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MORALITY BEFORE KNOWLEDGE

Biofortified biscuits with indigenous plants: An innovative approach to prevent stunting in early childhood

Yochidamai Akhsanitaqwim [1], Nor Isnaeni Dwi Arista [2*], Arifin Septiyanto [3]

[1] *Applied Natural Medicine, Graduate School of Pharma-Medical Sciences, Toyama University, Toyama City, Toyama Prefecture 930-0151, Japan;*

[2] *Agronomy and Horticulture, Faculty of Agriculture, IPB University, Bogor, West Java 16680, Indonesia;*

[3] *Science Education, Faculty of Science Education, Universitas Pendidikan Indonesia, Bandung, West Java 40154, Indonesia.*

*Correspondence: dewi.arista@apps.ipb.ac.id

ABSTRACT

Background: The increase in human living standards is in line with the demands of public health quality. Stunting in Indonesia has reached 37.2%, placing it in fifth place in the world and becoming one of the five major health problems being addressed by the government. This study aims to find the right biscuit formulation from cassava leaves and cowpea seeds as an effort to prevent stunting. **Methods**: Making biscuits needs to be preceded by making cassava leaf paste and winged bean seed flour and then determining various formulations. Variations in winged bean seed flour formulation: cassava leaf paste, namely F1 (20:10), F2 (25:15), F3 (30:10). Biscuits are made using the cream method, namely mixing sugar, skim milk, margarine and egg yolks until homogeneous then adding wheat flour, winged bean seed flour, cassava leaf paste, water and leavening agent. The dough is rolled, molded and baked at 170 ^{o}C for 30 minutes. **Findings:** after carrying out organoleptic tests to measure product quality and determine the best formulation, it turned out that F2 was the biscuit formulation that the panelists liked most. **Conclusion**: The development of stunting prevention biscuits from cassava leaves and winged bean seeds is a potential solution. The next step is to disseminate this product as part of a stunting prevention strategy in the community. **Novelty/Originality of this Study:** The use of local agricultural resources, specifically winged bean seeds and cassava leaves, to develop a nutritious and affordable biscuit aimed at preventing stunting is an innovative approach that not only addresses the chronic malnutrition problem but also supports local economies by utilizing underutilized crops.

KEYWORDS : children; folic acid; iron; pregnant women; stunting.

1.Introduction

In order to prepare Indonesia's golden generation, the quality of public health as an executor of development clearly needs to be improved. Unfortunately, the prevalence of stunting in Indonesia is ranked fifth in the world at 37.2%. Therefore, stunting is 1 of 5 health problems that the government is focusing on solving. This child growth and development disorder is characterized by the baby/toddler's body size being below standard and delays in cognitive and psychomotor abilities (Ministry of Health Indonesia, 2018). In Indonesia, stunting is particularly prevalent in rural areas where access to diverse and nutritious foods is limited. This highlights the importance of finding local solutions that can be easily integrated into existing diets. The selection of winged bean seeds and cassava

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leaves, which are locally abundant and rich in essential nutrients like iron and folic acid, provides a sustainable and culturally acceptable solution to improve nutritional intake.

Stunting is a problem of chronic malnutrition caused by a lack of nutritional intake over a long period of time, resulting in growth disorders in children, namely the child's height is lower or shorter (stunted) than the age standard (Ministry of Health, 2018). Stunting in children is the impact of nutritional deficiencies during pregnancy and the first 1000 days of life. Important micronutrients that have the potential to reduce the risk of stunting are iron and folic acid. The prevalence of deficiencies in pregnant and breastfeeding mothers even reached 33.4% for iron and 68.9% for folic acid.

Stunting (stunt) is a condition where a toddler has a length or height that is less than the WHO standard for child growth. Stunted toddlers are a chronic nutritional problem caused by many factors such as socio-economic conditions, maternal nutrition during pregnancy, pain in babies, and lack of nutritional intake for babies and children (Ministry of Health Indonesia, 2018). The problem of stunting can cause impaired development of cognitive and psychomotor functions, intellectual decline, increased risk of degenerative diseases and reduced productivity in the future.

The incidence of stunted (short) toddlers is a major nutritional problem facing Indonesia. In 2017, more than half of the world's stunted toddlers came from Asia (55%). Of the 83.6 million stunted children under five in Asia, Indonesia is ranked the fifth highest country in the world with a prevalence reaching 37.2% or the equivalent of 9 million children. The incidence of stunting itself is often found in children aged 12-36 months with a prevalence of 38.3–41.5%. In fact, this age is a golden period in determining the quality of human resources in terms of physical growth and intelligence, so this must be supported by good nutritional status (UNICEF, 2012).

Factors causing stunting in toddlers are low intake of protein, iron and folic acid. The presence of protein in food will prevent toddlers from experiencing growth failure and reduce the risk of stunting, especially after toddlers do not receive breast milk. The level of protein consumption is related to the toddler's hemoglobin level. Protein from food contains hemoglobin and myoglobin which are precursors of ferrous iron (Fe^{2+}). Thus, high protein intake can increase iron absorption (Andarina and Sumarmi, 2006).

Young children are particularly vulnerable to iron deficiency due to their increased need for iron during growth, insufficient intake or poor absorption of iron from food, and the impact of infections and parasites. Iron plays a crucial role in the body, particularly in hemoglobin production and oxygen transport. It contributes to hemoglobin formation in erythroblasts. A reduction in the iron supply to the bone marrow can lead to inadequate hemoglobin production, resulting in a decrease in the number of red blood cells. (Roziqo & Nuryanto, 2016).

Another nutrient that supports the growth and development of fetuses and toddlers is folic acid. Adequate folate intake during the periconceptional period, before and shortly after a woman becomes pregnant, helps protect against a number of birth defects including preventing neural tube defects, serious birth defects of the spinal cord (spina bifida) and defects of the brain (anencephaly). Supplementation with folic acid can also reduce the risk of congenital heart defects, limb defects and urinary tract anomalies (Astriningrum et al, 2017).

Improving maternal and child nutrition can be done by providing functional food intake rich in key nutrients to prevent stunting. Provitamin A-fortified foods are more preferred by preschool children compared to adults, likely because adults are more accustomed to traditional, non-fortified foods (Siwela et al., 2020). It is known that stunting is caused by infection factors and long-lasting deficiencies of macronutrients and micronutrients such as protein, iron and folic acid. With Indonesia's abundant agricultural resources, of course new food innovations can be created to reduce the incidence of stunting.

To fulfill the nutritional needs of toddlers, the government has introduced a supplementary food program (PMT), targeting underweight toddlers through both local and manufactured options, including toddler MT biscuits. Once a child's weight aligns with

WHO/Ministry of Health standards, PMT can be discontinued and replaced by a balanced family diet (Margawati & Astuti, 2018). However, this initiative has not yet been widely accessible across all regions. Additionally, pregnancy and breastfeeding supplements available in the market remain unaffordable for lower-income families. Consequently, researchers are exploring the development of affordable and nutritious food products to help reduce stunting rates. To support government efforts, these products are often designed in the form of biscuits.

Pregnant women and toddlers are a group prone to iron deficiency. Even though iron is an important component in the body, especially hemoglobin synthesis and oxygen transportation throughout the body. Meanwhile, folic acid plays an important role in the formation phase of the central nervous system. If the development of the main nervous system is disrupted, it will affect fetal development which includes hormonal system disorders, motor delays, a weak heart and weak intelligence (low cognitive ability). Scientifically, the need for iron during pregnancy is 15mg/day, while folic acid is 0.4-0.6mg/day. Facts show that winged bean seeds (Psophocarpus tetragonolobus) and cassava leaves (*Manihot esculenta*) are local agricultural resources that are rich in iron and folic acid. International efforts in biofortification, such as the development of iron-biofortified beans in Africa and zinc-biofortified rice in Asia, have shown promising results in addressing micronutrient deficiencies. These global initiatives provide a valuable framework for implementing similar strategies in Indonesia using indigenous plants like winged beans and cassava leaves.

Winged beans, also known as bottle beans or belingbing beans (Sumatra), jaat (Sundanese), kelongkang (Balinese), and biraro (Ternate) are minor legumes that are not yet well developed in Indonesia. In fact, in Malaysia, Myanmar and India, winged bean production reaches 35.5-40 tonnes of young pods/hectare or the equivalent of 4.5 tonnes of dry seeds/hectare. In Indonesia, the use of winged bean plants is still limited to the young pods as fresh vegetables or vegetables. The prospects for winged bean cultivation in Indonesia are quite large, especially from an ecological aspect, the winged bean's habitat is very suitable for Indonesian conditions. According to Ernawati and Palupi (2013), this type of legume has the potential to meet the food needs of tropical communities on the basis of its high protein content, namely 33.83 - 38.31% and various key micronutrients in it.

On the other hand, so far only a few people use cassava leaves as the main vegetable. In fact, the majority of uses for cassava leaves are still limited to animal feed. Even though it is relatively cheap, the nutrients in cassava leaves are very rich. There is no need to worry about the abundance of cassava leaves because cassava production per year reaches 21.80 million tons with a productivity of 22.95 tons/ha (Ministry of Agriculture, 2016). The production of biscuits to prevent stunting from these 2 vegetable sources is certainly worth developing. Because the characteristics of winged bean seeds and cassava leaves are not yet known, the initial formulation can be varied and the cream method chosen for making biscuits. According to Manley (2000), in the cream method, the raw materials are mixed gradually. The first is mixing fat and sugar, then milk and aeration chemicals along with salt which has previously been dissolved in water. The addition of flour is done at the very end. This method is good for biscuits because it produces a dough that limits excessive gluten development. After that, the dough can be molded and baked.

In this paper, we came up with the idea of making a health supplement to prevent stunting in the form of biscuits fortified with cassava leaves and winged beans. The manufacture of these biscuits needs to be researched further in terms of production, product quality and development potential as a supplement to support the preparation of Indonesia's golden generation. Therefore, we propose a paper with the title "Biscuits (Winged Bean Seed and Cassava Leaf Biscuits): Innovation in Stunting Preventing Biscuits Rich in Iron and Folic Acid to Support the Preparation of Indonesia's Golden Generation". The problem formulation for writing this scientific paper is: 1. What are the advantages of winged bean seeds and cassava leaves compared to other vegetable sources as raw materials for biscuits? 2. What is the best formulation for biscuits based on organoleptic tests? The aim of writing this scientific paper is: 1. To explain the advantages of winged bean

seeds and cassava leaves compared to other vegetable sources as raw materials for biscuits. 2. Explain the best formulation of biscuits based on organoleptic tests. The benefits of writing this scientific paper are: 1. Providing the latest innovations regarding the use of winged bean seeds and cassava leaves in the health sector. 2. Providing an alternative source of iron and folic acid at a relatively affordable price. 3. Increase the selling value of winged bean seeds and cassava leaves which so far have not been utilized optimally.

2. Methods

This type of research is quantitative experimental research, because it tries to find the best biscuit formulation based on organoleptic tests where the data is analyzed quantitatively. The type of design in this research is a completely randomized design (CRD) because it is applied to experiments carried out in homogeneous (or can be considered homogeneous) environments. The research was carried out at Wisma Atiga, Jebres Solo and the FMIPA UNS Biology Laboratory.

Data collection in writing this scientific paper uses documentary study techniques and direct research. The data used as supporting literature references was obtained from various library sources consisting of books, electronic media and scientific journals related to the problem of stunting and exploration of winged bean seeds and cassava leaves in making biscuits.

Data analysis was carried out qualitatively for data obtained from literature review and quantitatively for data obtained from organoleptic tests. In this paper, the process of selecting, processing and focusing on the discussion of data is carried out to support a framework of thinking related to the problem of stunting and exploration of winged bean seeds and cassava leaves in making biscuits.

2.1 Making Biscuits

The process of making biscuits begins with making winged bean flour. Comparison of biscuit formulations can be seen in Table 1. Winged bean seeds are sorted, washed, and soaked in water for 24 hours, then boiled for 30 minutes. After that, the seed skin is peeled manually, washed again, and dried in direct sunlight until dry. After drying, the seeds are manually ground and sieved to produce flour. This flour is then dried once more so that it is completely ready to be used in biscuit dough.

Table 1. Comparison of Biscuit Formulations

Ingredient Composition (grams)	Treatment		
	F1	F2	F3
Winged bean seed flour	20	25	30
Cassava leaf paste	10	15	10
Flour	70	60	60
Sugar	16	16	16
Egg yolk	20	20	20
Margarine	25	25	25
Skim Milk	15	15	15
Baking powder	2	2	2
Water	20	20	20

(Paramitha et al., 2018)

The next step is making cassava leaf paste. Cassava leaves are cut into small pieces, washed, and steamed at 80°C for 5 minutes. After that, the cassava leaves are crushed using a blender with the addition of water (ratio 1:2), then squeezed to extract the extract. In making biscuits, egg yolks, granulated sugar, skim milk, and margarine are mixed first. After that, winged bean flour, wheat flour, cassava leaf paste, baking powder, and water are

added. The biscuit dough is then rolled out, molded, and baked in the oven for 30 minutes at 170°C until it turns golden brown.

2.2 Hedonic Rating Test

The organoleptic test carried out is a hedonic test to determine the level of liking. Untrained panelists were randomly selected from residents of the boarding house of Wisma Atiga and Wisma Duta Jebres Solo. Panelists will be given 3 variants of biscuit samples with parameters tested including aroma, color, texture, taste and overall acceptability. There are 7 levels of assessment scores used in the formulation, namely 7 = like very much, 6 = like, 5 = like somewhat, 4 = neutral, 3 = somewhat dislike, 2 = dislike, and 1 = strongly dislike. The highest recapitulation result is identified as the best result.

In the biscuit assessment process, 4 different biscuit variants were presented. The assessment was carried out on three main attributes, namely color, taste, and texture of each variant. The biscuit variant located on the far left must be assessed first before moving on to the next variant on the right, until the rightmost variant is finished being assessed. The sense of taste was neutralized before and between each sample assessment to ensure the accuracy of the results. After each biscuit variant was tasted, a number describing the level of preference was written down. The assessment was carried out using a seven-level scale, where 7 means very much liked, 6 liked, 5 somewhat liked, 4 was considered neutral, 3 somewhat disliked, 2 disliked, and 1 very much disliked. With this method, preferences for the color, taste, and texture of each biscuit can be identified.

3. Results and Discussion

3.1 Advantages of Winged Bean Seeds and Cassava Leaves as Raw Material for Biscuits

Currently, one of the main challenges in overcoming stunting is the lack of accessibility and availability of food resources rich in important micronutrients such as iron and folic acid, especially among pregnant women and children. The majority of pregnant and breastfeeding mothers with low education tend not to pay attention to their intake of these micronutrients, which often results in deficiencies (GBD, 2015). Apart from that, pregnancy/breastfeeding supplements on the market also often have prices that are unaffordable for low-income people.

In this context, the development of biscuits enriched with iron and folic acid from local vegetable sources such as cassava leaves and winged beans is very important. Cassava leaves and winged beans have been proven to be local agricultural resources rich in iron and folic acid. By exploiting this potential, the production of stunting prevention biscuits can provide a more affordable and sustainable solution for the community.

The existence of biscuits not only provides important nutritional benefits for pregnant women and children in reducing the risk of stunting, but also has wider implications. First, by using local raw materials, biscuit production can help increase local farmers' income and support the rural economy. Second, with more affordable prices, Biscuits can be accessed by more levels of society, including those in remote areas or with low incomes. Thus, the development of Biscuits is not only an innovative step in overcoming the problem of stunting, but also an important step in supporting public health and inclusive economic development in Indonesia.

Winged bean seeds and cassava leaves were chosen as the main ingredients for biscuits because when compared, the nutritional profile and certain parameters are not inferior to other vegetable ingredients. Considering that the problem of stunting is being urgently sought for a solution, these 2 ingredients are thought to be relevant to be developed for wider public consumption. Winged beans (Psophocarpus tetragonolobus) are minor legumes that have not been utilized optimally. Generally, not many people plant it for commercial purposes, it is only planted as a protective plant in the yard. All parts of the

winged bean plant can actually be used, but currently they are still consumed on a limited basis, for example the leaves and young pods are consumed as vegetables while the seeds are consumed after roasting or boiling.

Winged bean seeds (*Psophocarpus tetragonolobus* (L) DC) contain quite high levels of protein (Table 2). The seeds, which are hard round and brown in color, are the part most often used by people in Indonesia. Winged bean seeds are high in protein and rich in minerals including Ca, Mg, K, Na, P and Fe. The most important mineral is Fe which is present in a form that can be directly used for the formation of hemoglobin. Winged bean seeds are a good source of the mineral iron and processing does not affect the iron content, so winged bean seeds can also be used as a raw material for making food (Ekmenyong and Borchers, 1980).

Table 2. Nutrient Content of Winged Bean Seeds Per 100 Grams

Composition	Mark
Calories (kcal)	409
Carbohydrates (grams)	42
Protein (grams)	39
Fat (grams)	6
Fiber (grams)	16
Iron (mg)	18
Folic Acid (mg)	9
Calcium (mg)	370
Phosphorus (mg)	280
Magnesium (mg)	255
Zinc (mg)	5

(USDA, 2018)

The use of old winged bean seeds as a substitute for soybeans is very possible to be realized because their nutritional value is equivalent to soybeans (Table 3). The essential amino acid profile of winged bean seeds is better when compared to soybeans. With a lysine content of 413-600 mg per 100 g, winged bean seeds are able to cover the limited lysine in rice, corn and tubers. Winged bean seeds are also low in fat but high in fiber. With high fiber, mother and child's digestion becomes healthier. Meanwhile, low fat can prevent the risk of fatty liver and obesity. Although the productivity of winged bean seeds is below that of peanuts, their protein and carbohydrate content is higher than that of peanuts.

Table 3. Comparison of Winged Bean Seeds with Other Nuts

Comparative Factors	Types of Nuts			
	Mung beans	Soybean	Peanuts	Winged Bean Seeds
Protein (g/100g)	23.25	35	28	39
Fat	2.61	17.30	42.8	6
Drat carbs	62.11	32.24	21	42
Iron (mg/100g)	7.54	4.77	2	18
Folic Acid (μg/100g)	42	31	30	63.5
Fiber (g/100g)	12.70	4.2	2.1	16
Plant productivity	0.9ton/ha/yr	1.5ton/ha/yr	3tons/ha/yr	2.38 tons/ha/yr

(USDA,2018)

Based on the data above, it is proven that winged bean seeds have the highest value of protein, iron and folic acid. This is in line with Haryoto (1996) who states that old winged bean seeds contain high protein with various essential amino acids. The presence of protein in food will prevent toddlers from experiencing growth failure and reduce the risk of stunting, especially after toddlers do not receive breast milk. The level of protein consumption is related to the toddler's hemoglobin level which will affect the brain's working system and level of intelligence.

Iron of 18 mg/100 g in winged beans is known to be able to prevent anemia which is commonly experienced by 48.2% of pregnant women in Southeast Asia. Iron functions to form red blood cells (erythrocytes) which are made in the spinal cord, and produces hemoglobin, which is a protein in red blood cells which functions to carry oxygen to all parts of the body. On the other hand, the folic acid contained can prevent brain function disorders in the fetus, maintain normal fetal development, prevent nervous disorders when the baby is born, and stimulate the development of brain tissue and body cells in babies and children.

Table 4 Nutritional Content of Cassava Leaves Per 100 Grams

Composition	Mark
Calories (kcal)	450
Carbohydrates (grams)	45.5
Protein (grams)	27
Fat (grams)	2
Fiber (grams)	10.5
Iron (mg)	4.1
Folic Acid (mg)	0.01
Calcium (mg)	18
Vitamin A (IU)	12500
Vitamin C (mg)	1.2

(USDA, 2018)

Cassava leaves are waste from the cassava agricultural production system, especially in tapioca industrial areas (Figure 1). The availability of cassava leaves continues to increase along with the expansion of planting areas and the productivity of cassava plants. Nearly 10-40% of the cassava plant consists of leaves. With cassava production of 22.95 tonnes/ha/year, it is estimated that the number of leaves that can be utilized is 3-9.2 tonnes/ha/year (Ministry of Agriculture, 2016). Even though it tends to have low economic value and is more often used as animal feed, cassava leaves have a fairly good nutritional profile (Table 4).

(a) **(b)**

Fig. 1 (a) Young winged bean pods and seeds (b) Cassava leaves
(At-Thariq Ecological Islamic Boarding School, 2018)

From the comparison table of cassava leaves with others (Table 5), it appears that cassava leaves have far more protein content than other broad-leaf vegetables. As cassava productivity reaches more than 24 million tons/year, cassava leaves that can be utilized are around 3-9.2 million tons/year. The iron content of cassava leaves is actually slightly more than spinach, even though it contains less folic acid. The very high fiber content prevents preeclampsia and constipation. Previous research, namely A nutritious biscuit recipe that promotes children's growth, can use bilih fish, which is rich in proteins, lipids, vitamins, and minerals (Diana et al., 2020). Our protein-based additional food has an effect on the growth

of the fetus in pregnant women (Prameswari et al., 2020). Next, below is a comparison table of cassava leaves and other leafy vegetables.

Table 5 Comparison of Cassava Leaves with Other Leafy Vegetables

Comparative Factors	Types of Vegetables			
	Spinach	Spinach	Mustard	Cassava leaves
Protein (g/100g)	3.5	3	2.05	27
Fat	0.5	0.3	0.4	2
Iron (mg/100g	3.9	2.5	1.9	4.1
Folic Acid (mg/100g)	0.02	0.06	0.02	0.01
Fiber (g/100g)	0.7	1	2.1	10.5
Price per kg	Rp. 15,000	Rp. 15,000	Rp. 13,000	Rp. 12,500
Plant productivity	>200 thousand tons/year	>300 thousand tons/year	>600 thousand tons/year	3-9.2 million tons/year

(Ministry of Agriculture Indonesia, 2016)

The selling price of cassava leaves on the market is also the cheapest. Considering facts like this, cassava leaves are very relevant as a functional food ingredient that is produced massively and sustainably. The use of local raw materials such as cassava leaves and winged beans can also be interpreted as an implementation of the concept of local food for health which is championed by sustainable food policies. By utilizing abundant local resources, the production of stunting prevention biscuits not only supports local food security but also has a positive impact on the local economy.

Biscuits are products obtained by baking dough made from wheat flour with the addition of other foods and with/or the addition of permitted food additives. Data results regarding consumption of foods made from processed wheat flour include instant noodles, wet noodles, bread and biscuits, as many as 13.4% of the Indonesian population consume biscuits ≥ 1 time per day. Meanwhile, data from the Ministry of Agriculture in 2016 stated that per capita biscuit consumption per year reached 1.8 kg. Toddlers themselves usually consume a minimum of 3 biscuits (30 grams)/day after they are 6 months old. Biscuits, as a processed pastry product, are a popular snack because they are delicious, sweet and crunchy and have a long shelf life. The low water content in biscuits results from the process of baking the biscuit dough perfectly.

Biscuits are a functional food that has high nutrition to overcome the problem of stunting. According to Almatsier (2001), the intake of various essential nutrients in a food needs to be considered based on scientific knowledge so that the intake of these nutrients can meet nutritional needs. These biscuits are recommended for consumption by pregnant women and toddlers because the need for essential micronutrients iron and folic acid is very high. Iron is an important component in the body, especially hemoglobin synthesis and oxygen transportation throughout the body. Meanwhile, folic acid plays a role in the metabolism of amino acids for the formation of red blood cells. Moreover, folic acid plays an important role in the formation phase of the central nervous system. If there is a lack of folic acid, it will affect fetal development which includes hormonal system disorders, motor delays, weak heart. and weak intelligence.

The United Nation for Development Program (2013) states that Indonesia's Human Development Index (HDI) is still relatively low, namely 0.629, which places Indonesia in 121st place out of 187 countries. Based on this, what influences human resource development is intelligence. This level of intelligence is also influenced by the food consumed. Both winged bean seeds and cassava leaves in biscuits contain protein, minerals, vitamins and other nutrients which are very beneficial for health and intelligence. Fulfilled nutrition will support the work of the central nervous system. This means that if these nutrients are not met, there will be a slowdown in a person's intelligence process, starting with stunting. Even though quality resources are really needed to welcome a Golden Indonesia.

Stunting prevention involves various parties who have an important role in overcoming this problem. The following are several parties who play a role and several references that support their role: Government: The government has a key role in formulating policies and programs that support stunting prevention, including community nutrition programs, nutrition education, and access to nutritious food. Health Workers: Health workers, including doctors, midwives and other health workers, play a role in providing information and health services to pregnant women, breastfeeding mothers and children, as well as carrying out early detection and intervention against stunting. Civil Society: Civil society organizations, including non-profit organizations and NGOs, can play a role in providing social services, education, support and advocacy to increase public awareness about stunting and fight for access to nutritious food. Food Industry: The food industry has a role in the development and production of high quality and affordable complementary foods for children, as well as ensuring the availability of nutritious food on the market. Education and Research: Education and research institutions have a role in generating new knowledge about the causes of stunting and effective interventions, as well as training a skilled workforce in the fields of health and nutrition (WHO, 2021; Menon et al., 2013; Ruel et al., 2013)

3.2 Biscuit Organoleptic Test Results

Biscuits have a long shelf life and do not require special preparation before consumption. This makes it a practical choice for busy mothers and children who are learning to eat independently. Biscuits specially formulated for children are often enriched with important nutrients such as iron, folic acid, vitamins and other minerals. Biofortification encompasses a suite of promising methodologies with substantial potential to enhance the nutritional status of global populations. This approach has the capacity to significantly mitigate issues of hunger and malnutrition worldwide (Ofori et al., 2022). This helps ensure that children receive a balanced and sufficient nutritional intake for optimal growth and development. There are various types of biscuits available on the market, with various flavors, textures and nutritional content. This allows mothers to choose products that suit their children's preferences and needs.

Complementary biscuits are often considered a practical and easy choice for children who are learning to eat independently. Easy to carry and store packaging also makes it a popular choice among parents. The use of accompanying biscuits can also be part of nutritional education aimed at parents and child caregivers. By introducing healthy and nutritious foods from an early age, parents can form good eating patterns in their children. The administration of biscuits fortified with eel-derived nutrients over a three-month period resulted in a significant improvement in linear growth among stunted children. In the 36-60 month age cohort, an increase of 0.93 standard deviations was observed in the height-for-age z-score (Herawati et al., 2020).

Some biscuit variants may contain high levels of sugar and fat, which if consumed excessively can increase the risk of obesity and other health problems in children (Agostoni et al., 2008), so it is important to pay attention to the formulation of the biscuits. Developing biscuit formulations as an innovation to prevent stunting using local raw materials, namely cassava leaf paste and winged bean seed flour which are rich in iron and folic acid. Variations in the formulation of winged bean seed flour: cassava leaf paste used are F1 (20:10), F2 (25:15), and F3 (30:10). The cream method is used in making biscuits by mixing sugar, skim milk, margarine and egg yolks until homogeneous, then adding wheat flour, winged bean seed flour, cassava leaf paste, water and leavening agent. The dough is then rolled, molded, and baked at 170°C for 30 minutes.

The findings from this research highlight the urgency of developing innovations such as biscuits as a stunting prevention strategy in Indonesia. The high prevalence of stunting, reaching 37.2%, places Indonesia as one of the five countries with the highest stunting rate

in the world. The impact of stunting on children is not only limited to delays in physical growth, but also includes delays in cognitive and psychomotor development, which can impact productivity and learning abilities in the future (Black et al., 2013).

Complementary breast milk (MP-ASI) foods, including biscuits, have an important role for pregnant women and support the growth and development of children. Biscuits that are specially formulated for toddlers or toddlers are often enriched with various important nutrients such as iron, calcium, vitamins and fiber. Research has shown that consumption of accompanying biscuits can make a significant contribution to the daily nutritional intake necessary for children's growth and development (Agostoni et al., 2008). Complementary biscuits that are enriched with nutrients can help in preventing stunting, especially if consumed as part of a balanced and varied diet. Longitudinal studies have shown a positive association between consumption of complementary foods, including biscuits, and linear growth in children (Iannotti et al., 2017).

The biscuit formula that has the best acceptability is F2 (winged bean seed flour: cassava leaf paste 25:15). The average level of panelists' liking for the taste of biscuits ranged from 3.95 to 4.7 (somewhat disliked to somewhat liked). The lowest level of taste preference was obtained from treatment F3 (winged bean seed flour: cassava leaf paste 30:10) (Figure 2).

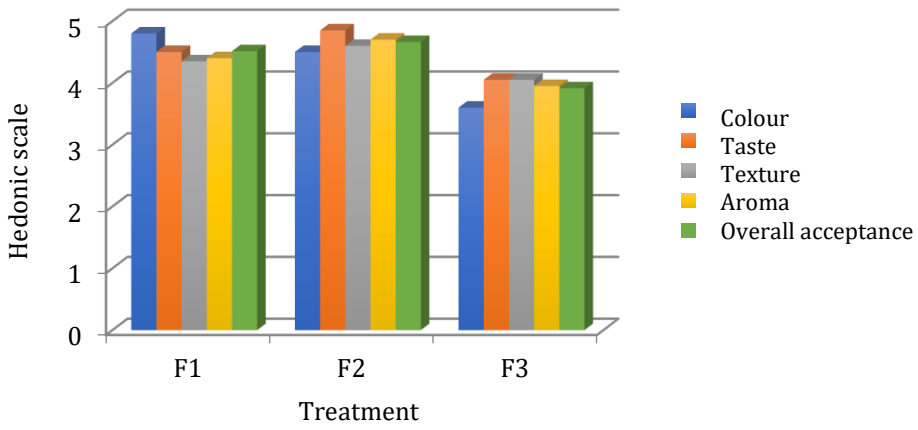

Fig. 2. Organoleptic test results

These findings show that the use of cassava leaf paste and winged bean seed flour in making biscuits has the potential to be an innovative solution in preventing stunting. Organoleptic test results indicating a preference for the F2 formulation indicated that the proportion of 25% winged bean seed flour and 15% cassava leaf paste provided optimal results in terms of sensory characteristics. The analysis showed that winged bean seeds and cassava leaves are rich in protein, iron, and folic acid. These findings suggest that biscuits made from these local ingredients could be effectively integrated into stunting prevention programs, supporting improved nutrition and health outcomes. Food fortification to prevent stunting was also found in orange almond potato cake which has the potential to improve the nutritional well-being of children in the preschool age group who experience stunted growth (Fatma & Utomo, 2023).

The color attribute plays a very important role because the first impression you get from food is color. The results of tests of between-subjects effects on the color attributes of Biscuit formula variants show that the color of formula F1 (winged bean seed flour : cassava leaf paste 20:10) is more preferred compared to the other formulas. The factors that influence the color of biscuit products are the color of the biscuit composition itself. This is because the color of the cassava leaf paste is dark green and the winged bean seed flour is light brown. The more winged bean flour, the darker the biscuit color and the quicker the biscuit will cook. Apart from that, the protein contained in winged bean seed flour triggers

the Mailard reaction. According to Winarno (1992), the Maillard reaction is a reaction between carbohydrates, especially sugars, with primary amino groups. The result of this reaction is a brown product which is less favorable.

The taste attribute test results show that the value range is not too far apart. This indicates that the taste of the three formulas is almost similar. Biscuit taste test results showed that formula F2 (winged bean seed flour: cassava leaf paste 25:15) was the best result. The taste of winged bean seeds and cassava leaves tends to be masked. There was no significant unpleasant (beany) aftertaste found in this formula because the portion of cassava leaf paste added was the largest among the other formulas. The average level of panelists' liking for the taste of biscuits ranged from 4-4.8 (neutral to somewhat like it). The lowest level of taste preference was obtained from treatment F3 (winged bean seed flour: cassava leaf paste 30:10). The more winged bean flour added, the more delicious the biscuits taste due to the antinutritional components in it.

The addition of winged bean seed flour and greater amounts of cassava leaf paste has a real influence on the texture of the biscuits produced. The texture tested was more focused on being crunchy and not leaving sticky lumps on the roof of the mouth. The texture of the resulting biscuits becomes crispier with the increasing use of cassava leaf paste. This is because cassava leaves are rich in fiber content. Winged bean seed flour with a high protein content also has high water absorption capacity. The more flour with a high protein content is added, while the amount of water in the dough is limited, this means that the starch in the dough cannot be gelatinized completely, as a result the resulting biscuits become brittle or break easily. The texture attribute test results showed that the F2 texture (winged bean seed flour: cassava leaf paste 25:15) was the best result. This is caused by the dough not holding too much water so that the resulting biscuits are denser and crispier.

According to Kartika et al (1988), aroma can be defined as something that can be observed with the sense of smell. In the food industry, testing for odor or aroma is considered important because it can quickly provide an assessment of whether the product is acceptable or not. Apart from that, aroma can also be used as an indicator of damage to the product. The texture attribute test results showed that the F2 texture (winged bean seed flour: cassava leaf paste 25:15) was the best result. Bad smells can be clearly masked. The less cassava leaf paste added, the more the panelists' preferences increased. Apart from that, the more winged beans you add, the more pleasant the smell will be. This happens because, when the lipoxygenase enzyme combines with the substrate when the cell wall breaks, for example during the grinding process.

The finding that the F2 formulation was the most preferred by the panelists is in line with previous research which shows that certain proportions of certain ingredients can produce a final product with optimal sensory characteristics (Martins et al., 2017). The proportions of winged bean seed flour and cassava leaf paste in the F2 formulation may provide the right balance between nutritional content, texture, taste, and aroma, which suits consumer preferences. The nutritional analysis of the biscuits highlighted significant levels of essential nutrients, including high protein, iron, and folic acid content from winged bean seeds and cassava leaves. Taste tests conducted revealed that the F2 formulation (25% winged bean seed flour and 15% cassava leaf paste) was the most preferred by the panelists, indicating a good balance of taste, texture, and aroma. Integrating these nutrient-rich biscuits into existing nutrition programs can provide a practical and accessible solution to improve maternal and child health outcomes.

The use of local raw materials such as cassava leaves and winged beans not only increases the nutritional value of the final product but also supports local economic growth and food sovereignty. Apart from that, using local raw materials can also reduce dependence on food imports. The use of cassava leaf paste and winged bean seed flour in biscuit formulations has the potential to be an innovative solution in preventing stunting. Previous studies have highlighted the importance of the availability of iron and folic acid in the diet as an important factor in preventing stunting in children (Rahman, 2016). In this context,

biscuits enriched with iron and folic acid from natural sources such as winged bean seeds and cassava leaves offer an attractive alternative to increase the intake of nutrients necessary for children's growth and development.

4. Conclusions

Winged beans have advantages in terms of protein profile, folic acid and iron which are higher than green beans, peanuts and soybeans. The productivity of winged bean seeds is also highest if they are properly cultivated on a massive scale. Meanwhile, cassava leaves have advantages in terms of protein content, availability and price on the market. Biscuits have great potential for development because the main ingredient has various prospective advantages. This really supports the achievement of the Golden Indonesian generation because the problem of stunting is also resolved. The best biscuit formulation is F2 which has a proportion of winged bean seed flour: cassava leaf paste of 25:15 with parameter values of color 4.5, taste 4.85, texture 4.6, aroma 4.7 and overall acceptability 4.66. Further research is needed regarding proximate analysis, production optimization, and long-term health effects on Biscuit products so that Biscuit production can be carried out on a large scale and the problem of stunting can be resolved. However, this study has several limitations, such as not carrying out a detailed analysis of the nutritional content of the final product and the absence of long-term consumption trials to evaluate the effectiveness of biscuits as an effort to prevent stunting.

In further research, it is recommended to conduct a more in-depth analysis of the nutritional content of the final product, involve more respondents in the organoleptic test, and conduct clinical trials to measure the effectiveness of biscuits in reducing the prevalence of stunting in the community. Thus, this study contributes to the development of functional food products that are not only highly nutritious but can also have a positive impact in overcoming nutritional problems such as stunting. The potential benefits of biofortified biscuits to prevent stunting are quite significant. Further research should focus on evaluating scalability and long-term effects to ensure that production can be expanded on a large scale and effectively address stunting.

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References
Agostoni, C., Decsi, T., Fewtrell, M., Goulet, O., Kolacek, S., Koletzko, B., Michaelsen, K. F., Moreno, L., Puntis, J., Rigo, J., Shamir, R., Szajewska, H., Turck, D., & van Goudoever, J. (2008). Complementary feeding: a commentary by the ESPGHAN Committee on Nutrition. *Journal of Pediatric Gastroenterology and Nutrition, 46*(1), 99-110. https://doi.org/10.1097/01.mpg.0000304464.60788.bd

Almatsier, S. (2001). *Prinsip dasar ilmu gizi.* PT Gramedia Pustaka Utama. https://books.google.co.id/books/about/Prinsip_dasar_ilmu_gizi.html?id=aEmYNwAACAAJ&redir_esc=y

Andarina, D., & Sumarni, S. (2006). Hubungan konsumsi protein hewani dan zat besi dengan kadar hemoglobin pada balita usia 13-36 bulan. *The Indonesian Journal of Public Health, 3*(1), 19-23. https://lib.fkm.ui.ac.id/detail.jsp?id=125996

Astriningrum, E. P., Hardinsyah, & Nurdin, N. M. (2017). Asupan asam folat, vitamin B12 dan vitamin C pada ibu hamil di Indonesia berdasarkan studi diet total. *Jurnal Gizi Pangan, 12*(1), 31-40. https://doi.org/10.25182/jgp.2017.12.1.31-40

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R., & Maternal and Child Nutrition Study Group. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet (London, England), 382*(9890), 427-451. https://doi.org/10.1016/S0140-6736(13)60937-X

Departemen Kesehatan RI. (2018). *Cegah stunting dengan perbaikan pola makan, pola asuh dan sanitasi.* http://www.depkes.go.id/article/view/18040700002/cegah-stunting-dengan-perbaikan-pola-makan-pola-asuh-dan-sanitasi-2-.html

Diana, F. M., Rimbawan, R., Damayanthi, E., Dewi, M., Juniantito, V., & Lipoeto, N. I. (2020). Effect of biscuits enriched with bilih fish (*Mystacoleucus padangensis*) on growth of experimental rats. *Jurnal Gizi dan Pangan, 15*(1), 11-18. https://doi.org/10.25182/jgp.2020.15.1.11-18

Ekpenyong, T. E., & Borchers, R. L. (1980). The fatty acid composition of the oil of the winged beans (*Psophocarpus tetragonolobus*). *Journal of Food Sciences, 45*, 1559-1565. https://doi.org/10.1007/BF02674137

Ernawati, & Palupi, H. T. (2013). Pengaruh rasio tepung kecipir (*Psophocarpus tetragonolobus*) dan tepung tapioka terhadap karakteristik sosis ikan gabus (Ophiocephalus striatus). *Jurnal Mahasiswa UNESA*, 117-129. https://publishing-widyagama.ac.id/ejournal-v2/agrika/article/view/118

Fatmah, F., & Utomo, S. W. (2023). Effectiveness of orange almond potato cookie vs. orange potato cookie supplementation on nutritional wellbeing of the Indonesian stunted

preschool-aged children during COVID-19 pandemic. *Frontiers in Nutrition, 10*, 1235841. https://doi.org/10.3389/fnut.2023.1235841

GBD 2015 Child Mortality Collaborators. (2016). Global, regional, national, and selected subnational levels of stillbirths, neonatal, infant, and under-5 mortality, 1980-2015: A systematic analysis for the Global Burden of Disease Study 2015. *Lancet (London, England), 388*(10053), 1725-1774. https://doi.org/10.1016/S0140-6736(16)31575-6

Haryoto. (1996). *Susu dan yogurt kecipir.* Kanisius.

Herawati, D. M. D., Asiyah, S. N., Wiramihardja, S., Fauzia, S., & Sunjaya, D. K. (2020). Effect of Eel Biscuit Supplementation on Height of Children with Stunting Aged 36-60 Months: A Pilot Study. *Journal of Nutrition and Metabolism, 2020*, 2984728. https://doi.org/10.1155/2020/2984728

Ministry of Agiriculture Indonesia. 2016. *Statistik produksi hortikultura.* http://hortikultura.pertanian.go.id/wp-content/uploads/2016/02/Statistik-Produksi-2014.pdf

Iannotti, L. L., Lutter, C. K., Stewart, C. P., Gallegos Riofrío, C. A., Malo, C., Reinhart, G., Palacios, A., Karp, C., Chapnick, M., Cox, K., & Waters, W. F. (2017). Eggs in early complementary feeding and child growth: a randomized controlled trial. Pediatrics, 140(1), e20163459. https://doi.org/10.1542/peds.2016-3459

Ministry of Health, Indonesia. (2018). Buku saku pemantauan status gizi tahun 2017. https://sehatnegeriku.kemkes.go.id/wp-content/uploads/2018/01/Buku-Saku-Nasional-PSG-2017-Cetak-1.pdf

Ministry of Health Indonesia. (2018). Buletin stunting (situasi balita pendek Indonesia). Jakarta: Pusat Data dan Informasi Kemenkes RI.

Ministry of Agiriculture Indonesia. (2016). Outlook komoditas pertanian tanaman pangan ubi kayu 2016. Pusat Data dan Sistem Informasi Pertanian Kementerian Pertanian. https://satudata.pertanian.go.id/assets/docs/publikasi/Outlook_Komoditas_Tanaman_Pangan_Ubi_Kayu_Tahun_2020.pdf

Manley, D. (2000). Technology of biscuits, crackers and cookies. Cambridge: Woodhead Publishing Limited. https://books.google.co.id/books/about/Manley_s_Technology_of_Biscuits_Crackers.html?id=v5NwAgAAQBAJ&redir_esc=y

Margawati, A., & Astuti, A. (2018). Pengetahuan ibu, pola makan dan status gizi pada anak stunting usia 1-5 tahun di Kelurahan Bangetayu, Kecamatan Genuk, Semarang. *Jurnal Gizi Indonesia (The Indonesian Journal of Nutrition), 6*(2), 82-89. https://doi.org/10.14710/jgi.6.2.82-89

Martins, Z. E., Pinho, O., & Ferreira, I. M. P. L. V. O. (2017). Food industry by-products used as functional ingredients of bakery products. *Trends in Food Science & Technology, 67*, 106-128. https://doi.org/10.1016/j.tifs.2017.07.003

Menon, P., Bamezai, A., & Subandoro, A. (2013). *Community-based child nutrition and development programs: reducing inequities in Indonesia.* The World Bank. https://documents1.worldbank.org/curated/en/955671468049836790/pdf/761920WP0P12640Box0379884B00PUBLIC0.pdf

Ofori, K. F., Antoniello, S., English, M. M., & Aryee, A. N. A. (2022). Improving nutrition through biofortification-A systematic review. *Frontiers in Nutrition, 9*, 1043655. https://doi.org/10.3389/fnut.2022.1043655

Paramitha, N. K. D. A., Ina, P. T., & Pratiwi, I. P. D. K. (2018). Karakteristik biskuit dengan pemanfaatan umbi dan pasta daun singkong (*Manihot esculenta Cranz*). *Jurnal Ilmu dan Teknologi Pangan, 7*(3), 140-147. https://doi.org/10.24843/itepa.2018.v07.i03.p08

Prameswari, F. S. P., Marliyati, S. A., & Dewi, M. (2020). A supplementary protein food for pregnant women with chronic energy deficiency to improve fetal growth. *Jurnal Gizi dan Pangan, 15*(1), 1-10. https://doi.org/10.25182/jgp.2020.15.1.1-10

Roziqo, I. O., & Nuryanto. (2016). Hubungan asupan protein, zat besi, vitamin C dan seng dengan kadar hemoglobin pada balita stunting. *Journal of Nutrition College, 5*(4), 419-427. https://ejournal3.undip.ac.id/index.php/jnc/article/view/16453

Ruel, M. T., Alderman, H., & Maternal and Child Nutrition Study Group. (2013). Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *The Lancet, 382*(9891), 536-551. https://doi.org/10.1016/S0140-6736(13)60843-0

Siwela, M., Pillay, K., Govender, L., Lottering, S., Mudau, F. N., Modi, A. T., & Mabhaudhi, T. (2020). Biofortified Crops for Combating Hidden Hunger in South Africa: Availability, Acceptability, Micronutrient Retention and Bioavailability. *Foods, 9*(6), 815. https://doi.org/10.3390/foods9060815

United Nations Children's Fund. (2018). *Levels and trends in child malnutrition: Key findings of the 2018 edition*. UNICEF. https://www.unicef.org/media/60626/file/Joint-malnutrition-estimates-2019.pdf

United Nations Development Programme. (1995). *Human development report 2013, published for United Nations Development Programme*. Oxford University Press. https://www.undp.org/sites/g/files/zskgke326/files/migration/me/HDR-2013-Report-ENG.pdf

United States Department of Agriculture. (2018). *USDA food composition databases.* https://ndb.nal.usda.gov/ndb/search/list/

Winarno, F. G. (1992). *Kimia pangan dan gizi. Gramedia.* https://books.google.co.id/books/about/Kimia_Pangan_dan_gizi.html?id=_P4StAEACAAJ&redir_esc=y

World Health Organization (WHO). (2021). *Implementation guide on maternal, infant and young child nutrition: maternal, newborn, child and adolescent health.* https://apps.who.int/gb/ebwha/pdf_files/EB150/B150_23-en.pdf

Biographies of Authors

Akhsanitaqwim, Y., student and researcher in the field of Natural Medicine, Pharmacy, Toyama University, Japan.

- Email: m23e8101@ems.u-toyama.ac.jp
- ORCID: 0000-0002-8093-0632
- Web of Science ResearcherID: JJC-4527-2023
- Scopus Author ID: 57855279200
- Homepage: https://journal-iasssf.com/index.php/JASSU/editorial

Arista, N.I.D., student and researcher in the field of agronomy and environment, Bogor Agricultural University, Indonesia.

- Email: dewi.arista@apps.ipb.ac.id
- ORCID: 0000-0001-7196-2838
- Web of Science ResearcherID: JKI-9867-2023
- Scopus Author ID: 58185882900
- Homepage: https://journal-iasssf.com/index.php/JASSU/editorial

Septiyanto, A., STEM educator and researcher in the field of STEM education and solar cells in Universitas Pendidikan Indonesia, Indonesia.

- Email: arifinseptiyanto3@upi.edu
- ORCID: 0000-0003-1496-4006
- Web of Science ResearcherID: HGU-1189-2022
- Scopus Author ID: 58088044700
- Homepage: https://journal-iasssf.com/index.php/JASSU/editorial