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Integration of moringa leaf cookies as healthy snacks to prevent stunting: A literature review

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Abstract

Stunting is a chronic nutritional issue affecting human resource quality from early childhood.This study aims to analyze the potential integration of Moringa leaf cookies as healthy snacks in ECE for stunting prevention. Using a systematic literature review with the PRISMA approach, this study examined SINTA-accredited journals and scientific sources published between 2022 and 2026. Data were analyzed through thematic synthesis and critical analysis. The results indicate that Moringa leaves possess high nutritional value and Moringa-based cookies are well accepted by children. However, a gap exists as most studies focus on food technology, while their integration into ECE pedagogical programs remains underexplored. This study identifies a conceptual gap between nutritional interventions and educational implementation. It concludes that integrating Moringa leaf cookies into ECE programs serves as both a nutrition education medium and a strategic preventive intervention based on local resources.

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INTRODUCTION

Stunting is a condition of growth failure in children due to chronic malnutrition that occurs from early life, especially in the First 1000 Days of Life (HPK) (Silaban et al., 2025). This period from pregnancy to age 2 is a critical phase for physical development and cognitive function (Basri et al., 2021)(Dian et al., 2023). Stunting is measured using the height-for-age (H/A) indicator, defined as being below the WHO reference standard with a z-score < -2 SD (Niswar & B, 2025). Not only does it impact anthropometric aspects, but stunting is also associated with decreased learning ability, decreased productivity in adulthood, and an increased risk of metabolic diseases (Susanti et al., 2024) (Setyaputri et al., 2025). Indonesia still faces a high prevalence of stunting, despite a gradual decline. The latest data shows that the national stunting prevalence is in the range of 19.8%–21, far above the national target of 14% (Sujadalillah & Karo, 2024).

The causes of stunting are multifactorial, including: Insufficient protein and micronutrient intake, repeated infections and poor sanitation, which inhibit nutrient absorption; Low parental nutritional knowledge, resulting in inadequate practices for providing optimal nutritious food; and Low socioeconomic conditions as a trigger for limited access to nutritious food (Shi et al., 2023). Stunting not only reflects a height deficit but also an indicator of social injustice and development challenges in efforts to improve children's quality of life (Khavhatondwi Rinah Netshiheni, 2023).

Early Childhood Education (PAUD) is an educational institution that serves as the first pathway for developing healthy behaviors in children (Ihlas & Hikmah, 2025). In the context of stunting prevention, PAUD plays a crucial role as an agent of nutrition education for children and parents, a facilitator of healthy food consumption habits, and a platform for collaboration between educational institutions, families, and health workers (Brar et al., 2022) . Within the framework of Bronfenbrenner's Ecological Systems Theory, PAUD serves as a vital microsystem that provides more consistent, structured proximal processes than the periodic nature of health post (Posyandu) interventions (Falensya, 2025). While home environments may have limited nutritional literacy, PAUD provides a controlled setting where healthy eating habits are reinforced daily through peer interaction and teacher guidance (Norsanah & Suryani, 2025)**.** This strategy aligns with the Holistic Integrative (HI) approach of PAUD, which combines nutrition, health, developmental stimulation, and education factors in a single learning program (Panova et al., 2025). Thus, PAUD acts as a strategic mesosystem that bridges institutional nutritional standards with household practices, ensuring that stunting prevention is not merely a medical intervention but a sustainable educational habituation(Ariani et al., 2023).

Research in various regions in Indonesia also shows that the role of early childhood education (PAUD) in reducing stunting rates can be implemented through interactions between teachers, parents, and health workers (Perwitasari & Nurita, 2023). This includes nutrition-based parenting education, counseling, and family mentoring programs to identify early risks for stunting in toddlers (Dwi et al., 2025). Thus, PAUD is not only an institution that provides formal learning activities but also an effective platform for influencing family nutrition practices to support optimal growth in early childhood(Nastiti et al., 2025).

In situations of limited resources, one community empowerment strategy to address stunting is the utilization of highly nutritious local foods (Heryanda & Khoriyah, 2024). Local foods can be an alternative source of diverse, affordable, and easily accessible nutrition for the wider community(Rizky et al., 2024) (Rizky et al., 2024). One local plant that stands out in scientific studies is the Moringa oleifera leaf. This plant has traditionally been known in various communities as a source of nutrition due to its high macro- and micronutrient content, including protein, vitamin A, vitamin C, iron, calcium, and antioxidants (Heryanda & Khoriyah, 2024, Dian et al., 2023) . Literature reviews indicate that Moringa leaves have potential as a nutritional supplement worthy of consideration in efforts to prevent chronic malnutrition, such as stunting (Kajuju et al., 2022) . Systematic studies also show that moringa leaf extract and supplementation can contribute to improving nutrient intake in children at risk of malnutrition, although the effects on height growth still require further study(Hermawan et al., 2023).

Although moringa leaves have high nutritional potential, a real challenge in utilizing them is children's acceptance of the food form (Kasih et al., 2024). Early childhood tends to reject foods that are unfamiliar in taste. To increase nutrient consumption, innovations in food processing into attractive and easily accepted

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forms for children need to be developed (Falensya, 2025) . One popular form is healthy snacks based on moringa leaves, such as cookies, sempol, pudding, or other appetizing snacks (Simatupang & Masta Melati Hutahaean, 2024). Several experimental studies have examined the chemical characteristics of processed foods made from moringa leaves, showing that adding moringa to snacks can enrich the protein content without significantly reducing the taste (Hanif & Berawi, 2022)(Fauziah et al., 2024) . Transforming moringa leaves into healthy snacks not only provides additional nutritional value but also serves as a strategy to increase local food diversification among early childhood, thus facilitating nutritional interventions in a more practical and entertaining format for children (Ika Muryasari, Melyana Nurul Widyawati1, Kurnianingsih, 2025). Based on the Health Belief Model (HBM), integrating these snacks into PAUD programs can increase the perceived benefits of nutritious food among children and parents while reducing perceived barriers to healthy eating (Nurmaliani et al., 2025);(Fatmawati et al., 2024) Integrating Moringa cookies into ECE programs holds potential as both a nutrition education medium and a practical preventive intervention.

Based on the above phenomenon, this study aims to critically analyze the integration of Moringa leaf cookies as healthy snacks in PAUD programs for stunting prevention. This study explores why stunting remains a challenge, the strategic role of PAUD as a microsystem in health interventions, and how the innovation of Moringa-based snacks can bridge the gap between nutritional theory and pedagogical implementation in early childhood settings.

METHOD

This study used a Systematic Literature Review (SLR) approach, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, to synthesize scientific evidence related to the integration of Moringa oleifera leaf cookies as a healthy snack in Early Childhood Education (PAUD) programs to prevent stunting. This approach was chosen because it allows for a systematic, transparent, and objective synthesis of cross-disciplinary research findings covering aspects of nutrition, food technology, and early childhood education

The literature search was conducted through Google Scholar, the Garuda Portal, and SINTA-accredited journals using a combination of keywords: stunting, Moringa oleifera or moringa leaves, moringa cookies/healthy snacks, PAUD or early childhood education, and local food. The publication period was limited to 2022–2025 to ensure the recency of the scientific evidence. The obtained articles were then selected based on established inclusion and exclusion criteria to ensure topic relevance and methodological quality.

Table 1. Article Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2021 and 2024	Articles published before 2021
Topics on stunting, Moringa oleifera leaves, healthy snacks, early childhood education (PAUD), or local food	Topics not relevant to the research focus
Articles in accredited journals (SINTA) or peer-reviewed international journals	Opinion articles, non-scientific reports, or unindexed proceedings
Full text available	Abstract only
Indonesian or English	Languages other than Indonesian and English
Contains empirical data (experimental/survey/intervention evaluation)	Conceptual articles without research data

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The article selection process followed the PRISMA stages, which included identification, title and abstract screening, eligibility assessment through full-text review, and inclusion of articles for analysis. The article selection process is visualized in the PRISMA Flow Diagram (Figure 1), while the number of articles at each selection stage is summarized in Table 2.

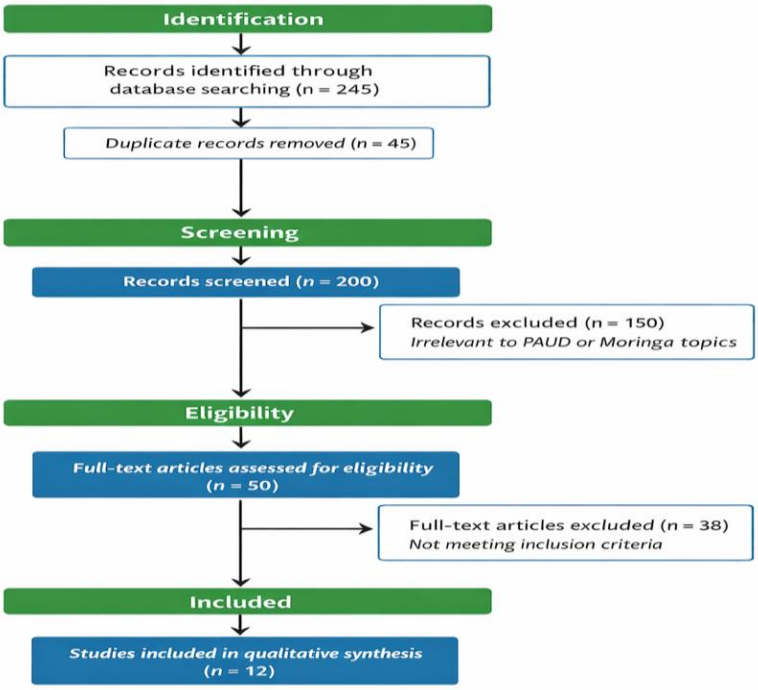

Figure 1. PRISMA Flow Diagram

Table 2. Number of Articles at Each PRISMA Selection Stage

PRISMA Stage	Number of Articles	Description
Initial Identification	245	Results obtained from database search
Duplicates Removed	45	Duplicate articles from multiple sources
Articles After Deduplication	200	Proceeded to screening stage
Title & Abstract Screening	200	Filtered based on relevance
Articles Excluded	150	Not relevant to PAUD/ECE topics
Full-Text Articles Assessed	50	Reviewed in full
Articles Excluded (Full-Text)	38	Did not meet inclusion criteria
Final Articles Analyzed	12	Used in synthesis

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Data analysis was conducted using thematic analysis, grouping research findings into main themes: (1) nutritional content and efficacy of moringa leaves on children's nutritional status, (2) acceptance of moringa-based snacks by early childhood, (3) the role of nutrition education in the context of early childhood education (ECUD), and (4) integration of local food interventions in educational settings. Thematic synthesis was used to identify patterns of findings, differences in research results, and unaddressed research gaps. Recent studies have shown that moringa leaves have significant potential in improving children's micronutrient intake. However, most research focuses on biological aspects and initial sensory testing without evaluating sustainable changes in eating behavior in educational settings(Rahman et al., 2025)(Isra et al., 2024). Furthermore, studies integrating local food interventions with early childhood education (ECUD)-based nutrition education programs are still relatively limited (Perez-Rodrigo et al., 2021)

Data validity was maintained through the use of articles from accredited, peer-reviewed journals, consistent application of inclusion and exclusion criteria, and selection of articles based on the PRISMA protocol. Source triangulation was conducted by comparing research findings from various journals and relevant disciplines. With this approach, the synthesis results are expected to have strong scientific validity and can serve as a conceptual basis for the development of moringa leaf cookie-based interventions in early childhood education programs to prevent stunting.

The distribution of articles shows a predominance of research on nutrition and food technology, while pedagogical studies remain limited. None of the articles specifically discusses the integration of moringa cookies into early childhood education, indicating a potential for novel research.

Table 3. Analyzed Articles

No.	Author (Year)	Title	Journal (SINTA)	Focus
1	Silaban et al. (2025)	Risk Factors of Stunting	JMKI	Stunting
2	Falenswa, R. (2025)	Education and Stunting	JIE	ECE (PAUD)
3	Marhaeni (2021)	Moringa as Functional Food	AGRISIA	Moringa
4	Atina et al. (2022)	Moringa and Child Nutritional Status	MANUJU	Nutrition
5	Hermawan et al. (2023)	Moringa Leaf Cookies	JPA (S2)	Food Products
6	Suwarni et al. (2023)	Acceptability of Cookies	JIGD (S3)	Sensory
7	Fatima et al. (2022)	Holistic Integrative ECE	Obsesi (S3)	Education
8	Utami et al. (2025)	Nutrition Literacy of Children	Obsesi (S1)	ECE (PAUD)
9	Shi et al. (2023)	School Nutrition Intervention	Kesmas (S2)	School
10	Pratiwi et al. (2024)	Local Food for Children	JPL (S3)	Local Food
11	Velayati et al. (2023)	Healthy Snacks for Children	JTI	Snacks
12	Filda Hawali et al. (2024)	Nutrition in ECE	Golden Age	ECE Nutrition

RESULTS AND DISCUSSION

Results

A literature analysis shows that research on moringa leaves, stunting prevention, and the role of early childhood education (PAUD) has been extensive, but remains fragmentary. Table 4 summarizes the key findings from the various studies that form the basis of this research:

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Table 4. Main Research Synthesis

No.	Author & Year	Research Objective	Method	Main Findings	Limitations
1	Silaban et al. (2025)	Analysis of stunting risk factors	Survey	Nutrition, hygiene, and environmental factors	Does not discuss ECE (PAUD) interventions
2	Falenswa et al. (2025)	The role of ECE in stunting prevention	Cross-sectional	ECE is effective as a prevention medium	Does not evaluate food products
3	Marhaeni (2021)	Moringa as functional food	Experimental	High nutritional content	Not contextual to ECE (PAUD)
4	Atina et al. (2022)	Evaluation of Moringa nutrition in toddlers	Quasi-experimental	Improvement in nutritional status	No link with educational interventions
5	Suwarni et al. (2023)	Development of Moringa cookies	Experimental	Sensory acceptance	Does not examine children's behavior
6	Hermawan et al. (2023)	Nutrition analysis of cookies	Laboratory test	Improved nutrition	No ECE (PAUD) curriculum integration
7	Fatima et al. (2022)	Holistic integrative ECE	Qualitative	Need for nutrition integration	No concrete solutions
8	Utami et al. (2025)	Development of ECE modules	Experimental	Increased literacy	No food product innovation
9	Shi et al. (2023)	School nutrition intervention	Quasi-experimental	Changes in eating patterns	Focused on school level, not ECE
10	Hanif & Fauziah (2022)	Local food and child nutrition	Case study	High nutritional potential	No integration in ECE
11	Velayati et al. (2023)	Healthy snack for children	Experimental	Good snack nutrition	Limited educational context
12	Hawali et al. (2024)	Nutrition implementation in ECE	Cross-sectional	Nutrition is important in ECE	No local food-based solutions

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Based on Table 4.1, moringa leaves are consistently recognized for their high micronutrient content, which is essential for child growth. Product innovation in the form of cookies has been shown to have a high level of sensory acceptance in early childhood through hedonic testing (Suwarni et al., 2023). However, the majority of research still focuses on biological nutritional content and food technology. There is a significant gap in the lack of systematic integration of moringa cookies into the curriculum or learning ecosystem of early childhood education (PAUD) as a teaching aid.

Discussion

Literature findings regarding the high nutritional value of moringa provide a strong biological basis for stunting interventions (Silaban et al., 2025). However, the effectiveness of these interventions should not be limited to biological aspects alone. From the perspective of Bronfenbrenner's Ecological Theory, the integration of moringa cookies in early childhood education institutions (PAUD) positions schools as a highly strategic microsystem. Unlike the family environment, which sometimes has limited menu variety or nutritional knowledge, PAUD offers a controlled social environment. Here, nutritional interventions transform from simply providing supplements to a daily habituation process supported by institutional structures.

More deeply, this study proposes that moringa cookies be positioned as a concrete "teaching aid" to bridge the gap between health and education. In the PAUD curriculum, these cookies can be integrated through a Simple Science approach, inviting children to observe the texture, color, and aroma of raw moringa leaves compared with those of the cookies (Hawali et al., 2024). This sensory experience is important for children's cognitive development and understanding of changes in matter(Hermawan et al., 2023). Furthermore, through role-play activities, children can act as little doctors or healthy snack sellers distributing cookies to their friends. This activity transforms the often didactic act of eating into a fun, symbolic game, thereby reducing children's psychological resistance to healthy foods (Marhaeni, 2021).

Regarding the challenge of palatability, this discussion emphasized the importance of sensory strategies based on Social Behavior Theory. One of the main obstacles to stunting prevention at the household level is the phenomenon of food neophobia, or children's fear of trying new flavors. However, in early childhood education settings, peer-group feeding strategies are key. Psychologically, early childhood is a phase where social imitation is dominant(Velayati et al., 2023). Seeing peers enthusiastically consume moringa cookies creates social reinforcement that is far more effective than adult persuasion. This creates a "mini-social norm" within the classroom that consuming green snacks is common and enjoyable, which in turn increases children's self-efficacy in choosing healthy foods.

This argument also aligns with the Health Belief Model (HBM). Through cookie innovation, we effectively lower the perceived barriers to the bitter taste of real moringa leaves. With familiar packaging and snack shapes, the perceived benefits children experience are no longer about "getting high" (which is abstract to them), but rather about delicious taste and "fun eating activities." For parents, easy access to healthy snacks that their children enjoy at school will boost their confidence in providing similar nutrition at home. Thus, PAUD serves as a mesosystem that bridges school nutrition standards into family parenting practices in a sustainable manner(Utami et al., 2025).

Ultimately, this integration makes a significant contribution to strengthening the Holistic and Integrative Early Childhood Education (PAUD HI) policy in Indonesia. Health and nutrition services in PAUD have often been administrative in nature, such as routine weight measurements. The proposed model integrates nutrition services into the pedagogical curriculum. Based on Experiential Learning Theory (Kolb, 1984), children are taught about nutrition not only through pictures on the board but also through a cycle of real-life experiences: seeing plants, feeling products, and experiencing their energy benefits while playing. Consequently, PAUD teachers are transforming into crucial mediators of nutrition education. This strategy offers a more contextual,

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affordable, and long-term model for stunting prevention that contributes to human resource development by strengthening a healthy learning environment.

Gambar 1. Conceptual Model of Moringa Leaf Cookie Integration in Early Childhood Education Learning for Stunting Prevention

As depicted in Figure 4.1, this model demonstrates a linear process that begins with local food innovation and then progresses to the Early Childhood Education (PAUD) learning integration stage. At this stage, the Teacher-Mediated Nutrition Education strategy is applied through tasting activities and fostering healthy eating habits. The result of this integration is increased child nutritional literacy, which then triggers permanent changes in eating behavior. Ultimately, these behavioral changes ensure the sustainability of children's micronutrient intake, thus achieving the primary goal of stunting prevention holistically.

It is important to emphasize that the success of this integration model depends heavily on the competence and self-efficacy of early childhood education (ECE) teachers as agents of change. Literature findings indicate that even when local food products are available, teachers often feel they lack the authority or pedagogical guidance to incorporate them into learning activities (Nurhayati, 2023). Therefore, this strategy requires a redesign of the teacher's role from mere literacy instructors to "nutrition mediators." Teachers need to be equipped with the ability to link nutritional intake to children's readiness to learn. When teachers are able to explain the connection between "eating healthy cookies" and "energy for play and thinking," children will develop a stronger internal awareness (intrinsic motivation) than mere external compliance.

Furthermore, the aspect of sustainability based on local resources is a key selling point in this intervention. Amid fluctuating global food prices and dependence on manufactured products, the use of Moringa oleifera, which grows abundantly in tropical Indonesia, offers nutritional independence. Sociologically, the use of local foods in ECE learning fosters a sense of pride in one's natural resources from an early age. This addresses the socio-economic challenges that often trigger stunting (Ashivatuszahra et al., 2025). where access to quality

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protein no longer has to be expensive but can be achieved through empowering the school environment. This integration indirectly promotes a green school ecosystem that connects the school garden to the children's dinner table.

Finally, this discussion emphasized that stunting prevention through early childhood education (ECE) should be viewed as a long-term investment in cognitive function, not simply improving anthropometrics (height). By positioning moringa cookies as a learning medium, we are actually building "nutritional literacy" that will form the foundation of a healthy lifestyle for children into adulthood. If nutritional interventions are solely medical (such as providing supplements without education), there is a risk that children's eating behaviors will deteriorate again after the program ends. However, with a pedagogical approach in ECE, we instill an understanding that nutrition is an integral part of their identity as healthy and strong learners. The implication is that this integrated model not only addresses current nutritional issues but also breaks the intergenerational chain of stunting through a shift in mindset that begins in the ECE microsystem.

CONCLUSION

Based on a literature synthesis and in-depth analysis, this study concludes that integrating moringa (Moringa oleifera) leaf cookies into Early Childhood Education (PAUD) programs is a highly potential and strategic strategy for sustainable stunting prevention. Biologically, moringa cookies have been shown to have high nutrient density and good sensory acceptance in early childhood. However, the study's primary contribution emphasizes that the effectiveness of this nutritional intervention cannot stand alone; it must be combined with a pedagogical approach that positions cookies as a contextual teaching aid.

Through the lens of Ecological Theory and the Health Belief Model, this study demonstrates that PAUD institutions function as microsystems capable of changing children's eating behaviors through peer interactions and consistent teacher guidance. The proposed conceptual model, using an experiential learning approach, demonstrates that direct nutrition education (tasting and learning about local foods) is far more effective than cognitive education alone. This strengthens the implementation of Holistic Integrative PAUD (PAUD HI) by positioning teachers as nutrition mediators, bridging school health with parenting practices at home.

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