ORIGINAL ARTICLE

Intervention of Bean Cookies Complementary Foods for Improving the Physical Growth of Stunted 12-24 Months Old Children

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ABSTRACT

Introduction: Nutrients intake from complementary feeding during breastfeeding period greatly important in supplying energy and nutrient for children's growth. This study aimed to evaluate the physical growth of stunted and non-stunted children aged 12-24 months olds who given innovative bean cookies complementary foods intervention for once snack in 30 days, in the highest prevalence stunting villages, Arjasa subdistrict, Jember district, Indonesia. **Methods:** The research stages included: 1) preparation of the bean cookies 2) obtaining ethical clearance, determining subjects, and obtaining informed consent; 3) evaluating subjects' dietary patterns and height-for-age of subject; 4) administering the bean cookies; and 5) measuring the height-for-age after the intervention. This ethical approved cross-sectional-single-blind design study was involving 22 non-stunted and 18 stunted children aged 12-24 months who fulfilled subject's criteria. The subjects physical growth (height-for-age) was evaluated using WHO Child Growth Standards for Z-scores values of -2SD up to -3SD that was determined as stunted. Subject's dietary intake and food consumption data were obtained through food recall method. **Results:** By 44% of the stunted subjects slightly improved their physical growth (Zscore>-2SD), due to the very low energy intake (66.25% in non-stunted and 64.25% in stunted subject), and low micro nutrient although the very high protein intake (above 100% RDA). Metabolically, the high protein intake that should be used for growth is reduced because it is forced for energy production. **Conclusion:** Statistically, the increase in physical growth of the stunted and non-stunted subject children was no real difference (sig = 0.77 > P 0.05).
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INTRODUCTION

Complementary feeding is given after the exclusive breastfeeding stage and plays an important role in supplying nutrients necessary for growth and development of children aged 7-24 months. Given the decreasing quantity and quality of breast milk, the energy and nutrient needs must be ensured from complementary foods that are given as 3 main meals and 3 times snacks in a day. The daily energy and macronutrient requirements for Indonesian children aged 12-24 months with a body weight of 13 kg and height of 92 cm, are 1350 kcal, 215 g carbohydrate, 20 g protein, and 45 g fat (1). The level of fulfilment of energy and protein, respectively by below 70-100% and 80-100% of the standard is considered insufficient (2}. The lack of macronutrient intake has a short-term impact on weight loss, while a long-term impact on height. According to WHO children growth standard, the height-for-age at Zscore = -2SD up to -3SD is considered as stunted.

Stunting is still the most prevalent form of child malnutrition worldwide (3) (4) (5) (6) and the best overall indicator of child growth evaluation. That is a condition of growth disorders characterised by a child's lack of height when compared to other children their peers. It adversely affects children's physical growth and cognitive development which can reduce intelligence and productivity in the future, and further effects on the quality of human resources. Data from Indonesian Nutritional Status Survey (SSGI) retrieved that Indonesia's stunting prevalence in 2022 is still high

21.6% (7) above WHO target by below 20%, and the highest prevalence is in Jember district, reaching 30.4%. Arjasa Subdistrict, where this study was conducted, had the highest prevalence of stunting at 44.17% in 2024. Stunting is multifactorial so it requires multi-sectoral handling as well (8) (9). In synergy with other multi-sectoral program (10), various nutrition intervention efforts are being made to reduce the prevalence to 14% by 2025. One of the efforts is specific nutrition interventions (11), such as providing food intake from complementary food for under-five children. In Indonesia, including in Arjasa Subdistrict, Jember District, the main type of malnutrition that causes stunting in the children is low food intake, especially protein intake, due to low economic conditions, and poor nutritional knowledge. The protein of the mung bean (Vigna radiata) and cowpea (Vigna unguiculata (L.) Walp) flour ingredient in making the bean cookies complementary foods given to the stunted children in this study has been tested to have quite high digestibility (51 %) and high protein efficiency ratio (PER= 2.7) (13) (18).

Children aged 12-24 months are able to consume more solid form of complementary foods such as macaroni, soft rice and soft bread, as main meal, while fruit flesh, pudding, biscuit, and cookies as snack. Their digestive system is ready to consume family foods, so that they can be given complementary foods that made from a variety of animal and plant-based foods such as eggs, milk, chicken, fish, rice, flour, corn, tomatoes, vegetables, fruits, and bean (12). Due to their high protein content and, mung bean (23.9%) and cowpea s (19.6%) flour (13) (14) are added in the cookies making became the innovative bean cookies complementary foods that potential for improving the under five children's growth. This is because the bean protein flours content has been scientifically proven to be of high value (20% and above), and quite high for its digestibility (above 50%) (15). The bean cookies complementary food developed has meet the quality requirements stipulated in the regulation of the National Standardization Agency of the Republic of Indonesia number 6 concerning Technical Guidelines for Baby and Children (16). According to the agency, in a quantity of 100 grams of complementary foods for children aged 1-2 years must contain at least 6 grams of protein, or fullfill 30% of the recommended daily protein requirement.

MATERIALS AND METHODS

This cross sectional single blind randomized design study has been approved by the ethics committee through the ethics certificate number of 279/UN25.1.14/ KEPK/ 2023, June 23 - September 23, 2023. A total 40 subject children aged 12-24 months who met the inclusion and exclusion criteria and have agreed by their parents whom received explanation about the research (informed consent) were participated as subject. This complementary food intervention research was registered at the National Unity and Political Agency of Jember District with the number of 074/1820/415/2023, June 5, 2023.

Determining Population and Subjects

The results of the 2022 Indonesian Nutrition Status Survey released by the Indonesian Ministry of Health show that Jember Regency ranks first in East Java in terms of the prevalence of stunting among toddlers, reaching 34.9 % or around 35,000 toddlers), significantly higher than the WHO standard (20%). Among the six subdistricts, Arjasa is categorised as one with the highest prevalence of stunted children in Jember district, at 44.1 %, and receives animal-based food assistance in the form of chicken meat and eggs from the government programme.

Data from the Community Health Centre (Puskesmas) shows that the total number of stunted children in Arjasa was 97 children (44.1% - stunting prevalence in 2024). A total of 72 children met the exclusion criteria, namely being aged 12-24 months and receiving food assistance program from the government (chicken meat and eggs) in the previous three-month period. Other exclusion criteria is those who were born with low birth weight and have chronic congenital diseases. Fifty-five percent of the children or 40 children met exclusive criteria, whom only 45% of them or 18 the children met the inclusive criteria which is their height for age value by Z-score below -2SD up to -3SD, were selected as stunted subjects in this research for receiving complementary bean cookies intervention. The normal children aged 12-24 months (22 children) selected randomly be control group. After receiving an explanation of the procedure, all parents agreed that their children would consume cookies as complementary foods for one meal a day for 30 days.

Making Bean Cookies Complementary Food

Complementary food cookies were made in the usual way of mixing ingredients (flour, egg yolk, butter. and 40% of two-bean, namely mungbean (Vigna radiata) and cowpea (Vigna unguiculata (L.) Walp) mix flour, making dough, molding, and baking in the oven at 150o C for 30 min. The protein of the two bean is of high quality with amino acid score (AAS) values of 90 and 75, respectively (17) (14), and very high digestibility of 80-90% (15). The mungbean and cowpea flour was made by grinding the dry bean, and sift using an 80-mesh sieve. The bean protein has been tested to have a positive effect on growth with a high protein efficiency ratio value (PER>2.5) in vivo (18). The nutrient composition of the complementary food was calculated using nutri survey application and data source on Indonesian food composition table (19). The amount of 50 gram or equivalent to three of complementary bean cookies per serving were consumed by the subjects every day for 30 days.

Cookies Nutrient Content Analysis

The nutritional value of cookies was analysed using a calculation method based on Indonesian food composition data published in 2018. The macro nutrient content of bean cookies complementary foods were determined using the following methods: water by oven drying and gravimetry, protein by Kjeldahl, fat by Soxhlet, and carbohydrate using by different method. Thiamine and riboflavin levels are determined by spectrophotometry. Meanwhile, the levels of calcium (Ca), sodium (Na), iron (Fe), and zinc (Zn) minerals of the bean cookies were determined using atomic absorption spectrophotometry (AAS).

The bean amino acids composition were determined using waters acquity UPLC H Class Bio Amino Acid Analysis System Guide Year 2012. The quality of protein of the bean cookies using amino acid score (SAA) parameters was analyzed by a calculation method based on Indonesian amino acid composition data comparing to the FAO/WHO 2013 EAA req. for children aged 1-3 years.

Children's Growth Assessment

The assessment of the physical growth of the subject aged 12-24 months in this study refers to the anthropometric standard of children using the height-for-age index (2). The index describes the growth in length or height of children based on their age, so that it can identify children who are stunted or severely stunted, which is caused by prolonged undernutrition or frequent illness. The standard refers to the WHO child growth standards for children aged 0-5 years Determination of stunted using WHO standards, namely the length for age or height for age index value of Zscore -3SD to - 2SD for the stunted category and Zscore -3SD for severely stunted. Calculation of Zscore and SD using WHO Anthro v 3.2.2 software application. The assessment showed there were 18 stunting and 22 unstunting subject children.

Dietary Intake Evaluation

Nutrient intake of the subjects that evaluated once after the intervention was calculated from their food consumption data collected thru the 2x24-hours Food Recall and was calculated and processed using the nutrient survey software program in 2007 (20). Below intake levels of 70-100% energy recommended and 80-100% protein recommended are considered insufficient or do not meet adequacy standards (1, 2).

Assessment of Food Consumption Patterns and Eating Behaviour

Food consumption patterns data includes the frequency of consumption of types and amounts of food from each food group through interviews with reference to the semi quantitative food frequency recall (SQFFR). The data was processed using Nutri Survey software. As for eating behaviour assessed by means of observations and interviews. While, the categories of food and nutrition knowledge were assessed based on the number of questions that were answered correctly by mothers of the subjects, according to their categories.

Statistical Analysis

The anthropometric data, in terms of height for age of the subject child aged 12-24 months was calculated by the WHO Anthro Survei Analyser Software and presented by Z- score value of height for age (20). Meanwhile, the children food consumption data collected after cookies intervention, was calculated by software application developed by Nutri Survey Indonesian Version based on a comprehensive database of Indonesian food items (21). The results of the food consumption data analysis were compared to the nutritional adequacy standards for children aged 12-24 years, in accordance with Indonesian Health Ministry Regulation No.28 of 2019, about the recommended nutritional sufficiency figures for the indonesian population.

RESULTS

Nutrient Content of Bean Cookies Complementary Food

Bean cookies complementary food made with mung bean (*Vigna radiata*) and cowpea (*Vigna unguiculata* (L.) Walph) flour, egg, and wheat flour (Figure 1), supply macro and micronutrients. Based on the results of the calculation referring to the Indonesian food composition table 2017, the nutritional composition of the bean cookies complementary food is presented in Table I. Bean cookies complementary food consumed by subjects in quantities of 100 grams during 30 days supply macro nutrients (above 10% of the recommended intake for children aged 1-3 years. These bean cookies supply the amounts of vegetable protein, namely 13.5% of the RDA. Protein is extremely important for growth as it is required for the formation of basic muscle tissue which is vital for height growth. These macro nutrients supply the branched-chain amino acids (BCAA), namely isoleucine, leucine, and valin, that needed for tissue growth and stimulate growth hormones, thereby directly determining linear height growth (22). The BCAA content in the mungbean and cowpea flour used in the experimental bean cookies is high, by 35-73 mg/g protein (Table II).

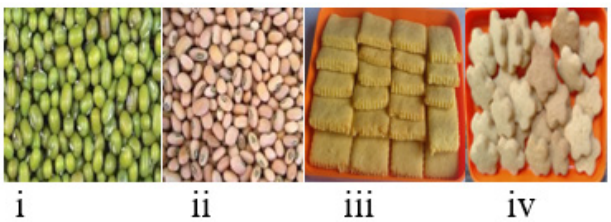


Figure 1: Mung bean (i), Cowpea (ii), and the Control Bean Cookies (iii) and Bean cookies complementary foods (iv)

Table I. Nutritional composition of the complementary bean cookies

Nutrient	RDA	Control Cookies	%RDA	Bean Cookies	%RDA	Cookies** Standard
Macro nutrient:						
Water (%)	-	4.4	-	3.6	-	4 (max)
Calory (Kcal)	1350	120	8.9	132	9.8	400
Carbohydrate (g)	215	15.5	7.2	21.7	10.1	30 (min)
Protein (g)	20	1.9	9.5	2.7	13.5	8-22
Fat (g)	45	5.6	12.4	5.7	12.7	6-15
Micro nutrient:						
Vitamin D (µg)	15	0	-	0	-	3-10
Vitamin C (mg)	40	0	-	0	-	27 (min)
Tiamin (mg)	0.5	0.05	10	0.06	12	0.4 (min)
Riboflavin (mg)	0.5	0.07	14	0.1	20	0.4 (min)
Sodium (Na, mg)	800	4.7	0.59	5.6	0.73	200 (max)
Calcium (Ca, mg)	650	4.2	0.65	8.6	1.32	200 (min)
Zinc (Zn, mg)	3.0	0.1	3.3	0.4	13.3	2-3.75
Iron (Fe, mg)	7.0	0.3	4.3	0.5	7.1	5 (min)
Fibre (g)	19	0.4	2.1	1.8	9.5	5 (max)

* RDA = Recommended daily allowance for Indonesian children under five years, Indonesian Health Ministry Regulation No. 28 of 2019

** Indonesian National Standard - SNI 01-7111.2-2005 of cookies-complementary food

Complementary-bean cookies provide plant-based protein from mung beans and cowpeas, supplementing the animal protein derived from chicken meat and eggs consumed since three months prior to the village food assistance programme for households with young children. The amino acid composition of mung bean and cowpea protein compared to chicken meat is presented in Table II. Although plant-based protein is not as complete as animal protein, it supplies the branched amino acids isolucine (Ile), leucine (Leu), and valin (Val), which stimulate the release of growth hormone (GH) that plays a role in tissue growth, including muscles and bones, thereby linearly affecting height. Additionally, the essential amino acid phenylalanine (Phe) in plant-based proteins plays a crucial role in the synthesis of neurotransmitters that support cognitive functions, including memory and concentration, thereby supporting overall growth.

Adequate and complete protein intake from a combination of plant and animal proteins is highly recommended to support optimal growth and development, thereby preventing stunting. Animal protein intake has been adequately met through the food programme in the form of meat and eggs since three months ago, supplying the amino acids lysine and methionine, which aid in the formation of muscles and body tissues, as well as tryptophan, which stimulates the release of growth hormones. Similarly, plant-based protein intake from bean cookie interventions supplies the amino acids arginine (Arg), lysine (Lys), and methionine (Met), which also stimulate the release of growth hormone (GH), which plays a role in height growth.

The complementary bean cookies also contributed micronutrients – vitamins and minerals (Table I). The bean cookies supplied vitamins, namely thiamine at 12% and riboflavin at 20% of the recommended adequate intake. The supply of vitamin B from a single dose in this intervention increased vitamin B fulfilment, which also

Table II. Amino acid composition of the mung bean and cowpea compared to animal protein sources (chicken) and the complementary food

Items	Mungbean* (mg/g protein)	Cowpea* (mg/g protein)	Chicken Meat* (mg/g protein)	FAO/WHO 2013 EAA req. children aged 1-3 years (mg/g protein)	Average of Bean %
Protein (g/100 g edible portion)	23.9	19.6	18.2	-	-
Protein Recommended (%)	120	98	91	-	-
a. Essential Amino Acid (EAA):					
Isoleucine (Ile)	38.48±0.18	35.64±0.13	38.5	32	116
Leucine (Leu)	73.45±0.34	66.95±0.27	77.6	66	106
Methionine (Met)	**10.87±0.03**	**10.47±0.04**	**27.4**	**27**	**81**
Cysteine (Cys)	**0.88±0.01**	**1.10±0.01**	**8.5**	**-**	**-**
Lysine (Lys)	73.14±0.33	71.33±0.25	76.6	57	126
Phenylalanine (Phe)	**67.62±0.33**	**46.77±0.17**	**39.6**	**52**	**161**
Tyrosine (Tyr)	**30.05±0.13**	**23.51±0.08**	**36.1**	**-**	**-**
Tryptophan (Trp)	5.02±0.12	6.08±0.01	9.5	8.5	65
Threonine (Thr)	26.52±0.13	27.25±0.05	47.1	31	87
Valine (Val)	32.33±0.13	28.73±0.10	39.8	43	71
Histidine (His)	27.02±0.21	23.47±0.07	-	20	126
b. Non Essential Amino Acid (N-EAA):					
Arginine (Arg)	**57.19±0.22**	**47.24±0.14**	**-**	**-**	**-**
Aspartate (Asp)	92.67±0.29	75.07±0.29	-	-	-
Glutamate (Glu)	159.20±0.85	136.38±0.46	-	-	-
Glycine (Gly)	30.73±0.08	26.63±0.06	-	-	-

* Determined using Waters Acquity UPLC H Class and H Class Bio Amino Acid Analysis System Guide year 2012

** Calculations based on the Indonesian amino acid composition table

came from other main food sources. Vitamin B supports children's growth because it plays a role in energy metabolism, oxygen distribution, nerve development for sensory and motor skills, and maintaining children's endurance.

In addition, the bean cookies contains macro mineral sodium (Na) and calcium (Ca), although in small quantities (below 2%RDA), they support children's growth because of their's role in bone and tooth growth, as well as tissue growth (Ca, P, Mg), muscle and nerve function (Na and Mg). The bean cookies also supply micro minerals in low quantity, although iron (Fe) in a considerable amount (7%RDA), and zinc (Zn) in quite substantial amount (13.3% RDA), they support children's growth. Iron minerals play a role in muscle and tissue growth, and Zn plays a role in bone mineralisation and accelerates bone elongation and cell division and protein synthesis.

Physical Growth of Child Aged 12-24 Months

Physical growth of the subjects as a manifestation of long-term food consumption was measured by height-for-age parameters that is the best overall indicator of growth. According to WHO standards, height-for-age values with Zscore values below -2SD to -3SD are categorized as stunted. Stunting or growth failure is caused by a lack of nutrient intake, which has short-term consequences for impaired brain development, metabolism, and impaired physical growth of children. Meanwhile, the long-term impact results in low thinking ability, low productivity and quality of human resources.

Before and after consuming bean cookies complementary food for 30 days, the height for age data was collected, evaluated and analyzed as Z-score value. Data on Z-score value by height for age of the subject children at before and after bean cookies complementary food intervention is presented in Table III.

In the group of stunted children, prior to the bean cookies complementary food intervention, all stunted children (S1-St to S9-St) were in a stunted condition, with Z-scores below – 2.04SD up to – 4.4SD. After the bean cookie intervention, the nutritional status of 8 subjects (44 %) improved to normal with Z- scores ranging from -1.09SD to -1.9SD. Meanwhile, before the control cookie complementary food intervention, all stunted children (S10-St to S18-St) were in a stunted condition (Z-score below -2.20SD up to -3.77SD). After the control cookie complementary food intervention, the nutritional status of the stunted subjects (89%) remained stunted (Z-score below -2.14SD up to -3.44SD), but there were 2 subjects (11%) (S17-St and S18-St) in a normal condition (Z-score below -1.42SD and -1.44SD).

In the group non-stunted children (22 children), prior to the bean cookies complementary food intervention, all normal subjects (S1-N to S10-N) were in a normal condition (Z-score below -0.61SD up to 2.0SD). Similarly, after the bean cookies complementary food intervention, all subjects were in a normal condition (Z-score below -0.64SD up to 2.7SD). Meanwhile, before the control cookie complementary food intervention, all normal (S11-N to S22-N) subjects remained in a normal condition, with Z-scores below -0.68SD up to Z-score=0.98SD. Similarly, after the intervention, all subjects remained in a normal condition, with Z-scores

Table III. Z-score value by height-for-age of the subject children before and after complementary cookies intervention

Subject	Cookies	Before Intervention Z-score	Before Intervention Nutritional Status	After Intervention Z-score	After Intervention Nutritional Status
S1-St	Bean	-2.45	St	-1.21	N
S2-St	Bean	-2.50	St	-1.90	N
S3-St	Bean	-2.80	St	-1.05	N
S4-St	Bean	-2.04	St	-1.12	N
S5-St	Bean	-3.33	VSt	-3.27	VSt
S6-St	Bean	-2.34	St	-2.26	St
S7-St	Bean	-4.51	VSt	-2.61	St
S8-St	Bean	-2.60	St	-1.90	N
S9-St	Bean	-2.44	St	-1.85	N
S10-St	Control	-2.41	St	-2.22	St
S11-St	Control	-2.74	St	-2.53	St
S12-St	Control	-2.28	St	-2.20	St
S13-St	Control	-2.33	St	-2.14	St
S14-St	Control	-2.83	St	-2.44	St
S15-St	Control	-3.77	VSt	-2.64	St
S16-St	Control	-2.20	St	-3.44	VSt
S17-St	Control	-2.50	St	-1.44	N
S18-St	Control	-2.93	St	-1.42	N
S1-N	Bean	0.20	N	0.35	N
S2-N	Bean	-1.90	N	-0.64	N
S3-N	Bean	-1.96	N	-1.88	N
S4-N	Bean	0.09	N	0.11	N
S5-N	Bean	-1.92	N	-1.54	N
S6-N	Bean	-0.78	N	0.34	N
S7-N	Bean	-0.70	N	0.51	N
S8-N	Bean	0.20	N	2.70	N
S9-N	Bean	-0.74	N	-1.74	N
S10-N	Bean	-0.61	N	0.31	N
S11-N	Control	-0.68	N	0.20	N
S12-N	Control	-0.93	N	-0.57	N
S13-N	Control	0.98	N	0.97	N
S14-N	Control	-1.72	N	-0.82	N
S15-N	Control	-0.78	N	-0.61	N
S16-N	Control	-0.95	N	-0.75	N
S17-N	Control	-1.93	N	-2.10	N
S18-N	Control	-1.82	N	-1.47	N
S19-N	Control	-1.85	N	-1.27	N
S20-N	Control	-1.98	N	1.29	N
S21-N	Control	-1.63	N	0.28	N
S22-N	Control	-1.58	N	-1.10	N

ranging from -0.57 to Z-score= 1.29SD.

In average, after the bean cookies complementary food intervention, in the non-stunted children group, the children's height increased from 80.4 cm to 82.9 cm (an increase of 2.5 cm), while in the stunted children group, it increased from 75.8 cm to 77.9 cm (an increase of 2.1 cm). The data shows that the intervention did not cause any significant difference in height gain between the non-stunted and stunted subject groups.

The children's Dietary Intake

The food consumed daily supplies nutrients to fulfill energy needs, maintenance functions, and growth. Children aged 12-24 months are in a period of rapid growth so that the fulfillment of energy and nutrients must be fulfilled in order to avoid growth disorders. Figure 2 shows the nutrient intake from the subject's food consumption data collected shows that the energy supplied from daily consumption by both non-stunted and stunted subjects before and after consumption of bean cookies complementary food did not meet the energy adequacy or below the energy recommended, namely 66.25% and 64.25%, respectively. In contrast, the protein intake of both stunted and non-stunted subject at before and after the intervention was high or above the protein adequacy recommended, namely 134.5% and 143.3%, respectively. However, according to the Indonesian Standard for complementary food, the cookies complementary food should provide in amount of 6 g protein per meal, or 12 g from two meals a day, or meet the protein requirement 40 %. The rest 60% of the protein requirement should come from three main meals of other complementary food in a day.

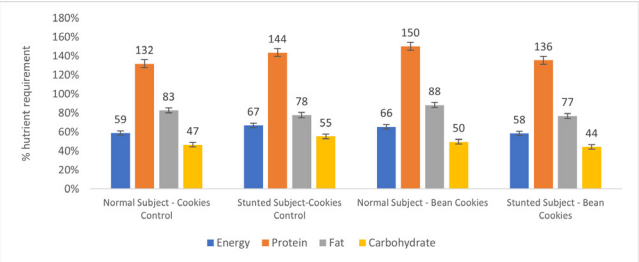


Figure 2: Macronutrient intake of normal and stunted subject from daily consumption at before and after intervention

Data on subject children's food consumption displayed in Figure 3 showed that normal and stunted subjects groups who consumed cookies control, the intake of micro nutrient-vitamine (vitamine A, B1, B2, C, E, and folic acid) were below recommended. Meanwhile, the data in Figure 4 showed that intake of micro-mineral zinc (Zn) above the recommended amount, but micro-mineral Fe intake was very low. Except for magnesium (Mg), the intake of other macro minerals, namely sodium (Na), calcium (Ca), phosphorus (P), and potassium (K), below the mineral recommended amount daily.

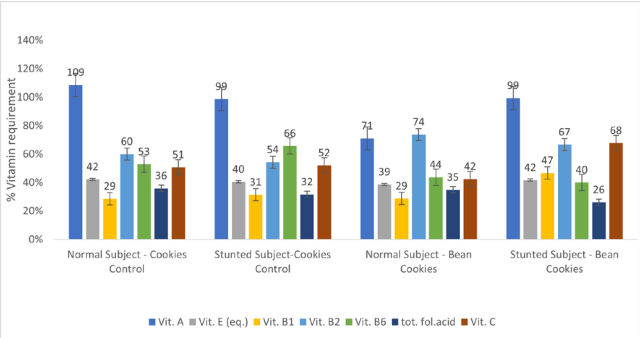
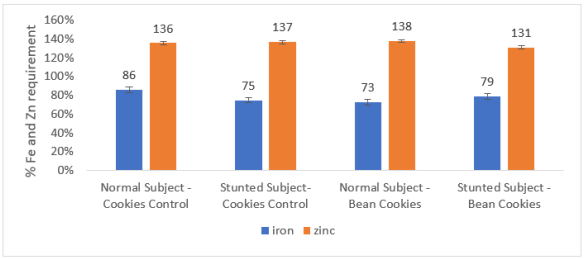


Figure 3: Micronutrient-vitamin intake from normal and stunted subject's daily consumption at before and after intervention



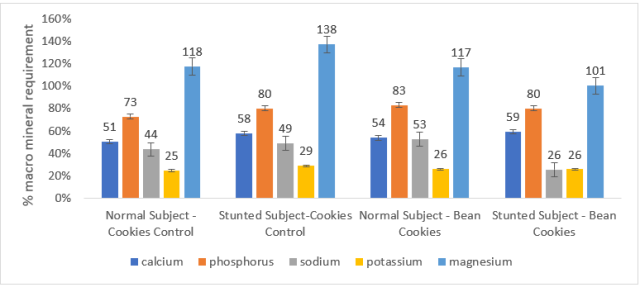


Figure 4: Micronutrient (a) trace minerals (b) macro-mineral intake from normal and stunted subject's daily consumption at before and after intervention

Food Consumption Pattern

Food consumption pattern describes the number of different types of food from each food group consumed, and the frequency of consumption per day, week and month. The consumption of staple food is still rice, which is consumed three times a day, but in small quantities. Regarding food sources of animal protein such as chicken and eggs consumed once a day, enough to provide a high protein intake. In addition to eggs, the subject obtained protein intake from the frequent consumption of tempeh three times a day. Meanwhile, regarding vegetables, the subjects consumed eggplant every day. The data collected show that kinds from every food group consumed was not diverse.

Eating Behaviour

Eating behaviour is shaped by food and nutrition knowledge and eating habits. Food and nutrition knowledge as well as eating habits of the subject's mothers affects food consumption pattern, and hence

the subject's growth. The food and nutrition knowledge of most of the subject's mothers of non-stunted and stunted subjects were categorized as moderate with a value of 11.1 and 10.95, respectively. Likewise, the results of the evaluation of the eating habit of the subject of non-stunted and stunted were categorized as moderate (score 25-48), with a score of 43.25 and 42.95.

DISCUSSION

The daily macro nutrient requirements recommended by the Indonesian Ministry of Health for children aged 1-3 years that come from their complementary food daily are 10.75 g of carbohydrates, 1.5 g of protein, 2.25 g of fat, and 0.95 g of dietary fibre per kilogram of body weight. The bean cookies complementary food given to the subjects in only one time as snack supply by 10% carbohydrates, 13.5% protein, 12.7% fat, and 9.5% dietary fiber of its daily recommended. Importantly, in terms of protein, the intake of plant-based protein from mungbean and cowpea in the bean cookies complementary intervention provides the amino acids isoleucine (Ile), leucine (Leu), and valin (Val), which stimulate the release of growth hormones that play a role in children's height growth.

In addition, the bean cookies also supply important micronutrient, namely thiamine (vitamin B1) and riboflavin (vitamin B2). Thiamine plays a role in energy metabolism, brain and nerve development, and red blood cell formation. Riboflavin helps the body break down carbohydrates, proteins and fats to produce energy, and it allows oxygen to be used by the body. It also used for the development and function of the skin, lining of the digestive tract, blood cells and other vital organs (23). Adequate of these vitamin B intake helps children obtain energy so they can be active and supports their motor and cognitive development. Research shows that children who are not given vitamins are 5.1 times more likely to suffer from malnutrition than children who are given vitamins (24).

Macro minerals, namely calcium (Ca) and sodium (Na), zincum (Zn) biologically plays an important role in the growth process and the function of various enzyme. Mineral Ca and zinc play an important role in the height growth of toddlers subject. Calcium functions in the formation of bone structure and strength, thereby directly supporting toddler's height increase. While, zinc plays a role in cell production and tissue regeneration, therefore aids in the growth, thereby supporting linear growth, such as height and body length. Together, these Ca and Zn minerals, and protein, support the formation of muscles and body tissue as a whole, ensuring that children do not suffer from stunting.

The increase in the subject's height is very small and not signifant (sig. 0.77>P 0.05) because the excess protein intake is used to make up for the lack of carbohydrate intake. Complementary food intervention to the children should be high in protein and carbohydrate as well to ensure adequate protein intake for growth. In addition, the under child growth or stunting is multi-factorial in nature (25). The very low carbohydrate intake condition is not good because the excess protein (30-40%) is used to cover the lack of energy from carbohydrates. The high protein intake is due to the frequent consumption of protein source foods such as eggs and tempeh. Protein (26), which is supposed to functions for growth, is used to cover the lack of energy from carbohydrate. Therefore, the child's growth is disrupted, the increase in height is very slow so that the child's height is not in accordance with his age or low height for his age. Another contributing factor is that the intervention period was too short—only 30 days. This is not sufficient to elicit a significant increase in the children's height.

The micronutrient intake of the subject's daily consumption also does not meet the needs of stunted subjects children. In fact, In fact, micronutrients such as vitamins support the process of child growth through their important functions as coenzymes, catalysts, and genetic regulators, collagen synthesis (skin, tendons), cell division (B complex), bone mineralization (D), and tissue regeneration (C, E, B complex), ensuring optimal repair and formation of new tissue throughout the body (22).

Micro mineral play a role in cell, teeth and bone growth. in the digestive system, metabolism, immunity formation, blood pressure, body fluids, and nerve control. Iron (Fe) are required for the formation of red blood cells and hemoglobin protein, in metabolic processes, and normal function of body cells. Zincum (Zn) plays a role in the digestive system, absorption of nutrients, and maintaining healthy body tissues. Together with vitamin C, Zn is responsible for brain development and maintaining immunity. Iodine (J) is needed for the formation of thyroid hormones and intellectual development (22).

Macro mineral magnesium (Mg) plays a role in helping to activate vitamin D in regulating calcium (Ca) and phosphate needs, in order to support bone growth and formation. Mineral Ca along with vitamin D plays a role in the formation of bones and teeth. Sodium (Na) and potassium (K) are electrolytes that play a role in maintaining fluid and acid-base balance, and in cell membrane potential transport in various physiological functions in the body (22).

Fat soluble vitamin, namely vitamn A, D. E. and K play an important role in the growth and development of children. Vitamine A in charge of maintaining eye health, plays a role in, hair and skin growth, and the formation of a good immune response. Vitamin E maintains skin health, and vitamin D in maintaining

bone health, while vitamin K plays a role in preventing blood disorders (22).

Water soluble vitamin such as vitamin B group (B-1 (thiamine), B-2 (Riboflavin), B-3 (niacin), B-5, B-6 (pyridoxine), B-7, B-9 (folic acid), and B-12 (cobalamin) play an important role in metabolic processes, energy production, blood circulation, and the nervous system. Vitamin B deficiency, especially vitamin B-12, results in weak cognitive development and developmental delays in children. Vitamin C helps produce collagen that can prevent wrinkles, maintain skin weakness, faster wound healing process, and helps iron absorption in the intestines (23).

The multi-factorial nature of stunting among children demands handling with a multi-sectoral approach to address the underlying factors of stunting (27). In addition to dietary intake imbalance, other underlying factors such as food consumption patterns, eating behaviour, food and nutrition knowledge also affect stunting. As in (5) aside dietary intake, other multi causative factors that affects stunting are associated with parents'occupation, household wealth index, low parental education, poor wealth index, environmental and sanitation issues. The same thing was also conveyed by (4) that aside dietary intake other associated factors of malnutrition among children are parental and environmental factors.

Dietary diversity takes an important role in increasing the nutrition fulfilment of young children aged 6–59 months for their optimal growth. Research done by (28) revealed that poor dietary diversity was significantly related with stunting. The risk of stunting in children can be reduced by providing a variety of foods in their diets, which includes at least four food groups a day. There is a need to increase awareness among the mothers about appropriate nutrition through dietary education, as mention in (29).

The study (30) revealed maternal factors determined to the length-for-age status of children 0-23 months. The moderate scores for food and nutrition knowledge can be improved through the food and nutrition training program. The training can help the mothers to be able and willing to prepare complementary foods so that the energy and nutrient needs of the subjects are met. In synergy with other stunting prevention programs, empowerment programs for both mothers and nutrition cadres can rapidly reduce the prevalence of stunting in the village. Eating habits assess the likes and dislikes of staple foods. side dishes. fish, eggs, milk, vegetables and fruits, menu variations, how to prepare and consume their food.

In order for complementary feeding to have an impact on reducing stunting rates quickly, it should be given in a variety of forms of main meal and snack, more than one meal. In relation to the energy adequacy of 12-24 months old children, it should be ensured first, in order to guarantee that protein intake is mainly for growth purposes. The variety of foods used in complementary feeding is important to ensure that the intake of micronutrients that play a critical role in a child's growth is met.

CONCLUSION

A total of 44% of stunted subjects children aged 12-24 months old (Zscore - 2SD up to -3SD) who consumed bean cookies complementary food for 30 days, improved their physical growth (height-for-age index) from stunted to non-stunted condition. However, the intervention of bean cookies complementary food at one time schedule for 30 days was not statistically significant in improving the physical growth of the 12-24 months old stunted children whose the very low carbohydrate intake (64.25 % RDA), low macro and micro mineral, and low vitamin intake, even the very high protein intake (134.5% RDA).

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