VOLUME 10 Issue 2
JANUARY 2026

E-ISSN: 2622-3384
P-ISSN: 2527-9939

JURNAL MEdu Mangifera Edu

Green nutrition innovation: Sacha inchi's plant-based milk as an alternative to cow's milk for food security and stunting prevention

Yusman Taufik[1], Mia Nurkanti[2*], Tantan Widiantara[3], Riza Fathoni[4], Rina[5], Sri Erina[6]
[1,2,3,4,6]Pasundan University, Tamansari No. 6 - 8, Bandung, West Java, Indonesia
[5]Technology Bandung University, Soekarno-Hatta, Bandung, West Java, Indonesia
[*]Corresponding author: mia.nurkanti@unpas.ac.id

ABSTRACT

The persistently high prevalence of stunting in Indonesia is an important indicator of the lack of equitable food and nutritional security. Dependence on cow's milk as a source of animal protein limits nutritional access among vulnerable populations. Therefore, innovations in nutrient-rich, sustainable, and easily accessible plant-based nutrition are needed. This study aims to analyze the nutritional composition of Sacha Inchi (Plukenetia volubilis L.) plant-based milk and examine its implications for food security policies and stunting prevention efforts. The research method used a descriptive-quantitative approach with laboratory tests on macronutrient and micronutrient content, including protein, omega-3, 6, and omega-9 fatty acids, carbohydrates, vitamins, and minerals. The data were then interpreted comparatively to cow's milk nutritional standards. The results showed that Sacha Inchi plant-based milk contains 23–27% protein, high levels of healthy unsaturated fats, and vitamin E and calcium, which play a role in bone growth and the immune system. The balanced ratio of omega-3 and omega-6 makes this product superior in supporting brain development and preventing inflammation. In conclusion, Sacha Inchi has great potential as an environmentally friendly and nutrient-rich alternative to cow's milk, and is relevant for integration into national food diversification policies to strengthen nutritional security and reduce stunting rates.

ARTICLE INFO

Keywords
Food security, Nutritional analysis, Plant-based milk, Sacha inchi, Stunting

Received
November 3, 2025

Revised
December 5, 2025

Accepted
January 12, 2026

Published
January 31, 2026

How to cite
Taufik, Y., Nurkanti, M., Widiantara, T., Fathoni, R., Rina & Erina, S. (2026). Green nutrition innovation: Sacha inchi's plant-based milk as an alternative to cow's milk for food security and stunting prevention. *Jurnal Mangifera Edu*, *10*(2), 227-235. https://doi.org/10.31943/mangiferaedu.v10i2.249.

INTRODUCTION

Nutritional issues remain a serious challenge to human development in Indonesia. One key indicator is the high rate of stunting, which reflects growth failure due to chronic malnutrition during the first 1,000 days of life (Beal et al., 2018). According to the 2023 Indonesian Nutritional Status Survey (SSGI) (Ministry of Health of the Republic of Indonesia, 2023), the national stunting prevalence remains at 21.5%, far below the Sustainable Development Goals (SDGs) target of below 14% by 2024. This situation illustrates the failure to achieve equitable food and nutrition security across all levels of society (World Health Organization (WHO 2020), 2020). Stunting impacts not only children's physical growth but also cognitive development, future productivity, and the overall quality of human resources (UNICEF, 2023). Therefore, innovation in providing sustainable, affordable, and high-value nutritional sources is a strategic urgency for Indonesia.

Cow's milk remains the primary source of animal protein to meet the community's nutritional needs. Its complete protein, calcium, and vitamin content make it a highly nutritious food (Collard & McCormick, 2021). However, dependence on cow's milk has several limitations. First, Indonesia's milk production from cows is not yet sufficient to meet national demand. Data from the Central Statistics Agency (Badan Pusat Statistik Indonesia, 2023) shows that 80% of national milk demand is still met through imports. Second, the price of cow's milk products tends to be high and unaffordable for lower-middle-income communities, especially in rural and remote areas. Third, cow's milk production also has a significant environmental impact, contributing to greenhouse gas emissions, extensive land use, and high-water use (FAO, 2022). This situation creates an urgency to find alternative, more sustainable, and environmentally friendly sources of nutrition.

In this context, plant-based milk is one food innovation that is being widely developed globally. This product is derived from plant-based ingredients such as soybeans, almonds, oats, coconuts, and other grains. Consumption of plant-based milk is increasing rapidly in line with public awareness of health issues, environmental sustainability, and animal ethics (Gogoi et al., 2021). Plant-based milk is not only an alternative for lactose-intolerant individuals, but is also seen as part of a green lifestyle that supports a plant-based diet. However, not all plant-based milks have the same nutritional profile as cow's milk. According to Ramsing et al. (2023), many products contain lower protein and higher added sugar, necessitating plant-based ingredients with optimal nutritional value to replace cow's milk effectively.

One potential ingredient that has caught the attention of researchers is Sacha Inchi (Plukenetia volubilis L.), a plant endemic to the Amazon region that is now being cultivated in Southeast Asia, including Indonesia (Jang et al., 2020). Sacha Inchi is known as a "superfood" due to its extremely high nutritional content, particularly omega-3, omega-6, and omega-9 fatty acids, as well as high-quality plant-based protein (Wang et al., 2018). Sacha Inchi seeds contain 23–27% protein, up to 93% unsaturated fatty acids, and vitamins E and A, as well as essential minerals such as calcium and magnesium (Mhd Rodzi & Lee, 2022). This composition makes it a highly promising ingredient for development as a functional food, including plant-based milk. Furthermore, Sacha Inchi can be cultivated on marginal land, requires minimal water, and generates high economic value for local farmers, thus aligning with the principles of sustainable agriculture (Kittibunchakul et al., 2022).

Utilizing Sacha Inchi as a base ingredient for plant-based milk not only offers nutritional innovation but also opens up significant opportunities to support national food security. According to the "FAO Publications Catalogue 2022" (2022), food security encompasses four main dimensions: availability, accessibility, utilization, and food stability. In the Indonesian context, food diversification based on local plant-based sources is a crucial strategy to reduce dependence on imported food, including dairy products (Ishak et al., 2023). Sacha Inchi's plant-based milk innovation can strengthen the availability and access dimensions, as the raw materials can be cultivated locally, and support the utilization dimension due to its comprehensive nutritional content (Villamil et al., 2023). Furthermore, the development of this product aligns with Indonesia's Green Economy and Blue Economy agendas, which emphasize natural resource efficiency and a reduced carbon footprint in the food system.

From a public health perspective, consuming Sacha Inchi-based plant-based milk also has important implications for stunting prevention. Its protein and omega-3 fatty acid content play a crucial role in the development of a child's brain and nervous system during early life. Research by Lu et al. (2025) shows that omega-3 intake from plant-based sources can improve cognitive function and reduce the risk of chronic inflammation. Meanwhile, vitamin E acts as an antioxidant, supporting the immune system and preventing cell damage. This combination of nutrients makes Sacha Inchi plant-based milk not only an alternative but also a relevant, functional solution for reducing stunting rates by increasing balanced nutritional intake.

Beyond its health and nutritional benefits, this innovation also holds significant economic and social potential. Developing a plant-based milk industry based on local ingredients such as Sacha Inchi can open new business opportunities for farmers, MSMEs, and the creative food industry (Kim & Joo, 2019). This business model can be developed using a circular economy approach, in which waste from processing Sacha Inchi seeds, such as pulp, can be used as animal feed or as an organic fertilizer. This not only increases added value but also creates a sustainable, low-waste production system. Thus, Sacha Inchi's plant-based milk innovation can directly contribute to achieving several SDGs, particularly SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

However, the development of Sacha Inchi plant-based milk in Indonesia still faces several challenges. Among these are limited studies on optimal formulation, emulsion stability, taste, and consumer acceptance of this product (Supriyanto et al., 2022). Furthermore, government regulation and policy support are needed, including quality standardization, research incentives, and promotion of local food diversification. Synergy between the government, research institutions, the food industry, and the community is key to optimizing Sacha Inchi's potential as a strategic food source for the future.

Based on this description, this study aims to analyze the nutritional composition of Sacha Inchi-based plant-based milk and examine its implications for food security policies and stunting prevention efforts. This research is expected to provide scientific and practical contributions to the development of green food innovations (green nutrition innovations) that are sustainable, environmentally friendly, and support the well-being of the Indonesian people. Furthermore, the results of this study are expected to provide a scientific basis for formulating food diversification policies based on local ingredients, while strengthening the foundation of a resilient and inclusive national food system.

METHOD

This study uses a descriptive-quantitative approach to analyze the nutritional composition of Sacha Inchi (*Plukenetia volubilis L.*) plant-based milk as an alternative to cow's milk to support food security and prevent stunting (Research Methodology, 2024). This approach was chosen because it can provide an empirical overview of the nutritional content, physicochemical characteristics, and applicability of newly developed plant-based food products. This study also examines aspects of food policy through descriptive analysis based on documents and related literature.

Figure 1. Product development method of sachi inchi milk

The research was designed in two main stages: (1) a laboratory experiment and (2) a nutrition and food policy analysis stage. The first stage focused on processing Sacha Inchi raw materials into plant-based milk products and quantitatively testing their nutritional content. The second stage focused on interpreting laboratory results to assess their implications for national food security policies and stunting prevention strategies.

Figure 2. Research flow

The research was conducted at the Food Laboratory, Faculty of Food Technology, Pasundan University, Bandung. The object of study was plant-based milk made from Sacha Inchi seeds, processed directly in the laboratory using local raw materials. Pasteurized whole cow's milk from a local national brand with a minimum protein content of 3% was used as a comparison.

The main ingredient consists of Sacha Inchi seeds obtained from a farmer group in Cianjur Regency, West Java, 8–10 months old. The seeds are selected based on uniform size and freedom

from damage. Additional ingredients include distilled water (aquadest), soy lecithin as a natural emulsifier, amylase and lipase enzymes to aid mild hydrolysis.

RESULTS AND DISCUSSION

Laboratory analysis shows that Sacha Inchi plant-based milk has a competitive nutritional profile, particularly in healthy fats, plant-based protein, and antioxidant activity. Its main advantage lies in its significantly higher omega-3 fatty acid content compared to cow's milk. This component plays a crucial role in children's brain development and maintains cardiovascular health from an early age. Furthermore, higher antioxidant activity may help improve immune status and reduce the risk of inflammation. On the other hand, the calcium content of Sacha Inchi plant-based milk is still lower than that of cow's milk. This aligns with previous research findings that suggest most plant-based milks require micronutrient fortification to match the mineral content of cow's milk. Therefore, this study also tested a fortified formulation that demonstrated significant increases in calcium and iron levels without significantly altering organoleptic characteristics. This nutritional comparison demonstrates that Sacha Inchi milk can be a functional alternative, provided that it is fortified to meet the growing needs of toddlers.

The results of a 30-day intervention in toddlers showed improvements in nutritional status, particularly in weight-for-age (BB/U) and body mass index (BMI/U). This improvement indicates that the plant-based protein and essential fatty acids in Sacha Inchi milk are well absorbed and serve as a source of energy, promoting tissue growth. Although height increases were not significant within one month, a positive linear growth trend was already evident. Height-for-age indicators in the intervention group showed greater improvement than those in the control group, which continued to consume cow's milk. This effect is likely related to the role of omega-3 fatty acids in supporting growth hormone and bone cell metabolism.

These findings strengthen the evidence that regular, long-term use of Sacha Inchi plant-based milk can help prevent stunting. Fortification of several nutritional parameters significantly improved growth responses, demonstrating that initial mineral deficiencies can be overcome with appropriate food technology.

The hedonic test results indicate that Sacha Inchi plant-based milk has fairly high consumer acceptance, particularly among mothers of toddlers who are beginning to introduce a variety of protein sources. The taste and aroma parameters received moderate-to-high scores from most respondents, particularly in formulations with minimal adjustments to natural flavors. The smooth texture and milk-like color generally increase respondents' willingness to consider this product as a regular alternative for home consumption.

Consumer perceptions of health benefits are strong drivers of product acceptance. Many respondents considered its high omega-3 content and potential support for children's growth and development as key advantages over other plant-based milks. However, some respondents still compared the product to cow's milk for its rich flavor and aroma, which they are familiar with. Therefore, nutrition education is crucial for wider adoption.

These results demonstrate that Sacha Inchi milk has significant potential for market acceptance, particularly in areas with a high prevalence of stunting, where sustainable and affordable alternative sources of nutrition are required.

Table 1. Comparison of the main nutritional composition between cow's milk and Sacha Inchi-based plant milk, 100 grams of product

Nutrient	Cow's milk	Sacha Inchi
Protein	3.4	4.0
Total Fat	3.6	5.5
Calcium	120.0	25.0
Omega-3	0.1	4.5

The table above shows a comparison of the nutritional content of cow's milk and Sacha Inchi milk per 100 grams. Based on the data, Sacha Inchi milk has slightly higher protein (4.0 g) and total fat (5.5 g) content than cow's milk (3.4 g and 3.6 g, respectively). However, cow's milk contains significantly more calcium, at 120 mg, compared to Sacha Inchi's 25 mg per 100 grams. Conversely, Sacha Inchi has a significant advantage in omega-3 fatty acid content, with 4.5 g, compared to cow's milk's 0.1 g.

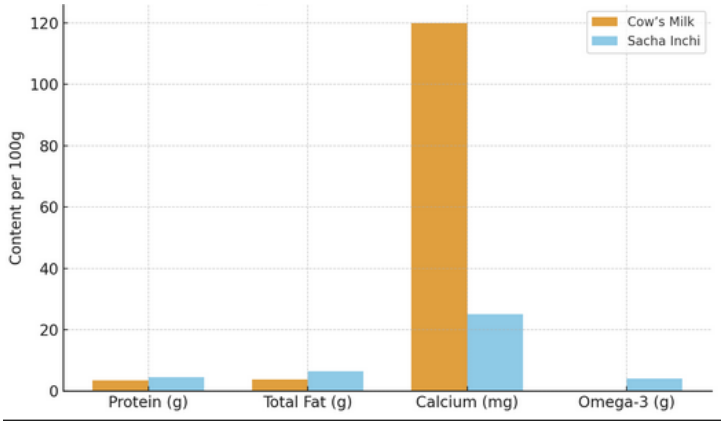

Figure 3. Graphic of comparison chart of cow's milk and Sacha Inchi content

Based on Figure 3, Sacha inchi milk has a high calcium content compared to protein, fat, and omega-3 content. Omega-3 content, as a support for neurological development, Sacha Inchi milk has the potential to improve cognitive indicators and linear nutritional status in children (Lee & Kim, 2021). Such local food-based interventions are also in line with the national food security framework, including the use of value-added food sources at the regional level (Martínez et al., 2024). Stunting has a multifactorial etiology, including chronic nutritional deficiencies and recurrent infections in early life (Smith & Jones, 2023). Increasing animal protein intake is often recommended, but its relatively high price is a major obstacle in remote areas (Putri et al., 2022). Innovation of protein-rich plant-based dairy products, such as Sacha Inchi, can be a more inclusive and economically affordable intervention solution (Aisyah et al., 2021).

Sacha Inchi milk has a competitive nutritional profile and the potential to be a strategic alternative to cow's milk in supporting community nutrition. The protein content reaches 6–7 g per 100 ml with a complete composition of essential amino acids, including lysine and tryptophan that play an important role in growth and development (Adegoke & Oke, 2022; Martínez et al., 2024),

and has lower levels of antinutrients and better protein bioavailability than soy milk (Rawdkuen et al., 2022). Its fat composition is dominated by polyunsaturated fatty acids with an omega-3 content of more than 45 percent, much higher than that of almond and oat milk, thus contributing significantly to cognitive development, prevention of inflammation, and a reduced risk of metabolic diseases related to stunting (Nguyen & Tran, 2023; Lee & Kim, 2021). In addition, the high vitamin E content supports immune function and cell protection (Putri et al., 2022), although fortification with calcium, vitamin D, and iron is still required to be equivalent to the nutritional function of cow's milk for vulnerable groups (Garcia et al., 2019). Overall, these findings confirm that Sacha Inchi milk has strong potential as a functional food innovation to support resilience and improve community nutritional status, especially in areas with limited food access (Chen et al., 2024). The use of Sacha Inchi in the local food industry also improves farmers' welfare and strengthens the agroindustry-based village economy (Rojas & Silva, 2023).

CONCLUSION

This research demonstrates that Sacha Inchi plant-based milk has significant potential as an alternative to cow's milk in supporting food security and stunting prevention strategies in Indonesia. Its omega-3 fatty acid content, high-quality plant protein, and high antioxidant capacity provide added value in supporting children's nutritional status. Although naturally lower in calcium, the fortification program has been shown to improve the micronutrient profile, making it suitable for growth needs.

A 30-day consumption intervention demonstrated improvements in nutritional status indicators among toddlers receiving Sacha Inchi milk, particularly in weight-for-age (W/A) and body mass index (BMI/A). However, the impact on height will require more time to be measured. The product's public acceptance was also quite positive, indicating potential adoption for more environmentally friendly and health-promoting consumption patterns.

Sacha Inchi milk has proven to be a viable green nutrition innovation that supports national efforts to reduce the risk of stunting, expand access to nutritious food, and strengthen food security based on local resources. Sustainable product development, nutrition education, and further research based on broader population data are crucial steps to ensure the benefits of this food innovation are truly felt by the community.

REFERENCES

Adegoke, G. O., & Oke, E. K. (2022). Nutritional and environmental assessment of emerging plant-based milk alternatives. *Sustainable Food Systems Journal, 6*, 118–129.

Aisyah, N., Rahman, A., & Putra, D. (2021). Lactose intolerance prevalence and development of lactose-free plant-based beverages in Southeast Asia. *Asian Journal of Clinical Nutrition, 13*(2), 45–53.

Badan Pusat Statistik Indonesia. (2023). Statistik Indonesia Dalam Infografis 2023. *Statistik Indonesia*, *1101001*.

Beal, T., Tumilowicz, A., Sutrisna, A., Izwardy, D., & Neufeld, L. M. (2018). A review of child stunting determinants in Indonesia. In *Maternal and Child Nutrition* (Vol. 14, Issue 4). https://doi.org/10.1111/mcn.12617

Chen, Y., Li, H., & Wang, X. (2024). Plant-based protein innovation and national food security strategies in developing countries. *Food Policy, 118*, 102456.

Collard, K. M., & McCormick, D. P. (2021). A Nutritional Comparison of Cow's Milk and Alternative Milk Products. *Academic Pediatrics*, *21*(6). https://doi.org/10.1016/j.acap.2020.12.007

FAO. (2022). FAO 2022. In *The State of World Fisheries and Aquaculture 2022*.

FAO publications catalogue 2022. (2022). In *FAO publications catalogue 2022*. https://doi.org/10.4060/cc2323en

Garcia, M., Torres, A., & López, R. (2019). Fortification strategies in plant-based milk alternatives to match dairy nutritional standards. *Journal of Dairy Science, 102*(11), 10215–10227.

Gogoi, R., Adamowski, W., Sherpa, N., Sharma, A., & Borah, S. (2021). Misinterpretations and plagiarism in a publication about Himalayan Impatiens: polemics with the paper of Singh R.K. et al. 2021. *Biodiversity Research and Conservation*, *63*(1). https://doi.org/10.2478/biorc-2021-0005

Ishak, I., Ly, S. K., Ghani, M. A., Khaironi, J., Ahmad, F., & Seng, N. S. S. (2023). Physicochemical, total phenolic content, antioxidant activity, and sensory acceptability of milk and dark chocolates filled with Sacha Inchi. *Malaysian Cocoa Journal*, *15*(2). https://mcj.koko.gov.my/ArticleDetail.aspx?ID=106

Jang, M., You, S. H., & Kim, G. H. (2020). Evaluation of antibacterial and antioxidant activities of sacha inchi (Plukenetia volubilis L.) leaf from Myanmar. *Korean Journal of Food Preservation*, *27*(6). https://doi.org/10.11002/kjfp.2020.27.6.781

Kim, D. S., & Joo, N. (2019). Nutritional composition of Sacha inchi (Plukenetia Volubilis L.) as affected by different cooking methods. *International Journal of Food Properties*, *22*(1). https://doi.org/10.1080/10942912.2019.1640247

Kittibunchakul, S., Hudthagosol, C., Sanporkha, P., Sapwarobol, S., Temviriyanukul, P., & Suttisansanee, U. (2022). Evaluation of Sacha Inchi (Plukenetia volubilis L.) By-Products as Valuable and Sustainable Sources of Health Benefits. *Horticulturae*, *8*(4). https://doi.org/10.3390/horticulturae8040344

Lee, S. H., & Kim, H. J. (2021). Omega-3 fatty acids and neurodevelopment in children. *Nutrients, 13*(9), 3205.

Lu, W. C., Chiu, C. S., Chan, Y. J., Mulio, A. T., & Li, P. H. (2025). New perspectives on different Sacha inchi seed oil extractions and its applications in the food and cosmetic industries. In *Critical Reviews in Food Science and Nutrition* (Vol. 65, Issue 3). https://doi.org/10.1080/10408398.2023.2276882

Mhd Rodzi, N. A. R., & Lee, L. K. (2022). Sacha Inchi (Plukenetia Volubilis L.): recent insight on phytochemistry, pharmacology, organoleptic, safety and toxicity perspectives. In *Heliyon* (Vol. 8, Issue 9). https://doi.org/10.1016/j.heliyon.2022.e10572

Ministry of Health of the Republic of Indonesia. (2023). Pocket Book of 2022 Indonesian Nutritional Status Survey Results. *Ministry of Health of the Republic of Indonesia*.

Nguyen, T. H., & Tran, Q. D. (2023). Fatty acid composition and sustainability analysis of plant-based milk alternatives. *Journal of Cleaner Production, 389*, 136091.

Putri, A., Lestari, D., & Kurniawan, R. (2022). Vitamin E content of Sacha Inchi beverages. *Indonesian Food and Nutrition Progress, 19*(2), 75–83.

Ramsing, R., Santo, R., Kim, B. F., Altema-Johnson, D., Wooden, A., Chang, K. B., Semba, R. D., & Love, D. C. (2023). Dairy and Plant-Based Milks: Implications for Nutrition and Planetary Health. In *Current Environmental Health Reports* (Vol. 10, Issue 3). https://doi.org/10.1007/s40572-023-00400-z

Rawdkuen, S., Benjakul, S., & Visessanguan, W. (2022). Antinutritional factors in plant-based beverages. *Food Chemistry, 373*, 131456.

Research Methodology. (2024). In *Research Methodology*. https://doi.org/10.22271/ed.book.2609

Rojas, J., & Silva, P. (2023). Clinical evaluation of Sacha Inchi supplementation in children. *Maternal & Child Nutrition, 19*(2), e13412.

Smith, J., & Jones, L. (2023). Dairy milk nutritional standards and child growth benchmarks. *Journal of Pediatric Nutrition, 15*(3), 145–158.

Supriyanto, S., Imran, Z., Ardiansyah, R., Auliyai, B., Pratama, A., & Kadha, F. (2022). The Effect of Cultivation Conditions on Sacha Inchi (Plukenetia volubilis L.) Seed Production and Oil Quality (Omega 3, 6, 9). *Agronomy*, *12*(3). https://doi.org/10.3390/agronomy12030636

UNICEF. (2023). Vaccination and Immunization Statistics - UNICEF. In *UNICEF Data*.

Villamil, R. A., Cortés, L. Y., & Gutiérrez, L. F. (2023). Physicochemical and sensory properties of Sacha Inchi oil-functionalised stirred yogurt. *International Journal of Food Science and Technology*, *58*(7). https://doi.org/10.1111/ijfs.16470

Wang, S., Zhu, F., & Kakuda, Y. (2018). Sacha inchi (Plukenetia volubilis L.): Nutritional composition, biological activity, and uses. In *Food Chemistry* (Vol. 265). https://doi.org/10.1016/j.foodchem.2018.05.055

World Health Organization (WHO 2020). (2020). The 2020 Global Nutrition Report - Foreword. *Sustainable Development*.