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Tempe Nuggets Provision Improves Energy Adequacy and Protein Intake in Underweight Underfive Children

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Abstract

Tempe is a well known fermented soybean food, inexpensive, and a good source of dietary protein and energy. To improve fresh Tempe as an attractive food to children, Tempe is processed into nugget. A study using pre and post-control group design was conducted to determine the effect of the Tempe nugget provision on energy and protein intake, and body weight/age (W/A) of 24-59 months old children. Forty six subjects were selected according to inclusion criteria from local Community Health Center (Puskesmas) and grouped into intervention (provision of Tempe nugget) and control group (no provision). Data of energy and protein intake of subjects before intervention were obtained by 2x24 food recall to determine deficiency in intake for the respective age. The amount of the nugget given to each underweight child in intervention group was calculated on the basis of deficiency in energy and protein intake of each child (W/A) per day. Body weight was recorded pre and post intervention. The deep-fried nuggets contained 276.53 calories per 100 g, 8.60%protein, 28.41% carbohydrate, 13.28% lipid, and 44.28% fiber. The mean age of the subjects in intervention and control group were homogeneous *i.e.* 40.52±10.88 months and 42.39±12.35 months respectively. Tempe nugget provision for 30 days improved significantly energy intake ($p<0.001$) in intervention compared to control group. Protein intake and W/A in intervention group were higher compared to control although not significant and further study with higher amount of Tempe nugget provision is needed. This study provides evidence that deep fried Tempe nugget can be used as inexpensive and nutritious food to improve protein and energy intake for underweight under five children.

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Introduction

Children under-five are the most vurnerable group as they are in a transition or weaning stage to adult diet[1]. Inadequate protein and energy intake can lead to underweight in under fives which is a risk factor to illness and in the long term compromising health and productivity[2]. Adequate protein energy is highly dependent on daily food intake. Inexpensive food with improved sensory properties is important to attract the under-five to increase food intake. Intervention studies showed that the best results were obtained using locally available health resources[3].Tempe is well known for centuries as an inexpensive fermented food, part of daily menu, and a good source of dietary protein and energy in Indonesia. Tempe with its protein, carbohydrate, fat, fibre, vitamins and minerals content is readily digestible and suitable for all age groups from infant to elderly[4]. A study showed that the growth of children who received Tempe was similar to those who received milk powder[5]. However, intervention study utilizing Tempe for underweight children are still rare. Tempe has short shelf life, after two days it starts to deteriorate giving off objectionable odours. With the advancement of food processing tempe can be processed into popular nugget. Tempe nuggets are more attractive and can be deep fried to improve its sensory properties and hence improving intake of underfive children. The following study was conducted to evaluate provision of Tempe nugget on the energy and protein intake, and body weight changes (BW/A) of underweight underfive (24-59 months) children.

Materials and Methods

This study had been approved by Ethic Committe of Faculty of Medicine Diponegoro University with Ethical Clearance No. 364/EC/FK-RSDK/2014.

Tempe

Fresh Tempe was obtained and produced by one local Tempe producer (home industry) in Salatiga city Central Java, commercial wheat flour (Segitiga Biru), corn flour (Maizenaku), eggs, quality drinking water, garlic, shallot, and salt (Refina) were obtained from local market from the same supplier.

Tempe Nugget Preparation

Fresh Tempe was sliced into small cubes. The cubes were blanched in water at 108 - 110^{0}C for 30 minutes and drained. The dried Tempe was ground into powder and filtered through 60 mesh screen.

Fig. 1: Fresh Tempe (left) and Tempe flour (right)

Two recipes of nugget was made from Tempe flour, wheat flour, corn flour, fresh eggs, drinking water, garlic and shallot. No sugar nor salt were used. The second recipe was made by omiting corn flour (Table 1). The dough was made into elongated rectangular shape, coated with bread crumb, steamed at 70-90^{0}C for 45 minutes, cooled, and stored frozen. Prior to each provision, the frozen nuggets were thawed and deep fried in fresh commercial palm oil at 170-172^{0}C for 3 minutes using house hold wok (round-bottomed cooking vessel). Palm oil for frying was used only for once frying to ensure food safety for under fives[6]. The size of each fried Tempe nugget was in average equal to 25 grams.

Tabel 1: Tempe Nugget Recipes

Composition	1st recipe	%	2nd recipe	%
Tempe flour (gram)	50	27,0	50	26.3
Wheat flour (gram)	20	10,8	30	15.8
Corn flour (gram)	5	2,7	-	-
Fresh egg (gram)	40	21,6	40	21.1
Garlic (gram)	10	5,4	10	5.3
Shallot (gram)	10	5,4	10	5.3
Drinking water (ml)	50	27,0	50	26.3
Total	185	100	190	100

Fig. 2: Fresh Tempe nugget (left) and deep-fried Tempe nugget (right) for intervention. Each size is equal to 25 grams

Determination of Tempe Flour and Nugget Nutrition

Tempe flour and nugget were analyzed for moisture, protein, carbohydrate, lipid determination by Moisture Analyzer (Mettler Toledo), Kjeldahl, Luff Schoorl, and Gravimetry methods respectively[7].

Preference Test for Tempe Nugget

A simple preference test was carried out to obtain the most preferred fried nugget from the two recipes. The test was conducted on underfives and their mothers at Public Health Centre in Salatiga city. Criterias for underfives are 1) the subject did not refuse to eat Tempe nugget and 2) the subject was able to consume the nugget. The test were done using three facial hedonic scales *i.e.* like, neutral, or dislike[8].The preference test for colour, aroma, and texture on their mothers was conducted using the samescale *i.e.* like, neutral, or dislike[9].

Under Weight Under-five and Control Subjects

The population of this study was all under five children aged 24-59 months who resided in Salatiga city and their data were obtained from Community Health Center (Puskesmas). The number of subjects for this study was determined according to the following formula : $n = \frac{(Z_\alpha\sqrt{2PQ}+Z_\beta\pm\sqrt{P_1Q_1+P_2Q_2})^2}{(P_1-P_2)^2}$, where n is aminimum sample size[10]. After calculation and including additional 10% sample to anticipate drop out, we obtained 23 subjects for intervention and 23 for control group. The inclusion criteria consisted of under-five aged 24-59 months who were 20% deficient in energy and protein intake, 2) the parent of the subjects had agreed and given informed consent to be a respondent, and 3) the subject is healthy and not ill from dengue, anemia, diare, or upper respiratory infection. Subject was excluded from the study when subject resigned during the study, or the subject consumed Tempe nugget less

than 70%, or they were allergy to soybean. Subjects for control group were obtained from the same Puskesmas with the same age and sex but without Tempe nugget intervention.

Determination of Energy and Protein Intake Deficiency of Under-Five Subjects

Data of energy and protein intake of under five subjects were collected from the respective under five mothers before and after the end of Tempe nugget provision. The data collection was done by 2x24 hour recall method assisted by house hold units[11]. The recall method was carried out at a separate day to avoid bias. The data collection before Tempe nugget provision was conducted to estimate deficiency in energy and protein intake. According to National standard for Food and Nutrition 2012, the daily requirement of energy and protein for one to 3 years old children are 1125 calories and 26 gram respectively. The daily requirement for 4 to 6 years old children is higher *i.e.* 1600 calories and 35 gram protein[12]. From the data of 2x24 hour recall, the number of Tempe nugget provision can be determined for each subject. Therefore, each subject received different amount of fresh fried Tempe nugget .

Intervention Study, Provision of Tempe Nugget

The intervention study was conducted at Puskesmas A, while control group with no intervention, was conducted in Puskesmas B in the same city of Salatiga. In both centres the subjects were dewormed by administration of Mebendazole 2x100 mg to prevent absorption disturbance due to worms infection. The medicine is safe for under-five with anemia or malnutrition. Tempe nugget provision was done at the centre by in duty pre- and post-natal health care officials. Measurement of body weight and age (BW/A), energy and protein intake in both Puskesmas was done at the beginning and at the end of 30 days intervention.

Statistical Analyses

All data were analyzed by SPSS 17. Data of energy and protein intake from recall method were converted to grams of food and calculated using Nutri survey year 2007. Total energy and protein intake was compared to National standard requirement of energy and protein adequacy and expressed in percentage[12]. Data of BW/A were compared to BW/A standard and expressed in kg unit[12]. The data of pre and post provision consisted of BW/A, energy and protein intake were analyzed for normality using Shapiro Wilk. When data distribution was normal, differences were analyzed by paired T test and when distribution was not normal they were analyzed by Wilcoxon test. To evaluate the difference between intervention and control group, the data when normally distributed were analyzed by unpaired T test or when not normally distributed by Mann Whitney test.

Results

Preference Tes for Tempe Nugget

Preference tests were conducted to ensure that Tempe nugget used for intervention is accepted by the subjects and their mothers. The results in Table 2 and 3 showed that 86.7% of the subjects and 76.7% of their mothers preferred the first recipe.

Tabel 2: Preference test of Tempe nugget by under-five panelists

	Tempe nugget			
	1st recipe		2nd recipe	
	n	%	n	%
Like	26	86.66	19	63.33
Neutral	2	6.66	6	20.00
Dislike	2	6.66	5	16.67
	30	100	30	100

Tabel 3: Preference test of Tempe nugget by the mothers of under-five panelists

	colour		aroma		taste		texture	
	∑	%	∑	%	∑	%	∑	%
1st recipe	17	56.7	14	46.67	19	63.33	23	76.67
2nd recipe	13	43.3	16	53.33	11	36.67	7	23.33

Tempe Flour and Nugget Nutrition

Nutrition analyses of Tempe flour compared to the nugget showed higher protein and energy content on dry basis(Table 4).

Profiles of Under-Five Subjects

The average age of both groups were similar (p=0,605>0,05) showing a homogenous age characteristic (Table 5).

Energy and Protein Intake

Table 5 showed the energy and protein intake before and after 30 days study. After 30 days study each group showed significant increase in energy intake (p<0.001), however the intervention groups had significantly higher energy intake compared to control group (p = 0.049). The change in energy intake was also significantly higher (p=0.028) in intervention group (242.56 calories) compared to control group (151.49 calories) .

Table 4: Nutritional content of Tempe flour and the fried Tempe nugget

Nutritional content	Tempe flour		Fried Tempe nugget	
	fresh weight	100% dry weight	fresh weight	100% dry weight
Moisture	5.47	-	28.71	-
Protein (%)	34.27	36.25	6.13 8.60	
Carbohydrate (%)	20.16	21.33	20.25	28.41
Lipid (%)	18.33	19.39	10.18	14.28
Crude Fibre (%)	44.69	47.28	31.57	44.28
Energy (calories/100g)*	382.7	404.8	197.1	276.70

* Energy was calculated by converting protein, carbohydrate and lipid into energy which are equal to 4, 4, and 9 calories per g respectively. Tempe flour or nugget was sampled from one batch.

Table 5: Average age of under five subjects before intervention

	Intervention Group (n=23)	Control Group (n=23)	p(a)
Age (months)	40.52±10.88	42.39±12.35	0.605

[a]*Mann Whitney* test (p>0.05), values are expressed as mean±SD

Tabel 5: Energy and protein intake pre and post 30 days provision of Tempe nugget

	Intervention Group	Control Group	(p<0,05)
Energy Intake (calories/day)			
Pre test	1153.60±185.22	1139.70±247.11	0.829[(a)]
Post test (after 30 days)	1454.80±247.35	1291.10±298.73	0.049[(a)*]
Δ pre-post test	242.56±170.13	151.49±85.79	0.028[(a)*]
p	0.001[(b)*]	0.001[(b)*]	
Protein Intake (gram/day)			
Pre test	26.06±7.72	30.51±11.97	0.202[(c)]
Post test (after 30 days)	32.71±7.29	33.87±12.71	0.818[(c)]
Δ pre-post test	5.38±3.77	3.36±1.90	0.084
p	0.001[(d)]	0.001[(d)]	

[(a)]Unpaired t test (p<0.05), to compare between intervention and control group
[(b)]Paired t test (p<0.05), to compare before and after intervention for each group
* significant
[(c)]Mann Whitney test (p<0.05), to compare between intervention and control group
[(d)]Wilcoxon test (p<0.05), to compare before and after intervention for each group

The protein intake prior to intervention were similar (p>0.05). After 30 days study each group showed significant increase in protein intake (p<0.001), in which the intervention groups had similar protein intake compared to control group (p> 0.05). An increase in protein intake was higher in intervention group (5.38 gram/day) compared to control group (3.36 gram/day) but the increasein protein intake between both group was not significantly different (p>0.05).

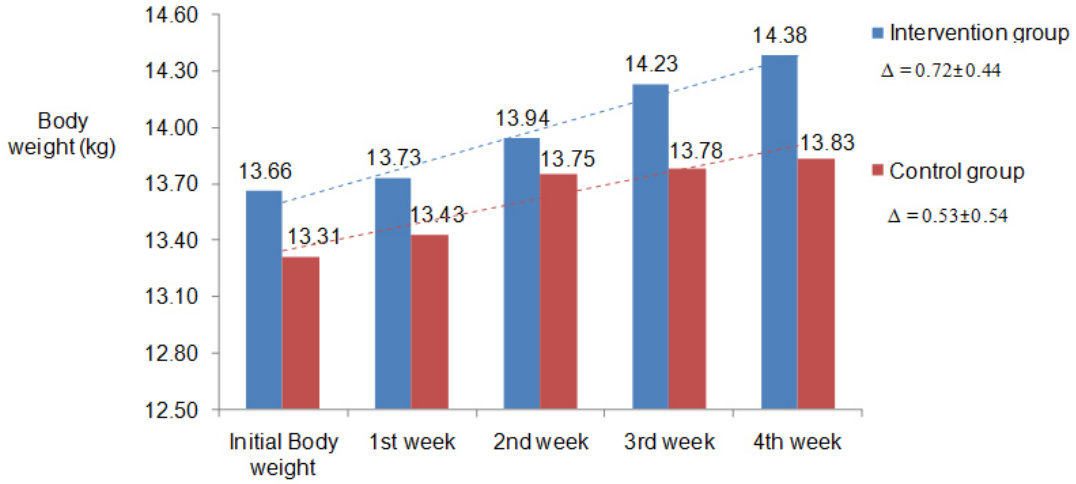

Fig. 3: Histogram of the average of W/A of under five subjects before and after 30 days study. There was significant increase of body weight in each group after 30 days study (Wilcoxon test with p = 0.001) in which the increase in intervention group was higher (0.72 kg) compared to control group (0.53 kg). Increase B/A between intervention and control group were not significant (Mann Whitney test with p = 0.830)

Discussion

We found that deep fried nugget from first recipe was more preferred by under fives and their mothers. We experience no drop out during our study which could be due to good overall sensory properties of the fried nuggets. In addition we also served the nugget in different shape every 5 days.Our study was in contrast to study by Rauf (2007) who experienced drop out due to boredom of shredded dried fish intake for three weeks intervention[13]. This study indicated that deep-fried Tempe nuggets give a good sensory properties which are enjoyed by the under five children and suitable for long term intervention.

The energy intake prior to intervention were the same ($p>0.05$) which signified that the subjects in both groups were homogenous. After 30 days intervention, fried Tempe nugget provision improved significantly the energy intake of the subjects. The difference in increase energy intake in intervention group was significant proving that deep fried Tempe nugget can improve energy adequacy in underfives. For protein intake, an increase in intervention group was found to be higher (5.38 gram/day) compared to control group (3.36 gram/day) suggestedthat Tempe nugget provision improved the protein intake of underfives. When both group was compared, the increase in protein intakewas not significantly different ($p = 0.830$) which could be due to several factors. The first one could be due to the length of provision which might need longer than 30 days. Protein synthesis requires energy and the energy provided from Tempe nugget provision may not be sufficient yet to be utilized for increasing protein synthesis. The second factor could be due to the amount of nugget which had been given which should have been higher than the calculated amount to fullfill the deficient amount to standard requirement for each W/A. This possibility is supported by an in vitro protein digestibility study of instant soup mix made of Tempe flour, corn flour, vegetable flour, and spices similar to our study[14]. The protein digestibility of the mix ranged from 75 to 91% which was in line with the amount of theTempe flour used in the study *i.e.* 50 to 65% respectively[14].In our study we used Tempe flour approximately only 27% (50 gram from a total of 185 gram) which is lower. This possibility lend the importance of adding digestibility factor in intervention study to determine the amount of intervention food to be given. According to W/A of 24-59 months children in National Reference Card diagram for weight monitoring, the average increase in body weight is 0.5 kg. The result of this study was in line with the Reference Card for control group ($\Delta 0.53 \pm 0.54$ kg) and higher for intervention group($\Delta 0.72 \pm 0.44$ kg). Although after 30 days study the difference in B/A increase (*Mann Whitney test* with $p = 0.830$) between intervention and control group was not different significantly, the W/A increase was larger in intervention group (0.72 kg) compared to control group (0.53 kg) suggesting the ability of Tempe nugget in improving W/A. Our study was different than that by Kurnia who used Tempe biscuits for underfives and found no improvement neither in energy nor body weight[15]. Overall, our results proved that deep fried Tempe nugget provision is well accepted and can improve protein and energy intake in underweight under five children.

Conflict of Interest

We declare no potential conflict of interest. This study was self funded.

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