

Potential Of Jicama as A Synbiotic Product for Stunted Children: A Narrative Literature Review

Potensi Bengkuang Sebagai Produk Sinbiotik Untuk Anak Stunting: Studi Literatur Naratif

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Abstract: *Stunting is a chronic nutritional problem associated not only with inadequate nutrient intake but also with imbalances in gut microbiota and digestive tract disorders. One potential strategy to improve this condition is the development of synbiotic beverages based on local food sources, such as jicama (*Pachyrhizus erosus*), which contains natural prebiotics, including inulin and fructooligosaccharides (FOS). This study aimed to examine the potential of jicama as a prebiotic source in the development of synbiotic beverages for stunted children. This study employed a narrative literature review method. A total of 120 articles were identified from PubMed/NCBI, ResearchGate, Taylor & Francis Online, MDPI, and Google Scholar, of which 105 were excluded due to duplication and irrelevance, 8 were excluded because only abstracts were accessible, and the remaining 6 articles were included in the narrative literature review synthesis. The keywords used included "stunting," "gut microbiota," "synbiotic," "prebiotic," and "jicama." Articles published between 2016 and 2026 were selected based on inclusion and exclusion criteria. The review results showed that jicama contains oligosaccharides, inulin, and fructooligosaccharides (FOS) that have the potential to enhance the growth of lactic acid bacteria and support the production of short-chain fatty acids (SCFA). In addition, a synbiotics product may help improve gut microbiota balance and digestive health in stunted children. In conclusion, jicama has the potential to be developed as a functional synbiotic beverage ingredient to support improvements in digestive health in stunted children.*

Key word: Jicama, prebiotic, synbiotic, stunting, gut microbiota, SCFA, functional food

1. INTRODUCTION

Stunting remains one of the major chronic nutritional problems receiving significant attention in many developing countries, including Indonesia. This condition is characterized by impaired linear growth in children due to long-term malnutrition, particularly during the first 1000 days of life (1). The World Health Organization (WHO) reported in 2024 that approximately 150.2 million children under five worldwide, or 23.2%, were affected by stunting. In Indonesia, the prevalence of stunting based on the 2024 Indonesian Nutritional Status Survey (SSGI) remained at 19.8%, while West Java recorded a prevalence of 15.9%, and Karawang Regency recorded 17.6% (3). These figures indicate that stunting continues to be a public health problem requiring sustained interventions because it contributes to cognitive developmental disorders, decreased immune function, and an increased risk of degenerative diseases in adulthood (4).

The problem of stunting is not only associated with inadequate nutrient intake but is also related to gastrointestinal disorders and imbalances in gut microbiota. Children with stunting generally experience gut microbiota dysbiosis, characterized by a decrease in beneficial bacteria such as *Lactobacillus* and *Bifidobacterium* and an

increase in enteric pathogenic bacteria (5). This condition may trigger Environmental Enteric Dysfunction (EED), a chronic disorder of the small intestine that causes prolonged inflammation, increased mucosal permeability, and impaired nutrient absorption (Budge et al., 2019). A reduction in beneficial bacterial populations also decreases the production of short-chain fatty acids (SCFAs), thereby disrupting intestinal mucosal integrity and increasing the risk of gastrointestinal infections (6).

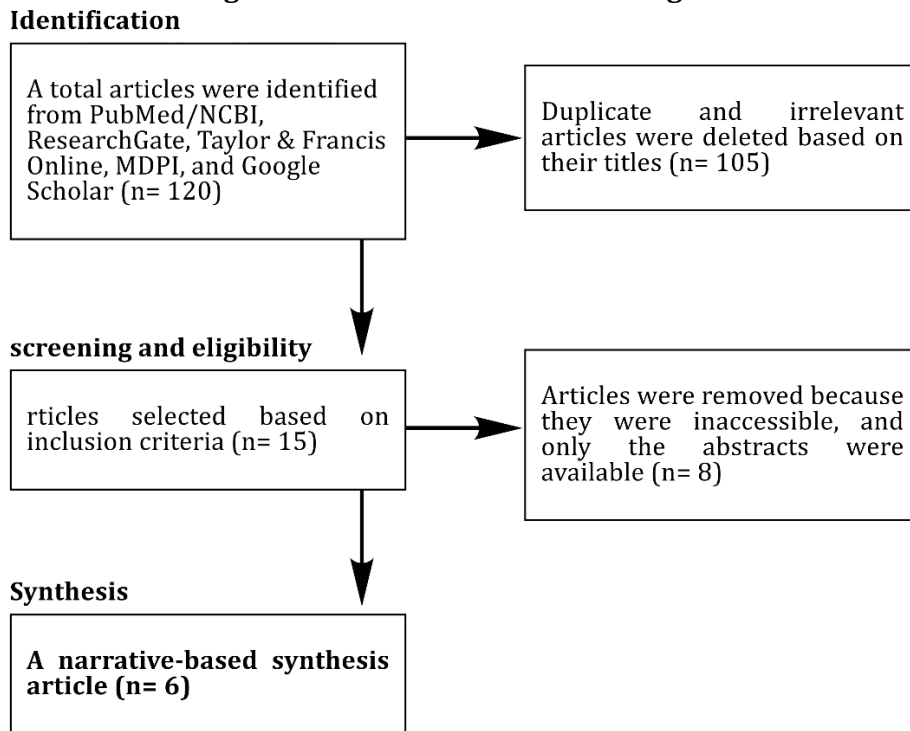
One of the emerging approaches to improve gut microbiota conditions is the administration of synbiotics, which are combinations of probiotics and prebiotics that work synergistically to enhance the viability of beneficial bacteria in the gastrointestinal tract (7). In the development of synbiotic products, jicama (*Pachyrhizus erosus*) has the potential to serve as a natural prebiotic source because it contains inulin and fructooligosaccharides (FOS) that can be fermented by lactic acid bacteria (8). Jicama is also a local tuber commodity widely available in Indonesia, including West Java, due to tropical climate conditions that support its cultivation and availability throughout the year (9). However, previous studies have predominantly focused on fermentation characteristics, lactic acid bacteria viability, and product formulation, while evidence regarding the direct role of jicama-based synbiotic beverages in improving gut microbiota balance and gastrointestinal health in stunted children remains limited. Existing studies also rarely integrate discussions on gut dysbiosis, SCFA production, and the potential synergistic effects of jicama-derived prebiotics in supporting intestinal health among children with stunting. Therefore, this narrative literature review was conducted to synthesize current evidence regarding the potential of jicama as a prebiotic source in the development of synbiotic beverages for children with stunting, particularly in relation to gut microbiota modulation and gastrointestinal health improvement.

2. METHODS

This study employed a literature review method with a narrative approach to examine the potential of jicama as a prebiotic source in the development of synbiotic beverages for children with stunting. A narrative review approach was selected because this study aimed to comprehensively synthesize and interpret findings from previous studies related to jicama, synbiotics, gut microbiota, and stunting. Article searches were conducted through several scientific databases, namely PubMed/NCBI, ResearchGate, Taylor & Francis Online, MDPI, and Google Scholar. The article search strategy used combinations of Indonesian and English keywords, including “stunting,” “stunted children,” “gut microbiota,” “intestinal microbiota,” “prebiotic,” “synbiotic,” “synbiotic drink,” “jicama,” “*Pachyrhizus erosus*,” “inulin,” “FOS,” and “gastrointestinal health.”

The inclusion criteria in this literature review comprised research articles and review articles published between 2016 and 2026, available in full-text form, written in either Indonesian or English, and discussing the relationship between stunting, gut microbiota, prebiotics, synbiotics, lactic acid bacteria, and the utilization of jicama as a functional food. Articles that were not directly related to the research topic, duplicate articles, and articles containing only abstracts were excluded from the review.

Figure 1. Article Selection Flow Diagram



The article search process was conducted from January to May 2026. A total of 120 articles were identified from several databases, including 18 articles from PubMed/NCBI, 32 articles from ResearchGate, 15 articles from Taylor & Francis Online, 10 articles from MDPI, and 45 articles from Google Scholar. The retrieved articles were systematically screened based on titles and abstracts, followed by full-text reading to assess the relevance of the article content to the topic of the literature review. Relevant findings from the selected articles were then synthesized narratively by comparing study characteristics, fermentation outcomes, gut microbiota findings, and the potential role of jicama-based synbiotics in improving gastrointestinal health in children with stunting. After the screening and eligibility process, six articles met the inclusion criteria and were included in this narrative literature review.

3. RESULTS

Six articles met the inclusion criteria and were included in this literature review. The selected articles discussed the relationships among stunting, gut microbiota, prebiotics, synbiotics, and the use of jicama as a functional food ingredient. Most studies have demonstrated that synbiotic-based interventions can increase beneficial bacteria in the gastrointestinal tract and improve disrupted gut microbiota conditions in children with stunting. The findings of these articles are presented in Table 1.

Table 1. Summary of Literature Review Result

Research Title and Year	Research Design and Sample	Results
Title: Quality of Beverages Synbiotic Jicama (Pachyrhizus erosus) Using Inoculum Lactobacillus fermentum with Different Time Incubation (7)	Design: Laboratory experimental study Sample: Jicama synbiotic beverages fermented using Lactobacillus fermentum with	Jicama supported the growth of lactic acid bacteria, with total LAB reaching 1.6×10^8 CFU/mL and decreased pH during fermentation,

Research Title and Year	Research Design and Sample	Results
Year: 2017	incubation periods of 12, 24, 36, and 48 hours	indicating active probiotic metabolism.
Title: Physiological Aspects of Short Chain Fatty Acid (SCFA) (10)	Design: Literature review	SCFAs produced by gut microbiota play important roles in maintaining intestinal integrity, regulating immune responses, and reducing inflammation.
Year: 2020	Sample: Compilation of previous studies on gut microbiota and SCFA metabolism in humans and animals	
Title: Utilization of <i>Lactobacillus plantarum</i> 1 RN2-12112 in the Manufacture of Synbiotic Drinks Made from Jicama Tubers and Red Dragon Extracts (11)	Design: Completely Randomized Design (CRD) laboratory experiment	A 3% starter concentration produced optimal LAB viability and acceptable sensory characteristics, demonstrating the potential of jicama as a synbiotic substrate.
Year: 2021	Sample: Five starter concentrations of <i>Lactobacillus plantarum</i> (2%, 3%, 4%, 5%, and 6%) with three replications each	
Title: Environmental Enteric Dysfunction Induces Intestinal Regulatory T Cells that Inhibit Local CD4+ T Cell Responses and Impair the Efficacy of Oral Vaccines (12)	Design: Experimental animal study (mouse model)	Gut dysbiosis and chronic intestinal inflammation contributed to impaired intestinal permeability and growth disorders associated with stunting.
Year: 2022	Sample: Four groups of mice: isocaloric controls, malnourished mice, <i>E. coli</i> -colonized mice, and Environmental Enteric Dysfunction (EED) mice induced with low-protein diets and adherent-invasive <i>E. coli</i>	
Title: Review Article: Potential of Fructooligosaccharide and Inulin of Local Foodstuffs as Prebiotic Sources (8)	Design: Literature review	Jicama was identified as a rich local source of inulin and fructooligosaccharides that can support the growth of beneficial bacteria.
Year: 2022	Sample: Review of studies discussing inulin, fructooligosaccharides (FOS), lactic acid bacteria, and local Indonesian food sources	
Title: Effect of a 6-Month Functional Food Intervention on the Microbiota of Stunted Children in East Nusa Tenggara, Indonesia—A Randomized Placebo-Controlled Parallel Trial (13)	Design: Randomized placebo-controlled parallel trial	After a 6-month intervention, Synbiotic-related interventions improved gut microbiota composition and reduced pathogenic bacteria, accompanied by improvements in height growth indicators.
Year: 2025	Sample: 200 children aged 3–5 years, consisting of 100 stunted children and 100 non-stunted children	

Based on the identification of articles from the PubMed/NCBI, ResearchGate, Taylor & Francis, MDPI, and Google Scholar databases, six articles were found to meet the inclusion criteria of this study. The selected articles were published between 2017 and 2025 and focused on gut microbiota in children with stunting, the prebiotic activity of

jicama, synbiotic beverage fermentation, and the relationship between lactic acid bacteria and gastrointestinal health.

Most studies employed laboratory experimental methods to evaluate the viability of lactic acid bacteria, pH values, and fermentation characteristics of jicama-based synbiotic products. Several other articles used literature review and observational study methods to explain the relationship between gut microbiota, short-chain fatty acids (SCFAs), and stunting conditions in children. The analyzed studies originated from various regions, including Indonesia and several other countries, that discussed gut microbiota health and prebiotic- and probiotic-based interventions.

Other articles showed that gut microbiota conditions are closely associated with stunting incidence. Children with stunting tend to experience gut microbiota dysbiosis, characterized by a decrease in beneficial bacterial populations and an increase in enteric pathogenic bacteria. This condition is associated with reduced SCFA production, impaired intestinal mucosal integrity, and increased chronic inflammation that affects nutrient absorption. Synbiotic-based interventions are considered to have the potential to help restore gut microbiota balance by enhancing probiotic bacterial activity and the production of functional metabolites.

Based on the overall findings of the analyzed articles, there was a relatively consistent pattern indicating that the prebiotic content of jicama supports the growth of lactic acid bacteria and promotes a healthier intestinal environment. Fermentation by probiotic bacteria produces metabolites, such as SCFAs, which help maintain intestinal mucosal integrity, reduce inflammation, and support gastrointestinal health. Nevertheless, most studies have primarily focused on microbiological characteristics and fermented product formulations, while clinical studies evaluating the effectiveness of jicama-based synbiotic beverages in improving the condition of children with stunting remain limited.

4. DISCUSSION

Growth disorders in children with stunting are not only associated with inadequate nutrient intake but also involve alterations in gut microbiota composition that affect metabolic function and gastrointestinal health. Several reviewed studies consistently showed that children with stunting tend to have lower gut microbiota diversity compared to children with normal nutritional status (13). A reduction in beneficial bacterial populations such as *Lactobacillus* and *Bifidobacterium*, accompanied by increased colonization of enteric pathogenic bacteria, may contribute to chronic intestinal inflammation and impaired nutrient absorption. These findings suggest that malnutrition alone may not fully explain the pathophysiology of stunting (14). An unstable gut microbiota environment also disrupts dietary fiber fermentation and reduces the production of key metabolites involved in maintaining gut homeostasis. Bhattacharjee et al. (2022) explained that these conditions are closely related to Environmental Enteric Dysfunction (EED), a chronic disorder of the small intestine characterized by inflammatory cell infiltration, shortening of intestinal villi, and increased mucosal permeability. Mucosal damage reduces nutrient absorption efficiency even when energy and protein intake are relatively adequate. Persistent inflammatory responses may further increase metabolic demands, causing nutrients to be utilized predominantly for immunological processes rather than supporting children's linear growth (15)

Changes in microbiota composition also affect the production of short-chain fatty acids (SCFAs) such as acetate, propionate, and butyrate (6). Reduced SCFA production causes intestinal mucosal integrity to become more vulnerable to damage because colonocytes lose their primary energy source needed to maintain epithelial function (16). Impaired intestinal barrier conditions facilitate the translocation of pathogenic bacteria and endotoxins into systemic circulation, thereby worsening inflammation. This indicates that stunting is not only related to malnutrition but also involves physiological disorders of the gastrointestinal tract and gut microbiota metabolism (17).

Jicama (*Pachyrhizus erosus*) tubers contain inulin and fructooligosaccharides, which belong to the group of natural prebiotics. The $\beta(2\rightarrow1)$ structure of inulin prevents it from being hydrolyzed by human digestive enzymes, allowing it to reach the colon intact (18). Fermentation by probiotic bacteria produces various metabolites that support gastrointestinal health and maintain gut microbiota balance (19). Cahyaningtyas and Wikandari (2022) reported that the FOS and inulin content in jicama reached 44.06 grams, indicating its potential to support the growth of lactic acid bacteria. The jicama juice contains oligosaccharides, vitamin C, fiber, and flavonoids that contribute to antioxidant activity and metabolic health. The fermentation activity of inulin and FOS creates a more acidic intestinal environment due to the formation of organic acids (20). This condition helps inhibit the growth of pathogenic bacteria and maintain gut microbiota stability. The soluble fiber content in jicama also affects intestinal viscosity, resulting in slower glucose absorption and more stable intestinal conditions (21).

The ability of jicama to support probiotic bacterial growth has been demonstrated in several studies on synbiotic beverage fermentation. Zakiy et al. (2017) reported that fermentation of jicama juice using *Lactobacillus fermentum* produced a total lactic acid bacteria count of $10^{9.16}$ CFU/mL after 36 hours of incubation, with a pH value of 3.52. The decrease in pH during fermentation indicates active metabolism by probiotic bacteria utilizing the available carbohydrate substrates in the fermentation medium. Although these findings suggest that jicama has strong potential as a synbiotic substrate, most available studies remain limited to laboratory-scale evaluations focusing on fermentation characteristics, pH values, and probiotic viability rather than direct clinical outcomes in children with stunting.

Fajri and Pato (2021) obtained similar results through the fermentation of jicama and red dragon fruit juice using *Lactobacillus plantarum*. A starter concentration of 3% produced a total lactic acid bacteria count of $10^{9.18}$ CFU/mL with sensory characteristics that were still acceptable to panelists. The high bacterial viability indicates that the prebiotic content in jicama can maintain bacterial metabolic activity throughout the fermentation process. Differences in pH values and total lactic acid bacteria counts among studies are thought to be influenced by probiotic strain type, incubation duration, and the composition of fermentation substrates used. Variations in probiotic strains, fermentation methods, and measured parameters also limit comparability across studies. Clinical evidence evaluating the effects of jicama-based synbiotic beverages on gut microbiota composition, SCFA production, intestinal inflammation, and catch-up growth in stunted children is still scarce.

Fermentation of prebiotics by gut microbiota produces short-chain fatty acids such as acetate, propionate, and butyrate, which play important roles in metabolic health and gastrointestinal integrity (22). Wangko et al. (2020) explained that butyrate serves as the primary energy source for colonocytes, thereby helping maintain intestinal

mucosal structure and strengthening epithelial barrier function. SCFA activity is associated with increased expression of tight junctions that regulate intestinal mucosal permeability. This condition helps reduce the translocation of endotoxins and pathogenic bacteria into systemic circulation. The anti-inflammatory effects of SCFAs also influence the regulation of proinflammatory cytokines and help maintain local immune homeostasis (23). Optimal SCFA production affects the effectiveness of nutrient absorption in children with stunting. Healthier intestinal mucosal conditions support more efficient nutrient absorption, allowing children's linear growth processes to improve. These microbiota metabolite activities indicate that synbiotic-based interventions have potential as a supportive approach in stunting management (24).

The utilization of jicama as a raw material for synbiotic products has strategic value in the development of locally based functional foods. Jicama is relatively easy to find in various regions of Indonesia, including West Java, due to the tropical climate conditions that support its growth (25). The relatively stable availability of raw materials provides opportunities for developing food products with more affordable production costs compared to imported ingredients. Liquid fermented products are considered easier for children to consume than solid products, especially under conditions of gastrointestinal disorders or reduced appetite. The sensory characteristics that remained acceptable to panelists in the study by Fadilah Fajri and Pato (2021) indicate that jicama has the potential to be developed into an applicable synbiotic product suitable for community preferences.

Most available studies still focus on microbiological characterization and fermented product formulation. The included studies showed considerable heterogeneity in research design, probiotic strains, fermentation conditions, and outcome parameters, making direct comparison between studies difficult. Most available evidence emphasized microbiological characterization, bacterial viability, and fermented product formulation, whereas studies evaluating physiological or clinical outcomes were still limited. Investigations regarding the effects of jicama-based synbiotic products on gut microbiota modulation, intestinal inflammation, SCFA production, nutrient absorption, and linear growth in children with stunting have not been extensively explored.

Existing intervention studies also frequently combined synbiotics with other nutritional or hygiene interventions, making it challenging to identify the specific contribution of jicama-derived prebiotics. In addition, the limited number of human studies involving children with stunting indicates that current evidence remains insufficient to support definitive clinical recommendations. These conditions highlight the need for further *in vivo* studies and well-designed clinical trials to strengthen the scientific evidence regarding the therapeutic potential of jicama-based synbiotic products in stunting management.

5. CONCLUSION

Based on various studies that have been analyzed, jicama demonstrates potential as a natural prebiotic source in the development of synbiotic beverages because it can enhance the viability of lactic acid bacteria and support SCFA production. Nevertheless, most studies are still limited to product formulation and microbiological characterization stages. Research regarding the clinical effectiveness of jicama-based synbiotic beverages in improving gut microbiota, reducing gastrointestinal inflammation, and supporting linear growth in children with stunting remains very

limited. Therefore, further studies, both in vivo and clinical trials, are needed to evaluate the effectiveness of jicama-based synbiotic beverages as a supportive intervention for stunting management.

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