Jurnal Ilmiah Mahasiswa **Fakultas Tarbiyah dan Keguruan**
ISSN : 2988-6228 **UIN Ar-Raniry- Banda Aceh**

Vol. 3 Nomor 2 Desember 2025

Fortification and Utilization of Local Food Rich in Vitamin A (Yellow Pumpkin) for Stunting Prevention in South Sumatra

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Abstract. Stunting remains a major nutritional problem in Indonesia, including in South Sumatra, which is influenced by low vitamin A intake. Yellow pumpkin (*Cucurbita moschata*), as a local food rich in β-carotene, has the potential to be a sustainable source of provitamin A. This review analyzes the scientific evidence on the role of vitamin A in child growth and the effectiveness of yellow pumpkin fortification as a stunting prevention strategy. Literature search was conducted using the PRISMA approach on PubMed, ScienceDirect, and Google Scholar. Ten relevant articles were reviewed to assess biological aspects, nutritional composition, processing technology, and implementation challenges. The results showed that yellow pumpkin fortification improved the provitamin A content and nutritional quality of the product without decreasing sensory acceptability, with the best β–carotene retention through steaming and light roasting. In South Sumatra, the abundant availability of raw materials and low production costs support the implementation of local food-based fortification. However, evidence on the direct impact on vitamin A status and linear growth is still limited so further research is needed. Overall, yellow pumpkin fortification is a potential and sustainable approach to support efforts to accelerate stunting reduction.

Kata kunci: *Vitamin A, stunting, yellow pumpkin, food fortification.*

INTRODUCTION

Vitamin A plays an important role in bone growth, immunity, and cell differentiation. Vitamin A deficiency increases susceptibility to infection and slows down linear growth. Local food-based interventions such as orange sweet potato (OFSP) and yellow squash have been shown to increase intake of β-carotene that can be converted into active retinol. Vitamin A is one of the essential fat-soluble nutrients, because the human body is unable to synthesize it itself and must obtain it from food intake. These nutrients are stored primarily in the liver and play an important role in

vision function, growth processes, and immune system enhancement. The role of vitamin A is very large for the growth and development of children, especially in supporting epithelial tissue health, immunity, and cell metabolism.

Vitamin A deficiency (VAD) can be measured by vitamin A levels in serum or plasma, with a threshold of < 0.70 µmol/L. VAD is categorized as a major health problem in children aged 6–59 months. Data from 2013 showed that about 29% of children in 138 lower-middle-income communities were deficient in vitamin A, a condition associated with high rates of illness and death from infections, and is one of the leading causes of blindness. Efforts to overcome vitamin A deficiency are not only focused on preventing blindness, but are also directed to support optimal growth and health of children (Ministry of Health of the Republic of Indonesia, 2016). The problem of subclinical vitamin A deficiency in some areas is still a serious concern because about 50% of children under five have low vitamin A levels. A deficiency of this vitamin can lead to a decrease in immunity, making children more susceptible to infections and this has a direct impact on their survival and growth and development.

According to a report by the World Health Organization (WHO), around 20 million children under five in Indonesia are deficient in vitamin A, and half of them show symptoms of deficiency. WHO also stated that the level of vitamin A fulfillment in Indonesia is still relatively low (Ministry of Health of the Republic of Indonesia, 2016). Limited intake of beta-carotene and vitamin A in children's food can be one of the factors that contribute to the increased risk of stunting or growth disorders. Efforts to prevent this condition require regular consumption of foods rich in provitamin A, such as dark green leafy vegetables, carrots, sweet potatoes, red peppers, and several types of orange fruits that are known as the main source of beta-carotene (Ramadhani et al., 2022).

Some cases show that toddlers in some regions of Indonesia do not like foods processed from local foods, such as yellow pumpkin, orange sweet potato, or moringa leaves, due to taste, texture, and family eating habits (Suryani et al., 2021). Food preferences formed from an early age often make children prefer instant or modern processed foods that have a savory and sweet taste rather than traditional foods that are considered less attractive (Rahmawati & Putri, 2020). This condition causes low consumption of food sources of provitamin A and other important nutrients, so that

efforts to improve nutritional status through local food interventions are less optimal (Ministry of Health of the Republic of Indonesia, 2019). Therefore, nutrition education strategies and innovation of processed products based on local food need to be carried out to increase the acceptance of toddlers to nutritious foods typical of the region (Nurjanah et al., 2022).

One of the foods that has a high beta-carotene content is yellow pumpkin (Cucurbita moschata). The main component that gives yellow pumpkin its yellow-orange color is carotenoid pigments, which after being digested will be converted by the body into active vitamin A (retinol). This nutritional content has an important role in maintaining immune function, supporting tissue growth, and supporting optimal child development. In the context of public health programs, increasing the consumption of vitamin A foods is one of the strategies that is often implemented, especially in areas with a high prevalence of stunting. This intervention is considered effective for lowering the risk of vitamin A deficiency, while improving children's nutritional status and growth through increased intake of beta-carotene-rich foods (Sanyoto et al., 2021). The average yield of yellow pumpkin production throughout Indonesia ranges from 20-21 tons per hectare while the consumption rate of yellow pumpkin in Indonesia is still very low, which is less than 5 kg per capita per year.

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One of the processes of food processing innovation is through the fortification of staple foods, such as salt, oil, and flour, with the addition of important micronutrients such as vitamins and minerals. Food fortification plays an important role in increasing

the nutritional content of foodstuffs, so that it can contribute to meeting the nutritional needs of the community and support efforts to improve children's nutritional status in a sustainable manner.

Against this background, this article is expected to provide a comprehensive overview of the relationship between vitamin A in helping children's growth. In addition, this article will also review the potential of yellow pumpkin as a source of Vitamin A that can be utilized through food fortification strategies to reduce the prevalence of stunting.

METHOD

The literature search in this article was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach to ensure that the reference selection process takes place in a systematic, transparent, and replicable manner. The procedure includes four main stages: identification, screening, eligibility assessment, and inclusion.

At the identification stage, literature searches are carried out through three reputable scientific databases, namely Google Scholar, PubMed, and ScienceDirect. Search is limited to articles published within the last ten years to obtain up-to-date scientific evidence. Keywords used included vitamin A, beta-carotene, pumpkin, Cucurbita moschata, stunting, food fortification, biofortification, and nutritional interventions. Keyword combinations use Boolean operators such as AND, OR, and NOT to expand and clarify the scope of the search. The screening stage is carried out by eliminating duplication and selecting articles based on titles and abstracts. Exclusion criteria include articles that are not relevant to the topic of the review, non-scientific publications, reports without empirical data, and studies that do not address vitamin A, yellow squash, or nutritional interventions related to stunting prevention.

At the eligibility stage, articles that pass the screening are assessed in depth through a full-text review. This assessment considers the suitability of the topic, methodological quality, clarity of the variables studied, and the relevance of the research results to the purpose of the review. The inclusion stage results in a collection of literature that meets all criteria and is worthy of analysis. The selected articles include experimental studies, epidemiological research, intervention trials, and

policy reviews related to the role of vitamin A and the use of local foods based on yellow gourd in stunting prevention efforts in Indonesia, as well as providing a solid basis for the analysis of the relationship between local fortification of vitamin A-rich foods and stunting control strategies, especially in the South Sumatra region. This writing uses a literature study method by examining three main journals and several supporting references

RESULTS AND DISCUSSION

According to *Presidential Regulation of the Republic of Indonesia Number 72 of 2021*, stunting is a disorder of children's growth and development due to chronic malnutrition and recurrent infections, which is characterized by a child's height being below the standards set by the Minister of Health. Meanwhile, *the Ministry of Health of the Republic of Indonesia* defines stunting as a growth disorder in toddlers so that the child's height is not appropriate (shorter) compared to the age standard. The *Ministry of Villages, Development of Disadvantaged Regions, and Transmigration (Kemendesa, 2017)* explained that stunting is a condition when a person's height is shorter than the average height of a child of his age. Malnutrition that occurs from pregnancy to toddlerhood is the main cause of stunting and low levels of adequacy of micronutrients such as vitamin A, which is often triggered by a lack of maternal knowledge about nutrition and health before and during pregnancy. In addition, limited access to nutritious food also worsens the condition (Wahdah et al., 2015).

A joint report *by UNICEF, WHO,* and *the World Bank* in May 2022 showed that in 2020 around 22**%** of children in the world or around 149.2 million people were stunted. This figure is slightly lower than in 2019 which reached 22.4% or around 150.2 million children. Thus, within one year there was a decrease in global prevalence by 0.4%, which indicates progress, although it is still relatively slow in combating stunting globally. The results of the 2018 Indonesian *Basic Health Research (Riskesdas)* noted that the prevalence of stunting reached 30.8%, down from 37.2% in 2013. This decline shows an improvement in children's nutritional status in recent years. However, the stunting rate in Indonesia is still relatively high. Based on *the 2022 Indonesian Nutrition Status Survey (SSGI),* the national stunting prevalence is at 21.6%, which according to *the World Health Organization (WHO)* criteria is still in

the high category. This condition illustrates that stunting is still a priority issue that requires serious attention in the development of child nutrition and health in Indonesia (Sebayang,2023;Sebayang,2024)

One of the cases of stunting in Indonesia occurred in the province of South Sumatra. The average prevalence of stunting in South Sumatra Province based on the results of the 2022 SSGI has decreased from 2021 to around 6.2% from 24.8% to 18.6% below the national level but still above the RPJMN target of 14% in 2024. Data from the SSGI survey shows that from 17 Regencies/Cities, 8 Regencies/Cities have a stunting rate of less than 18.6% with the lowest *stunting* value of 11.6% in Pagar Alam City while there are 9 other Regencies/Cities that still have a *stunting* rate above 18.6% with the highest *stunting* value of 25.4% in Musi Rawas Regency, but there is an increase in stunting prevalence in 2023 by 1.7% from 18.6% in 2022 to 20.3% in year 2023 (Table 1)

Table 1. Stunting *Prevalence Figures* in Regencies/Cities in Province1 of South Sumatra for the period 2021 to 2024

No	Kabupaten/Kota	*Prevalensi Stunting*			
		2021	2022	2023	2024
1	Ogan Komering Ulu	31,1	19,9	15,7	19,2
2	Ogan Komering Ilir	32,2	15,1	32,5	17,6
3	Muara Enim	29,7	22,8	25,9	16,6
4	Lahat	22,4	19,0	07,8	10,6
5	Musi Rawas	28,3	25,4	21,9	15,3
6	Musi Banyuasin	23,0	17,7	16,5	-
7	Banyuasin	22,0	24,8	20,4	-
8	Ogan Komering Ulu Selatan	24,8	19,4	23,0	12,4
9	Ogan Komering Ulu Timur	21,5	19,1	09,3	-
10	Ogan Ilir	29,2	24,9	22,9	20,7
11	Empat Lawang	26,0	18,5	32,6	21,6
12	Penukal Abab Lematang Ilir	20,2	14,6	15,4	17,4
13	Musi Rawas Utara	28,3	20,2	33,1	-
14	Palembang	16,1	14,3	18,9	07,8
15	Prabumulih	22,0	12,3	15,4	09,3
16	Pagar Alam	15,5	11,6	23,3	-
17	Lubuk Linggau	22,8	11,7	17,5	15,7
	Sumatera Selatan	24,8	18,6	20,3	15,9*

Sources of SKI 2021, 2022, 2023 and 2024 data
*There are Regencies/Cities that are still in the process of further analysis

Stunting prevention strategies not only rely on improving access to food, but also emphasize the quality and nutritional density of the food consumed by children during the growth period. One of the approaches that is increasingly recognized as effective is food fortification, which is an effort to enrich food ingredients with essential micronutrients to overcome specific nutritional deficiencies. In this context, the use of

yellow pumpkin as an abundant source of provitamin A is a strategic, sustainable, and relevant alternative to nutritional interventions for the people of Indonesia, especially in the South Sumatra region with a high risk of stunting.

A. Vitamin A and Child Growth

Vitamin A plays a very important physiological role in the child's growth process, especially in the function of bone cell proliferation (osteogenesis), tissue differentiation, and maturation of the immune system. A review of a number of studies shows that retinol and its active metabolites not only work as essential components in the regulation of immunity, but also act as molecular regulators in cell differentiation and proliferation through the activation of *retinoic acid receptors* (RAR). These receptors regulate the expression of genes related to osteoblast formation and osteoclast control, thereby supporting the process of bone formation and lengthening (Rahayu et al., 2018). The mechanism provides a strong biological basis for why adequate vitamin A status is associated with increased bone mineral density as well as optimal linear growth in childhood.

Various empirical studies show a strong correlation between vitamin A deficiency and an increased risk of stunting. Vitamin A deficiency impairs the function of the epithelium in various organs, decreases tissue regeneration capacity, and increases children's susceptibility to chronic or recurrent infections. This condition triggers a pathological cycle of infection nutrition, in which the body allocates energy to fight infection instead of for growth (Dewey et al., 2021). The results of the study of Winata, Herliani & Suhartati (2024) confirm that vitamin A supplementation has a positive impact on the growth and development of toddlers, while national surveys show a significant correlation between vitamin A levels and linear growth (Arifin, Rimbawan, Riyadi & Ernawati, 2024).

Thus, vitamin A's ability to maintain the integrity of the immune system, support bone metabolism, and strengthen tissue regeneration, places it as a strategic micronutrient in efforts to prevent stunting, both through supplementation interventions and local food-based strategies.

B. Local Food Rich in Vitamin A Characteristics and Potential of Yellow Pumpkin

Yellow pumpkin (*Cucurbita moschata*) is one of the local food commodities that is rich in provitamin A in the form of β-carotene. Various nutritional composition studies have shown that the meat and skin of yellow pumpkin contain high concentrations of β-carotene, as well as flavonoids and phenolic compounds that are antioxidants (Lismawati, 2021). This compound not only plays a role in increasing the body's antioxidant capacity, but also contributes to nutritional stability during storage and processing.

The β-carotene content in yellow pumpkin can change depending on the processing technique. Research by Purba et al. (2022) and Arifin, A. Y., Rimbawan, Riyadi, H., & Ernawati, F. (2024) shows that the process of overheating or high-temperature drying can cause a significant decrease in β-carotene levels. Instead, techniques such as steaming or short cooking can increase bioavailability as it softens the plant cell matrix.

Compared to other sources of vitamin A such as liver or synthetic supplements, yellow squash has advantages due to its wide availability, affordable price, and production sustainability. In stunting-prone areas such as South Sumatra, yellow pumpkin has the potential to be processed into various forms of complementary foods for children such as baby puree, porridge, snacks, and snacks that are culturally accepted and easy to process. Research by Winata, C. T., Herliani, O., & Suhartati (2024) shows that some types of processed yellow pumpkin still maintain high antioxidant activity after processing.

In addition, a number of modern food studies show the adaptability of yellow squash in various product innovations. Substitution of yellow pumpkin puree in *noodle-based products* increases antioxidant capacity by up to 35% without interfering with the elasticity of the noodles (Rahmawati et al., 2022), while the addition of 10–15% yellow pumpkin flour to breadsticks improves color and sensory reception (Harrington & Kolawole, 2020). In functional beverages, *pumpkin-based beverage formulations* with pectin stabilizers are able to retain more than 70% β-carotene during cold storage (Nasution et al., 2021). In fact, the fermentation process in yellow pumpkin yogurt increases the bioavailability of carotenoids (Olivia & Martins, 2019).

These findings reinforce that yellow squash has high technological flexibility and great potential as a local food ingredient rich in vitamin A.

C. Local Food-Based Fortification Approach

Food fortification is an effective strategy to increase vitamin A adequacy through the addition of micronutrients to processed foods. In yellow pumpkin, fortification can be carried out in the form of flour, puree, or β-carotene extract, both at the household, small industry, and industrial scale levels. Various studies have shown the success of yellow squash fortification in products such as bread, sponges, puddings, tortillas, sausages, and jams. This process not only increases the content of provitamin A and dietary fiber, but also enriches natural color and enhances sensory appeal.

Examples of fortification applications include filling substitution in sausages using yellow pumpkin that increases β-carotene without lowering protein content (Prayitno et al., 2009), making cookies made from yellow pumpkin flour that are well received organoleptically (Dyana, 2022), to nutrient-dense flakes formulations made from yellow pumpkin and moringa leaves (Panjaitan & Rosida, 2022). A quasi-experimental intervention by Lestari et al. (2022) even showed an increase in height of almost 3 cm in stunted toddlers thanks to the consumption of fortified pumpkin products.

In addition to solid products, fortification is also successfully applied to baby food. Encapsulation of yellow pumpkin flour improves the stability of provitamin A during instant porridge rehydration (Sari & Kusnadi, 2020), while yogurt made from yellow pumpkin significantly increases the β-carotene content and potentially prevents vitamin A deficiency (Ahmed et al., 2023). Snack bars, wet noodles, and various other MSME products also show stability and good quality during storage (Phanthavong et al., 2021; Damanik & Putri, 2022).

Overall, the findings confirm that yellow pumpkin fortification is a practical, adaptive, and significant approach in increasing provitamin A intake in children.

D. Implementation Challenges in Yellow Pumpkin Fortification in the Community

Although the potential of yellow pumpkin is very large, the implementation of fortification in the community faces various challenges. From the socio-cultural aspect, some people view yellow pumpkin as a simple food or with low economic value, so it does not become a routine part of daily consumption. The low level of knowledge

about the benefits of provitamin A also affects the low interest in consuming products made from yellow pumpkin.

In terms of production, the yellow pumpkin supply chain is still not optimal. Varieties with high β-carotene levels are not evenly distributed, harvest periods are not always in accordance with the needs of nutrition programs, and commodity prices can fluctuate. In addition, small industries and households may be constrained by adequate processing equipment to maintain the stability of carotenoids.

Policy constraints are also an obstacle. In order for the local food fortification program made from yellow pumpkin to run sustainably, government support is needed through integration in national nutrition policies, PMT programs, and public education. Collaboration across agriculture, health, education, and MSME sectors is essential to overcome technical and social barriers.

However, the results of the extension program show positive developments. Education on stunting prevention combined with a demonstration of yellow pumpkin processing increased the knowledge of mothers under five and healthy food cooking skills. Products such as yellow pumpkin pudding, fortified sponges, and healthy snacks made from yellow pumpkin have proven to be well received and have the potential to improve children's nutritional status. With the support of the community and the government, the implementation of yellow pumpkin fortification can be a sustainable strategy for stunting prevention in South Sumatra

CONCLUSION

Yellow pumpkin-based food fortification (*Cucurbita moschata*) is a nutritional intervention strategy that has a strong scientific basis and high social relevance in the context of stunting prevention, especially in the South Sumatra region. The high β-carotene content of yellow pumpkin, its stability to various processing techniques, and its ability to be converted into vitamin A physiologically make this commodity a superior source of provitamin A. Studies have shown that the integration of pumpkin flour and puree in a variety of food products such as bread, puddings, snacks, purees, and processed meat products consistently increases the content of provitamin A while maintaining sensory quality that is acceptable to consumers. The findings show that yellow pumpkin fortification is not only able to enrich the nutritional profile of the

product, but also offers formulation flexibility and technological compatibility that allows its application at the scale of small industries, households, and community empowerment programs. In the context of South Sumatra, the agronomic characteristics that support the cultivation of yellow pumpkin, coupled with low prices and stable availability of raw materials, strengthen the position of this commodity as a strategic part of the local food system. Nutrition education and processing training that has been implemented in several communities has shown a positive response, indicating that the integration of pumpkin fortification into family diets is highly likely to be widely adapted if supported by adequate educational interventions.

However, the effectiveness of yellow pumpkin fortification in reducing the prevalence of stunting still requires more comprehensive empirical evidence. Most research still focuses on the technological and sensory aspects of the product, while the direct impact on vitamin A status and linear growth has not been extensively studied in long-term research design. Studies on the bioavailability of β-carotene after processing, variations in nutritional content between local pumpkin varieties, and the economic feasibility of the supply chain are also aspects that need to be further worked on before fortification can be implemented as a structured regional nutrition policy. Overall, pumpkin fortification offers a feasible, sustainable, and community-based approach to strengthening children's nutritional resilience. In the context of South Sumatra, this strategy not only has the potential to increase provitamin A intake in toddlers, but can also strengthen the local food system through family empowerment, food diversification, and abundant use of available raw materials. With the support of advanced research, cross-sectoral policy integration, and strengthening nutrition education in the community, yellow pumpkin fortification has real potential to become an important pillar in accelerating local food-based stunting reduction.

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