Green Beans *(Vigna Radiata L.):* Nutrients and Processed Products as Additional Food to Overcome the Malnutrition

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Abstract. The prevalence of malnutrition in Indonesia is high, which is caused by a lack of nutritional intake. Green beans (*Vigna Radiata L.*) contain various nutrients and processed products can be used as additional food to overcome this problem. This literature study aims to determine the nutritional composition and processed product of green bean. This research method uses a literature review study sourced from Pubmed, ScienceDirect, Google Scholar and Semantic Scholar and obtained 21 articles. Results: Green beans contain carbohydrates, protein, fat, vitamin and mineral. Green beans can be processed into various food products, one of which is cookies. Conclusion: Processed green bean products contain variety of nutrients and can be used as an alternative additional food to overcome the problem of malnutrition.

1. Introduction

Factors that influence malnutrition include low energy consumption and insufficient protein consumption. Low energy consumption causes the body to respond by increasing the use of energy reserves such as muscle and fat which causes a decrease in growth leading to a thinner individual compared to adequate energy intake. Protein deficiency will have an impact on disrupting growth, development and productivity. The function of protein, which is supposed to be a growth and building material, will be hampered over time, resulting in malnutrition, even if it is too long, it will result in malnutrition. Mung bean (Vigna radiata L.) is a pulse crop widely cultivated and consumed in Asia, India and the warmer part of Europe and America, with a short growth cycle around 2–3 months. [1] Mung bean is a rich source of proteins, essential amino acids, complex carbohydrates, vitamins and minerals and it is easy

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to be digested.[2] Carbohydrates are the largest component (more than 55%) of mung bean seeds, which consist of starch, sugar, and fiber. The starch in mung beans has a very high digestibility (99.8%), which makes it a nice food ingredient for infants and toddlers whose digestive systems are not as perfect as adults. The second largest content is a protein (20-25%) with 77% digestibility. Mung beans contain 22.2 grams of protein, 345 Kcal of energy, 1.2 grams of fat, 62.9 grams of carbohydrates and various vitamins and minerals.[1] In addition, consuming mung bean has many benefits for health compared to other types of nuts. For example, mung bean has a very low trypsin inhibitor compared to others. Mung bean is also an important source of minerals, including calcium and phosphorus and amino acids such as leucine, arginine, isoleucine, valine, and lysine. This shows that green beans have good potential to be used as a basic ingredient or additional ingredient for making food that is used to improve malnutrition status. [3] Providing additional food (PMT) made from local food is one strategy for handling nutritional problems in toddlers and pregnant women. It is hoped that PMT activities made from local food can encourage food independence and family nutrition in a sustainable manner. Indonesia is the third largest country in the world in terms of biodiversity. There are at least 77 types of carbohydrate sources, 30 types of fish, 6 types of meat, 4 types of poultry; 4 types of eggs, 26 types of nuts, 389 types of fruit, 228 types of vegetables, and 110 types of spices and seasonings (Food Security Agency, 2020 and Food Ingredients Balance, 2022). [4] This shows that the potential for using local food is wide open, including for providing family food, including improving the nutrition of pregnant women and toddlers. One of the efforts made to improve the nutritional status of toddlers is by supplementary feeding (PMT). PMT can be processed using food-based ingredients local food at affordable prices. The local food ingredient that is often used as a basic ingredient for making PMT is green beans. The aim of this research (study) is to determine the nutritional composition and processed green beans which can be used as an alternative additional food to overcome the problem of malnutrition.

2 Methods

The research method used is literature study. An electronic search of databases was run on Pubmed, ScienceDirect, Semantic Scholar, and Google Scholar. The article search was guided by the keywords "green bean", "nutritional composition", "undernutrition", and "additional food products". These keywords are combined to achieve search results more specific. Inclusion criteria for selecting articles were pre-intervention research experimental or quasi-experimental; Full text pdf articles are available and obtainable online free; Indonesian or English.

3 Result and Discussion

3.1 Nutritional value of the mungbean seeds

Table 1. Article study results regarding the nutritional composition of green beans

Title	Author/ Year	Nutritional Composition				
		Protein (%)	Carbohydrate (%)	Fat(g)	Vitamin (mg)	Mineral (mg)
Proximate composition and estimation of mineral content from different mungbean (*Vigna radiata* (L).Wliczek) genotypes	SC Nagrale et al., 2018	15.8 to 24.59	11.97 to 41.88	-	-	Calcium=120.20 Iron=9.58 Zinc=1.98 Phosphorus=104.00 Potassium=1,120.00 Magnesium=131.60
Indian food composition tables	Longvah et al., 2017	22.53 ± 0.43	Total=46.13 ± 0.064 Glucose=0.14 ± 0.02 Fructose=0.10 ± 0.02 Sucrose=0.30 ± 0.11 Raffinose=0.11 ± 0.053 Stachyose=0.30 ± 0.076 Verbascose=1.57 ± 0.308 Ajugose=0.03 ± 0.018 Starch=39.21 ± 5.42	1.14 ± 0.17	B1=0.45 ± 0.27 B2=0.27 ± 0.011 B3=2.6 ± 0.13 B5=2.02 ± 0.24 B6=0.35 ± 0.034 B7=1.35 ± 0.16 B9=145 ± 5.4	Sodium= 12.48 ± 0.07 Potassium = 1,177 ± 74.0.3 Calcium= 92.43 ± 10.68 Phosphorus= 353 ± 33.6 Magnesium= 198 ± 39.2 Iron= 4.89 ± 0.46 Manganese = 1.05 ± 0.08 Zinc= 2.67 ± 0.13
Nutritional composition, enzyme activities	Pham Van	26.4 ± 0.1g	70.9 ± 0.1a	1.6 ± 0.1a	-	-

and bioactive compounds of mung bean (Vigna radiata L.) germinated under dark and light conditions	Hung et al., 2020					
Influence of germination on physicochemical, thermo-pasting, and antioxidant properties of moong grain (Vigna radiata)	Vijay Singh Sharanagat, 2019	27.94 ± 1.87	66.33 ± 1.86	2.31 ± 0.00	-	-
Extraction and characterization of low molecular weight bioactive carbohydrates from mung bean (Vigna radiata)	Cipriano Carrero-Carralero et al., 2018		Glucose= 0.3, Galactose=0.3 Fructose =0.10, Maltose= 0.11, Sucrose= 0.27, Raffinose =0.07, Stachyose=0.85, Verbascose=5.48, Ajugose =0.11.	-	-	-
Assessment of biochemical composition and nutritional potential of three varieties of *Vigna radiata* (L.) Wilezek	Tresina, P. S., et al.,2014	25.51–26.82	62.04 – 63.20	-	-	Sodium= 107.98 ± 0.53 Potassium = 1627.60 ± 1.16 Calcium= 405 ± 23.68 Phosphorus= 520.83 ± 0.00 Magnesium= 190.67 ± 14.15 Iron= 9.77 ± 0.07 Manganese = 5.97 ± 0.04

						Zinc= 2.71 ± 0.03 Copper= 1.88 ± 0.02
Physico-chemical Properties of Extracted Mung Bean Protein Concentrate	Zar Zar Oo et al., 2017	51.37 ±0.02	37.63±0.01	0.3±0.02	-	-
Nutritional Assessment and Antioxidant Activities of Different Varieties of *Vigna radiata*	Riaz Ullah et al.,2014	13.20-17.05	-	1.15-2.26	-	-
Nutrient composition of selected newly bred and established mung bean varieties.	Dahiya et al. (2013)	-	-	-	-	Sodium=9.4 ± 0.3 Potassium =363 ± 1.5 Calcium= 103 ± 1.6 Magnesium=157 ± 2.4 Iron= 3.9 ± 0.06 Zinc=1.2 ± 0.03
Dietary fibre and fermentability characteristics of root crops and legumes	Mallillin, A. C. et. al., 2008	14.6	64.1	5.8	-	-
Evaluation of Physicochemical, Functional and Pasting Properties of Soybean, Mung Bean and Red Kidney Bean Flour as Ingredient in Biscuit.	L Ratnawati et al., 2019	24.99a	65.41b	1.31	-	-

The proximate composition of green bean reported by different workers has given in Table 1. The protein content varied from 13.20% to 51.37 %. Green bean comprises monosaccharides like glucose, galactose, fructose, xylose, arabinose, disaccharides like

maltose, melibiose, sucrose, oligosaccharides like raffinose, stachyose, verbascose, ajugose, and polysaccharides like cellulose and starch. The total carbohydrate content of green bean varied from 11.97 % to 70.9 %. Starch is the main carbohydrate constituent present in green bean, content 39.21%. The lowest and highest fat content reported were 1.14 % and 5.8%, respectively. The composition of water-soluble vitamins in green gram reported by different workers has depicted in Table 1. Green bean contains a considerable amount of folic acid/B9 (145 mg/100 g), which is a crucial factor by forming folate coenzyme for several enzymes involved in amino acid and nucleotide metabolism. Niacin (Vitamin B3) content in green bean is 2.6 mg/100 g. Pantothenic acid (Vitamin B5) is described as a growth factor as well as antidermatitis or antigray factor, and its content in green bean is 2.02 mg/100 g. Thiamine(Vitamin B1) is an important vitamin involved in glucose metabolism as it forms the active form of Thiamine pyrophosphate (TPP), which is an essential coenzyme that releases the energy from carbohydrates and its content in green bean is 0.45 mg/100g. Riboflavin(Vitamin B2) content in green gram reported is 0.27 mg/g.

Green bean is an excellent source of minerals. Green bean contains macro-minerals like calcium, magnesium, phosphorus, potassium, sodium, and micro-minerals like manganese, iron, copper, zinc. Potassium is involved in muscle contraction, fluid balance, and nerve transmissions. [16] Green bean contains an appreciable amount of potassium, ranges from 363 to 1627 mg. Sodium is a crucial micronutrient involved in heart functioning, electrolyte balance, nerve transmission, etc.[16], and its content ranges from 9.4 to 107.98 mg. Calcium needs for the proper functioning of the immune system, blood pressure control, bone health, etc. [16], and its content ranges from 92.43 to 405 mg. Iron plays an important role in the process of hemoglobin in red blood cells, energy metabolism, etc. [16] and the iron content of green bean ranges from 3.9 to 9.77 mg Phosphorus involved in energy production, protein formation, nerve signaling, etc. [16], and the content of phosphorus ranges from 104 to 520.8 mg, Magnesium is involved in the regulation of the immune system, muscle contraction, protein formation, etc. [16], and it is an essential mineral that is involved in several biochemical reactions; its content in green bean ranges from 131.60 to 198 mg. Manganese is involved in regular brain functioning as well, as it helps to impede osteoporosis [16], and its content ranges from 1.05 to 5.97 mg. Zinc is required for the functioning of the immune system, fetal development, production of sperm, etc. [16], and its content in green gram ranges from 1.2 to 2.71 mg. Copper involved in protein metabolism, and Molybdenum serves in cell protection [16]; its content in green gram ranges is 1.88 ± 0.02 mg.

Table 2. Article study results regarding the green bean processed product as an additional food

Research Title/Author's Name	Processed Product	Nutritional Component	Research Result
Germinated Legumes (Mung Bean and Cowpea) as Potential Commodities for Preparing Complementary Baby Foods. (A. Yasser et al., 2020)	Baby food formulation	Protein= 22.4%, Calcium=6,100 mg kg- 1, Phosphorus=5,133 mg kg - 1, Vitamin D=329 IU in 100, c= 55.5 mg kg - 1, Vitamin C as ascorbic acid=0.1 mg in 100 g, Vitamin B12=1.2 mg in 100 g	The finalized formula had higher protein, calcium, phosphorus and vitamin D but lower contents of iron), vitamin C as ascorbic acid and vitamin B12 than the control. A finalized formula with good appearance, flavor and taste as well as an overall general

			acceptance was obtained that can be used to fight mal-nutritional issues in certain developing countries.
Nutritional And Physicochemical Attributes of Cowpea and MungBean Based Weaning Foods. (Ahmad Bilal et al., 2017)	Weaning Foods	Crude protein in W3=17.01±0.19%, Potassium=387.51± 14.11a Calcium= 78.33±2.52 Sodium= 10.46±0.48b Iron= 5.31±0.81b Zinc= 2.17±0.14a	legumes based weaning food; W3 (10% cowpea+10% mungbean) demonstrated better nutritional and physicochemical attributes. Therefore, cowpea and mungbean should be incorporated in the development of weaning foods to overcome the prevailing malnutrition.
Composite Flour from Indonesian Local Food Resources to Develop Cereal/Tuber Nut/Bean-Based Ready-to-Use Supplementary Foods for Prevention and Rehabilitation of Moderate Acute Malnutrition in Children(Fetriyuna Fetriyuna et al., 2021)	RUSF Biscuit	Energy= 533.0 ± 0.1kcal Protein= 14.5 ± 0.10g Vitamin A= 564.7 ± 5.3µg Thiamine= 0.17 ± 0.17mg Riboflavin= 0.30 ± 0.01 mg Vitamin E= 6.2 ± 0.3 µg Calcium= 186.0 ± 0.1mg Phosphor= 357.6 ± 0.1 mg Magnesium= 69.8 ± 0.2mg Iron= 4.1 ± 0.0mg Zinc= 2.3 ± 0.1 mg	The RUSF biscuit showed promising results, presenting a high level of acceptance and a macronutrient composition that meets the standards for MAM children.
Formulation of nutrient enriched germinated wheat and mung-bean based weaning food compare to locally available similar products in Bangladesh	Weaning Food	Fat= 09.29% - 11.40% Carbohydrate= 52.80% and 61.20%, Protein= 20.33%–27.70% Energy=	The formulated weaning food had the desired characteristics of a weaning food; hence, it could decrease malnutrition

(Sharmin Jahan et al., 2021)		411.40 ± 1.51 kcal to 419.30 ± 1.12 kcal.	in children.
Valorization of Vigna radiata (l.) Wilczek. and Moringa oleifera to improve food recipes of 6-23-month-old children in northern Benin (Malikath Bankole et al., 2023)	*Abobo* of mung bean with moringa leaves (*AMM*) and *Zankpiti* of mung bean (*ZM*) (Complementary Foods)	Total energy= 203.86 ± 0.23 and 172.33 ± 8.97 kcal/100 g Total minerals=0.61 ± 0.01 0.70 ± 0.03 mg/100 g, Calcium=5.91 ± 0.20 and 9.83 ± 0.52 mg/100 g, Iron= 1.74 ± 0.26 and 0.52 ± 0.00 mg/100 g, Zinc=0.79 ± 0.02 and 0.18 ± 0.00, vitamin A=2211.95 ± 6.41 and 1768.5 ± 41.3 µg RE/100 g	The two recipes formulated have good estimated energy and nutritional densities as well as good energy and nutritional densities in vitamin A. Both recipes were well accepted by the children aged 6–23 months.
Production and Evaluation of Weaning Food Made from Mungbean (Vigna radiata (L.), Millet and Tigernut (Cyperus Esculentus) Flour Blends (Ibeogu, I.H, 2020)	Weaning Food	Moisture =8.03 to 10.04 %, Fat=5.41 to 11.15 %, Protein 17.00 to 20.52 %, Fibre=3.04 to 4.01 %, Ash=2.09 to 2.43 Carbohydrate=53.87 to 61.33 %	Sample with 50% mung bean, 20 % millet and 30 % tigernut flour recorded the highest value and was best accepted by the panelist. The result showed that weaning food of high nutritional value can be made from blends of mung bean, millet and tigernut Flour.
The Effectiveness of Counseling and Mung Bean (Vigna radiata L) Premix Cookies as Complementary Food to Prevent Stunting (Zuraidah Nasution et al., 2022)	Cookies	Protein=27.69%, Fat=56.59% Carbohydrates=24.04% Energy=56.89%	Premix cookies were 82.14% effective in increasing the children's body weight and achieving good nutritional status, therefore preventing the incidence of stunting
The Effect of Yoghurt and Green Bean Flour Substitution (Phaseolus radiatus) on Organoleptic Assessment, Protein	Silky Pudding	Protein=0,67 g calcium=130 mg.	The protein and calcium contents of P2 silky pudding were higher than the standard pudding. The

Content and Calcium Content in Silky Pudding as Alternative Food Supplement for Stunting Children. (Evi Kusumawati et al., 2022)			P2 silky pudding product could contribute 2.58% to the protein and 20% to the calcium requirements of children aged less than five years old.
Effect of Substitution of BreadFruit (Artocarpus Communis) and Green Beans (Vigna Radiata) on Acceptance and Flakes Protein Content (Alzha Adila Harisina et al., 2016)	Flakes	Protein=9,8 g	The results of the acceptability test that were most liked by the panelists were flakes F1 (breadfruit 50 g, peanuts green 50 g and tapioca flour 50 g) Flakes protein content (9.8g). F1 has met 20% of the AKG for school-aged children and meets supplementary feeding of schoolchild (PMT-AS) product requirements that is minimum 5 g/serving.
The Effect Of Granting Green Bean On Change Body Weight With Less Nutrition Status In The Working Area Of Tawangharjo Health Center Grobogan District. (Purhadi et al., 2019)	Green bean porridge	Vitamins B1 and B2, various essential amino acids, proteins, fiber, micronutrients, minerals and vitamin B6.	There is pre and post mean difference in weight body of respondents in the intervention group of 372.8 grams, thus there is significant difference between weight pre and post porridge administration mung beans.

Legumes and pulses have high nutritive values and functional properties that exert positive effects on health and nutrition.Yasser et al. 2020 study developed a novel complementary baby food using germinated mung bean and cowpea as sources of extra nutrients supplemented to the infants (aging 6-12 months). Cowpea (*Vigna unguiculata* L.) or black eye pea is a famous legume in Africa, South America, Asia and Europe. It's an important source of protein, vitamins and minerals such as calcium, potassium, phosphorus, zinc, and iron (Devi *et al*., 2015). It has been used for the preparation of different foods mostly in developing countries (Jayathilake *et al*., 2018). Mung bean (*Vigna radiata* L.) is a nutritious crop with grains having large amounts of protein, certain minerals and vitamins (Pataczek *et al*., 2018).

Germination resulted in some changes in the nutritional attributes of mung bean and cowpea. It did not, however, increase the crude fat contents and carbohydrate levels of the seeds. Results of the current study can be applied for designing such functional foods as baby

foods and to prevent malnutrition and cardiovascular diseases. This study revealed that enriched flours can be formulated by utilizing Germinated Mung Bean and Germinated Cowpea and skim milk. Complementary Baby Foods prepared in the current study possesses high contents of calcium, phosphorus, vitamin D, and protein. Using a CBF similar to what prepared here can be a good approach to fight malnutrition, particularly micronutrient deficiency diseases in children.

The research of Ahmad Bilal et al., 2017 was designed to formulate protein based weaning food using indigenous legumes *i.e.* cowpea seeds and mungbean. The formulated weaning foods were evaluated for proximate composition andphysicochemical properties including energy value, bulk density, reconstitution index and viscosity. Afterwards, three cowpea or/and mungbean based weaning food treatments were prepared; W_1 (20% cowpea), W_2 (20% mungbean) and W_3 (10% cowpea+10% mungbean) along with control; W_c (20% soybean). Results depicted significant decline of anti-nutritional factors in roasted legumes. Proximate analyses illustrated highest crude protein in W_3 (17.01±0.19%) and lowest in W_c (14.09±0.27%). In the current study, legumes based weaning food; W_3 (10% cowpea+10% mungbean) demonstrated better nutritional and physicochemical attributes. Therefore, cowpea and mungbean should be incorporated in the development of weaning foods to overcome the prevailing malnutrition.

The Sharmin Jahan's study aimed to develop a cheap and nutritious weaning food for the children of Bangladesh. For this purpose, three weaning formulations of Q1, Q2, and Q3 with different ratios of germinated wheat, germinated mung-bean, and soya-bean, and a constant amount of sweet potato, sugar, salt, and milk flavor were processed and evaluated. The prepared formulations were investigated for proximate composition and sensory evaluation and compared with six commercial weaning food products. The proximate composition values indicated that the fat content of formulated foods ranged between 09.29% and 11.40%. The carbohydrate content was ranged between 52.80% and 61.20%, which was low compared with commercial ones. The protein content of the formulated foods was 20.33%–27.70%, and that was approximately two times more than available commercial foods. The energy content was also more than locally available commercial weaning foods, which were 411.40 1.51 kcal to 419.30 1.12 kcal. Sample Q2 had an 8.4 acceptance score in sensory analysis of a 9-point hedonic scale scorecard, which made it more acceptable than the other two samples. The values of mineral elements (Na, K, Fe) were similar to all analyzed varieties of commercial weaning foods. This nutrient-enriched weaning food will easily be affordable for the people of developing countries like Bangladesh. The results showed that the formulated weaning food had the desired characteristics of a weaning food; hence, it could decrease malnutrition in children.

The concept of ready-to-use foods is involved in the prevention and rehabilitation of undernourished children in the community. Ready-to-use food (RUF) is defined as any food designed to be directly consumed from the packet without the need for cooking, dilution, or other preparation. RUF is, therefore, an umbrella term that includes ready-to-use therapeutic food (RUTF) and ready-to-use supplementary food (RUSF). RUTF and RUSF consist of energy-dense, micronutrient-enhanced pastes used in therapeutic feeding that contain all or a portionpart of the energy and nutrients necessary for rapid catch-up growth of those with severe acute malnutrition.

The study of Fetriyuna et al.,2021 aimed to develop a ready-to-use supplementary food (RUSF) from the composite flour of local food resources in Indonesia following the guidelines for the management of moderate acute malnourished children under five years of age. Limited reports have revealed the use of talas banten as a food ingredient. Thus, to optimize the nutritional profile of the developed RUSF, talas banten were mixed with groundnut/peanut (*Arachis hypogaea* L.) and mungbean (*Vigna radiata*) as protein and lipid sources, red rice (*Oryza longistaminata)* and maize (*Zea mays*) as carbohydrate sources, and

banana (*Nangka*) (*Musa textilia*) as a mineral source. RUSF biscuits are easy to prepare and favored by children under five years of age. The utilization of local foods as the source of ingredients follows the national and provincial government strategy to promote diversification in staple foods and the utilization of underutilized local foods. The composite flour mix of the local foods with wheat flour and milk powder resulted in biscuits high in vitamins A and E, as well as a moderate content of phosphor and magnesium for children under the age of five. In addition, the cereal/tuber nut/bean-based formulation depicted the presence of other micronutrients (e.g., thiamine, riboflavin, calcium, iron, and zinc), although at a low level. Based on the selection criteria weighting scores (nutritional composition of all RUSF biscuits, variety of local food resources used in the formulation, and acceptance of sensory testing) applied in the study, of 12 RUSF biscuits, five recipes were selected for further research in the field. After the pilot testing in Banten, two recipes, namely taro-peanut and taro peanut/mungbean-based, were chosen by the local women.

4 Conclusion

Nutritional problems in toddlers are still a priority to be addressed. Malnourished children are the main cause of child mortality, disease, and disability. One of the efforts made to improve the nutritional status of toddlers is by providing additional food (PMT). PMT can be processed using local food-based ingredients at affordable prices. One of the management of malnutrition is by giving supplements using food. Modifying and providing food and drinks using common food ingredients can increase energy and nutritional intake. One alternative for improve the malnutrition status in toddlers by increasing consume food sources of protein. High source protein ingredients of food includes legumes. One member of legumes known as Mung bean (*Vigna radiata*), also called "green gram" is rich in proteins, carbohydrate, dietary fiber, vitamins, and minerals and contains a low amount of fat. Green beans can be processed into basic ingredients or additional ingredients (mung bean flour) in making weaning or additional foods. Different researchers already developed functional foods to improve the nutritional status of toddlers such porridges, cookies, biscuits, pudding, etc.

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