifted to normal. The toddlers in the stunted group with mean Z-scores indicating they were very stunted in height/age (<-3 SD) improved to stunted (-2 to +2 SD). Improvements to normal were also shared by toddlers in the wasted group who had mean Z scores for weight/height indicating they were very thin (<-3 SD). Toddlers in the wasted and stunted toddler group had a change in the intake of

Table 1: Mean weight, height, Z score W/H, Z score W/A, Z score H/A pre- and post-study

Variables	Wasted-stunted (Mean±SD)	Stunted (Mean±SD)	Wasted (Mean±SD)	Normal (Mean±SD)	p-value
Weight (kg)					
Pre-study	8.5±1.2	10.3±1.5	9.4±1.6	10.70±2.2	*0.005
Post-study	9.7±1.8	10.3±1.5	11.3±2.5	10.95±2.4	
Height (cm)	0.553				
Pre-study	80.2±7.9	81.4±99	87.0±1.6	84.6±9.5	
Post-study	82.7±7.4	83.7±7.2	88.9±9.9	86.7±9.6	
Z-score W/H					
Pre-study	-2.6±1.1	-0.6±0.9	-3.1±1.7	-0.9±0.6	
Post-study	-1.8±0.8	-1.1±0.7	-1.5±1.0	-1.2±1.2	
Z-score H/A					
Pre-study	-3.3±1.1	-3.2±1.2	1.4±2.9	-0.4±1.6	
Post-study	-1.5±2.2	-2.6±1.2	2.2±2.9	0.3±1.8	

SD: Standard deviation, *p<0.05

Table 2: Change in nutritional status, macro-nutrient and micro-nutrient intake, mothers' knowledge about stunted and wasted children

	Wasted-stunted		Stunted		Wasted		Normal		Total	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Anthropometry at pre-study										
Weight (kg)	8.51	1.15	10.27	1.53	9.37	1.58	10.70	2.19	9.80	1.82
Height (cm)	80.19	7.88	81.44	7.13	87.00	9.94	84.56	9.53	83.30	8.83
Height-to-age (H/A)	-3.26	1.05	-3.16	1.19	1.39	2.91	-0.44	1.57	-1.41	2.65
Weight-to-age (W/A)	-3.25	0.67	-2.22	1.12	-1.64	1.16	-0.91	0.85	-1.97	1.27
Weight-to-height (W/H)	-2.60	1.09	-0.62	0.98	-3.07	1.65	-0.88	0.63	-1.68	1.55
Anthropometry at post-study										
Weight (kg)	9.67	1.75	10.30	1.46	11.26	2.45	10.95	2.36	10.57	2.06
Height (cm)	82.72	7.40	83.68	7.16	88.96	9.98	86.69	9.64	85.50	8.74
Height-to-age (H/A)	-1.45	2.24	-2.56	1.15	2.17	2.89	0.25	1.76	-0.51	2.73
Weight-to-age (W/A)	-2.21	1.40	-2.21	0.94	-0.09	1.56	-0.74	1.15	-1.34	1.54
Weight-to-height (W/H)	-1.76	0.79	-1.11	0.69	-1.46	1.04	-1.17	1.18	-1.34	0.95
Macro-micronutrient intake at pre-study										
Energy (kcal)	897.20	359.70	1241.00	697.90	1193.00	730.10	900.30	222.50	1077.90	577.80
Carbohydrate (g)	113.90	49.80	157.00	84.10	143.80	99.30	107.80	38.30	133.20	75.40
Protein (g)	28.40	14.60	40.00	32.70	43.40	30.80	29.90	8.80	36.10	25.40
Fat (g)	31.70	12.40	44.50	29.50	42.70	26.20	31.80	12.70	38.40	23.00
Vitamin A (mcg)	468.50	582.90	665.90	657.60	1181.50	1426.70	551.50	500.60	723.90	893.80
Vitamin B1 (mg)	0.40	0.50	0.60	0.50	0.90	1.30	0.50	0.40	0.60	0.80
Vitamin B6 (mg)	0.60	0.50	0.80	0.50	1.20	1.70	0.80	0.60	0.90	1.00
Calcium (mg)	405.40	551.80	561.90	877.60	918.20	1923.10	493.00	571.40	600.40	1122.90
Iron (mg)	5.40	5.50	8.80	12.80	21.20	39.40	6.30	5.50	10.50	21.50
Macro-micronutrient intake at post-study										
Energy (kcal)	1326.50	512.60	1525.10	706.70	1420.00	728.70	1276.10	376.30	1399.40	606.10
Carbohydrate (gr)	171.90	74.80	188.40	83.90	184.90	98.50	148.20	54.50	174.50	79.90
Protein (gr)	46.10	23.00	52.80	31.80	49.70	30.00	38.80	11.90	47.30	26.10
Fat (gr)	50.00	20.20	60.00	27.70	53.80	26.20	49.60	21.80	53.90	24.50
Vitamin A (mcg)	854.60	938.90	1292.50	1218.70	1545.70	1471.60	1216.90	1833.50	1248.00	1397.80
Vitamin B1 (mg)	0.80	0.80	1.00	0.60	1.10	1.30	0.70	0.40	0.90	0.80
Vitamin B6 mg)	1.10	1.10	1.20	0.80	1.50	1.70	1.10	0.60	1.20	1.10
Calcium (mg)	899.40	1204.80	1002.60	1205.90	1109.50	1883.30	685.20	612.90	930.90	1284.60
Iron (mg)	10.90	11.60	11.90	12.70	23.20	38.80	9.20	8.20	13.80	21.70
Mothers' knowledge score at pre-study	1.10	0.80	1.30	0.80	1.50	1.40	0.80	0.80	1.20	1.00
Mothers' knowledge score at post-study	3.10	2.70	2.30	1.40	2.80	2.00	2.70	2.00	2.70	2.00

macro-nutrients (energy, carbohydrates, protein and fat) and iron intake that was greater than that of the three other nutritional status groups. Stunted toddlers had the highest vitamin A intake which can increase appetite in toddlers.

The mean increases in weight and height of the three nutritional status groups of children under five at the end of the study were not found in the normal nutritional status group. The differences in weight among all the groups of toddlers were significantly different before and after the programme ($p = 0.001$), but no significant differences were observed in height ($p = 0.398$). The underweight toddler group had the largest weight increase (1.9 kg) and the largest increase in height (2.5 cm) was in the stunted-wasted toddler group during the 3 months intervention. The largest change in weight was experienced by underweight toddlers due to the largest mean adherence to the consumption of biscuits (29%) among all the groups. Stunted-wasted toddlers had the highest energy, carbohydrate, protein and fat intake changes compared to the 3 other groups. This group also had a difference of 2 points in the mother's knowledge score about the stunted toddler at the end of the programme. There were significant differences in the intake of macro-nutrients and micro-nutrients before and after the programme ($p = 0.001$). Similar differences were observed with indicators of nutritional status of children under five, such as weight, Z score H/A and W/H ($p = 0.001$).

DISCUSSION

A total of 78 toddlers who met the inclusion criteria after validation of initial nutritional status based on the weight/height and height/age index, 8 toddlers dropped out and resigned from the study. This was because some toddlers got bored of eating the biscuits, mothers were less encouraging of their toddlers to eat the biscuits, fasting month that influenced the low efforts of mothers to

encourage their toddlers to eat the biscuits and moving house. In examining the nutritional content of the biscuits, it can be concluded that the biscuit have met the Indonesian Minister of Health standards/requirements regarding the composition of nutrients per 100 g of biscuit. The energy content per 100 g of biscuit of 485 calories meets the requirements of at least 400 kcal of energy per 100 g of biscuit, the 8.44 g of biscuit protein content is in the range of the required 8-12 g. Even the 22.6 g of fat content has exceeded the requirement for fat content between 10-18 g[13].

Changes in nutritional status in the study are in line with 3 previous studies[8-10]. In initial studies in 2010 in underweight children, the biscuit increased the mean weight and height by approximately 1.3 kg and 1.5 cm, respectively, after 1 month[8]. A similar study in underweight toddlers suffering from tuberculosis in Depok City found that the mean weight increased by 0.4 kg and height increased by 1.6 cm after 4 weeks[9]. The mean change in weight was 0.4 kg and that in height was 3.4 cm after 6 weeks[10]. The increased height and weight in this study were also in line with another four studies[14-17]. Tempeh is one of the Indonesian local food which high in plant protein and can gain weight of underweight children[18]. Pre-school age children have lower caloric needs, but an increase in the amount of protein in relation to weight. The fulfillment of protein needs become one of the alternative way to overcome malnutrition case[19].

The theoretical/methodological contribution of the study results is that the biscuits are suitable to be given to stunted toddlers and wasted toddlers. This is because the biscuits can increase weight and height. Indirectly, this programme is able to improve the nutritional status of underweight and stunted toddlers based on indicators of W/H and H/A during the 3 months of intervention. This is due to the increased intake of macro-nutrients, which include energy, carbohydrates, proteins and fat and micro-nutrients Zn, vitamin A and vitamin C in toddlers who consume the biscuits. Based on the information obtained by the Universitas Indonesia team from the toddlers' mothers, it was known that there was an increase in the appetites of the toddlers and in toddler body strength resistance. Toddlers who experienced a change in appetite tended to eat the biscuits 3 times a day on a regular basis and developed a new habit of buying snacks from food stalls. This pattern has confused the toddlers' mothers, because they were overwhelmed by the increase in the toddlers' appetites. Moreover, few toddlers suffered from cold, cough and fever while consuming the biscuit.

The protein content in 100 g of tempeh flour is higher (46.5 g) than that in soybean flour (42.6 g). High protein content in tempeh can increase weight by the breakdown of protein into energy-producing glucogenic amino acids[18]. The fat and carbohydrate content in 100 g of tempeh flour is also greater than that in soybeans (19.7 and 30.2 g compared with 19.1 and 28.5 g, respectively). In addition, 100 g of dates palm fruit contains 463 kcal of energy, 9.17 g of protein and 9.12 g of fat. Dates palm fruit has function to increase the activity of the immune system and increase appetite. The combination of tempeh flour and date palm fruit as the basic ingredients of the biscuit is a proper composition because it can increase the appetite and immunity significantly, rather than biscuits that are made from tempeh alone or dates alone. Additionally, the nutritional composition of tempeh (levels of carbohydrates, proteins and fat) is easy to digest[20].

The biscuit and cookie SNI quality requirements of 1992[21] stated that they must have a minimum calorie content of 400 kcal, be wheat flour based and contain at least 9% protein. These provisions have been met by the date-tempeh biscuit, except the protein and carbohydrate requirements. The percentage of fat in the date-tempeh biscuit is 22.6% and every 100 g of the biscuit contains 485 kcal. Although the percentages of protein and carbohydrates in the biscuit do not meet the quality requirement because the biscuit is only 8.44% protein and 61.9% carbohydrates, these percentages are close to the SNI standard. Lack of protein and carbohydrate can be met through the addition of tempeh flour and date palm fruit into the dough of date-tempeh biscuit.

Study limitations: Several limitations of the study that may have impacted the sensitivity to changes in macro and micronutrient intakes related to H/A and W/H scores. First was the influence of fasting month in dietary intake from baseline to end-line. The fasting months may have a large effect on the mothers' persistence giving biscuit to their children. Some mothers forgot and got laziness to give the biscuit for their children. A second limitation concerns the boredom of children eating their biscuit. Even-though we developed variety of biscuit's taste regarding their preference like chocolate, strawberry and orange, but most children got boredom. Third was the absence of a placebo group (the plain biscuit), making it difficult to compare the nutritional status improvement between the intervention and control groups. Finally, it is essential to consider that use of dates-tempeh biscuits for PMT recovery may be the one of option to provide nutritious food for stunted and wasted children.

CONCLUSION AND RECOMMENDATION

Although there was no effect between macro and micro-nutrient intake in change H/A and W/H scores in underweight children, this group had the highest mean difference in energy, carbohydrate, protein, fat and iron intakes compared to the others. There was a correlation between mean difference in carbohydrate intake with mean difference in weight and between final weights with the difference in mean fat intake in all groups.

Weight, height, Z score for W/H and Z score for H/A in toddlers differed significantly before and after the programme. Significant differences were also found in changes in energy intake such as carbohydrate, protein, fat, vitamin A, calcium and iron as well as the nutritional knowledge of toddlers' mothers on stunted toddlers and wasted toddlers at the beginning and end of the programme. Improvement of the nutritional status of toddlers was found in underweight children. There was also a decline in the number of underweight toddlers from 17-11 toddlers with normal nutrition status and 6 toddlers who remained underweight. Of the 22 stunted toddlers, there was a shift towards normal in 3 toddlers and of the remaining toddlers, 16 toddlers remained stunted, 1 was a wasted toddler and 2 were stunted-wasted toddlers. From a total of 14 stunted toddlers, there was a change in nutritional status to 3 toddlers with normal nutritional status, 4 stunted toddlers, 3 wasted toddlers and 4 stunted-wasted toddlers after following the programme for 3 months (12 weeks).

Date-tempeh biscuit are recommended as an alternative option for PMT recovery at community health centres, integrated health post for children under-five (posyandu), school-children feeding programmes and TFC (Therapeutic Feeding Center) at community health centre by District Health Office. The improvement of flour-based tempeh date biscuits can be converted into mocaf flour (modified cassava) or cassava flour, ganyong flour, arrowroot flour, breadfruit flour and other starch sources. In addition, tempeh flour can also be substituted with lentil bean flour (koro) as a source of protein. Date-tempeh biscuit based on the flours described above are safe for children with autism who should avoid wheat flour and cow's milk.

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