Proceedings Academic Universitas Jambi
Volume 2, Issue 2, July, 2026

Ethnoscience of Enau (arenga Pinnata): Exploring the Local Knowledge of Jambi Communities for Contextual Science Learning

Bambang Hariyadi[1], Azizah Turrohmah[2], Winda D. Kartika[3], Cut Multahadah[4], Rahma Dani[5], Danial Mursyid[6], Fitri Astriawati[7], Ine Tentia[8]

[1,2,3,4,5,6,7,8] Universitas Jambi, Jambi, Indonesia

*Coressponding Authors: bambang_h@unja.ac.id

Abstract

Several traditional communities possess rich local knowledge and traditions related to the management of the sugar palm (enau, Arenga pinnata), encompassing ecological, economic, and cultural values. However, much of this knowledge remains undocumented and has not been optimally utilized in science education. This study aims to explore and document local community knowledge about the sugar palm and to examine the ethnoscientific values embedded within it for potential integration into contextual biology learning. The research was conducted in Jambi Tulo Village, Muaro Jambi Regency, using a descriptive qualitative approach. Informants were selected purposively and expanded using snowball sampling, involving sap tappers, palm sugar producers, customary leaders, and community members possessing traditional knowledge related to the sugar palm. Data were collected through participant observation, in-depth interviews, visual documentation, and literature review, and analyzed using thematic and content analysis to identify relevant scientific concepts. The results indicate that the traditional management of the sugar palm reflects an integration between local knowledge and biological concepts such as plant structure and function, physiological processes (osmosis, root pressure), as well as ecological and conservation principles. Integrating these ethnoscientific values into biology learning can enrich learning contexts, strengthen students' scientific understanding, and foster ecological awareness and appreciation of local wisdom.

Keywords: Arenga Pinnata; Contextual Learning; Ethnobotany; Ethnoscience; Local Knowledge

Cite This Article

Bambang Hariyadi, Azizah Turrohmah, Winda D. Kartika, Cut Multahadah, Rahma Dani, Danial Mursyid, Fitri Astriawati, Ine Tentia. (2026). Ethnoscience of Enau (arenga Pinnata): Exploring the Local Knowledge of Jambi Communities for Contextual Science Learning. Proceedings Academic Universitas Jambi, 2(2): e55518. DOI:

Editor

Dr. Azolla Degita Azis, MBA., M.Ak.

Article info

Received: May 14, 2026 · Revised: July 11, 2026 · Accepted: July 19, 2026

© 2025 The Author(s). Published with license by LPPM Universitas Jambi. This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0 International). This license enables reusers to distribute, remix, adapt, and build upon the material in any medium or format, so long as attribution is given to the creator.

INTRODUCTION

The sugar palm (enau, Arenga pinnata) has long been recognized as a versatile plant that plays an important role in ecological, economic, and cultural aspects across various regions of Indonesia. Its wide range of uses—from preventing soil erosion to supporting local livelihoods through diverse derived products—illustrates its multifaceted importance [1-4]. In Jambi Province, the sugar palm has long been part of the local socio- economic system. Its utilization often involves rituals and symbolic practices that reflect the traditions and cultural identity of the community [5,6]. In several villages in Jambi, the sugar palm forms an essential component of community life, particularly in traditional palm sugar-producing centers such as Malapari, Napal Sisik, and Rambahan in Batang Hari Regency, as well as Jambi Tulo and Pulau Mentaro in Muaro Jambi Regency [7-9]. The use of the sugar palm in these villages extends beyond economic necessity—it has evolved into an integral part of the community's local knowledge systems, traditions, and culture. Techniques for tapping sap, determining the right tapping time, and processing palm sugar are inherited through generations and are often accompanied by beliefs and rituals that illustrate a deep human–nature relationship [1,2,10]. Such traditions represent vital ethnobotanical heritage, where ecological understanding intertwines with spiritual and symbolic meanings. Despite their importance, these systems of knowledge remain poorly documented and underutilized in scientific and educational contexts. Several scholars [11-13] emphasize that preserving and integrating such local practices into biodiversity conservation and education is crucial amid the accelerating pace of land-use change and cultural erosion.

One of the most critical issues threatening the sustainability of sugar palm utilization in Jambi is the high dependence on naturally growing wild populations. Very few people cultivate sugar palm intentionally. In traditional palm sugar-producing areas such as Malapari and Jambi Tulo, most palms grow spontaneously in gardens or other landscapes, making their availability heavily dependent on natural regeneration. Cultivated sugar palms are still rare. Many local people believe that cultivated palms produce less sap than those growing in the wild—a pattern also reported for other sap-producing species [14]. This reliance on wild populations exerts pressure on natural habitats and creates vulnerability in local livelihoods, particularly in the face of habitat loss, aging tree populations, and climate change. The absence of structured domestication and propagation strategies reveals a research and development gap that needs urgent attention to ensure the sustainability of both sugar palm populations and the associated local knowledge and traditions. The sugar palm population in several parts of Jambi is currently experiencing a significant decline, mainly due to rapid land-cover changes, especially the conversion of forests into oil palm plantations. Similar declines have been reported in other regions of Indonesia [15]. This shift not only leads to the loss of natural habitats but also disrupts ecological balance, including natural regeneration processes [16]. Landscape transformation also erodes traditional knowledge such as tapping techniques, cultural rituals, and local ecological practices, as these depend heavily on the continued presence of sugar palm in the community environment [3]. If this trend continues, both the sugar palm population and its accompanying cultural heritage will face extinction. Therefore, integrated conservation strategies encompassing ecological, educational, and socio-cultural dimensions are urgently needed.

Despite the general decline in sugar palm populations, several rural communities in Jambi continue to maintain traditions related to the management and use of the plant. These traditions represent an ethnoscientific system deeply embedded in daily life. Practices such

as reciting poems or chants before tapping, uttering mantras, and performing symbolic actions—such as viewing the tree as the embodiment of a princess—reveal a complex body of local knowledge that goes far beyond practical functions [17]. These rituals and beliefs also reflect keen ecological observations and empirical biological knowledge (such as determining the optimal tapping time and tree maturity), as well as spiritual perspectives and social norms that express a sustainable interaction with nature [18,19]. Preserving such traditions and local knowledge is important not only for safeguarding intangible cultural heritage but also for enriching formal scientific understanding through interdisciplinary approaches that bridge science and culture.

Although local knowledge about sugar palm is abundant, academic studies focusing on its ethnoscientific dimensions remain scarce. Ethnoscientific knowledge related to sugar palm has not been systematically explored or integrated into formal science education, offering an opportunity to enrich meaningful classroom learning with contextually relevant, locally grounded content [20,21]. Ethnoscientific practices associated with the sugar palm—such as ecological observation, sustainable harvesting techniques, and cultural rituals—carry real-world contexts that are valuable for contextual learning in biology, environmental science, and cultural studies. However, current educational curricula often prioritize universal scientific knowledge over local wisdom, resulting in low student engagement and a lack of culturally responsive pedagogy [22,23]. Bridging this gap is an urgent task—not only to preserve local knowledge systems but also to foster science education that is meaningful, inclusive, and responsive to students' lived experiences.

Developing contextual biology learning rooted in local wisdom—such as sugar palm-related ethnoscientific knowledge—is essential for transforming science education into a more meaningful and culturally responsive experience. Integrating local knowledge into science curricula has been shown to enhance student engagement, deepen conceptual understanding through real-world application, and foster awareness of cultural and environmental interconnections [24,25]. Ethnoscience-based learning not only bridges abstract scientific concepts with tangible local practices but also aligns with the principles of deep learning, emphasizing flexibility, critical thinking, and relevance to everyday life [26-28]. Furthermore, contextual learning supports the deep learning frameworks, which promote education that adapts to local contexts and cultivates 21st-century competencies. Integrating the cultural and ecological wisdom embedded in sugar palm traditions into science education will foster holistic, inclusive, and transformative learning experiences, especially in culturally diverse regions such as Jambi.

This study also contributes to addressing both global and local issues, particularly in the conservation of biodiversity and the protection of intangible cultural heritage. By focusing on the ethnoscientific knowledge surrounding the sugar palm, the study supports the Sustainable Development Goals (SDGs)—specifically Goal 4 (Quality Education) through integrating local wisdom into science curricula; Goal 13 (Climate Action) by promoting sustainable ecological practices; and Goal 15 (Life on Land) through the conservation of native plant species and traditional agroforestry systems [29]. Moreover, this research aligns with the advancement of community-based education, recognizing local knowledge holders as educators and co-creators of knowledge, thereby fostering inclusive and participatory educational approaches [30,31]. This research not only addresses environmental and educational priorities but also strengthens rural community resilience in the face of social, ecological, and educational transformations.

METHODS

This study employed a descriptive qualitative approach to explore and document local knowledge related to the enau (Arenga pinnata). Furthermore, the study examined the ethnoscientific values that could be integrated into science education. The research was conducted in Jambi Tulo Village, Muaro Jambi Regency. The qualitative approach was chosen to deeply uncover the meanings, symbols, and values embedded in community life [32]. The research subjects consisted of local community members actively involved in the utilization of the enau palm, such as sap tappers, palm sugar producers, traditional leaders, and villagers possessing traditional knowledge related to the palm. Informants were selected using purposive sampling to ensure the inclusion of participants with relevant experience [33], followed by snowball sampling to expand the network of informants [34].

Data collection techniques included participatory observation, semi-structured and in-depth interviews, visual documentation, and literature review. Participatory observation was conducted to understand the community's daily practices and cultural expressions [35]. Interviews were carried out to explore narratives, techniques, and beliefs attached to the utilization practices of the enau palm. Visual documentation was used to enhance contextual validity, while literature review supported the analysis and positioned field findings within a broader scientific framework [36]. The research instruments consisted of observation and interview guides developed based on ethnobotanical and ethnoscientific indicators. Ethnobotanical indicators included plant parts used, utilization techniques, economic value, and cultural dimensions [37]. Ethnoscience indicators were designed to capture the implicit scientific concepts within local practices, such as fermentation, plant ecology, and human–environment relationships [38].

Data analysis employed thematic analysis to identify major themes emerging from the field data [39]. Source and method triangulation were applied to ensure validity. Member checking was conducted with key informants to verify interview results, while peer debriefing involved discussions with fellow researchers in ethnobotany and science education [40]. To support the integration of research findings into education, content analysis was performed on field data to identify contextual scientific concepts, which were then mapped to science curriculum topics. This process referred to the contextual learning approach and local wisdom–based education, both recognized as effective in improving students' understanding and learning relevance [41].

RESULTS AND DISCUSSION

The traditional management of the enau (A. pinnata) among the Jambi Tulo community represents multiple dimensions of ethnoscience—a system of local knowledge built through experience, belief, and direct interaction with nature. The local people regard the sugar palm not merely as a source of sap or sugar but as an entity with social, cultural, spiritual, and ecological significance. This worldview is reflected in the taboos, rituals, and symbolic practices that govern human–tree relationships, such as prohibitions against asking for sap along the road or the custom of "proposing to the tree" before tapping begins. Similar perceptions are found in other cultures: for instance, the Toba people in North Sumatra believe that the sugar palm originated from a young woman who sacrificed herself to redeem a family member's wrongdoing [17]. Likewise, communities in Bangka Island view the palm as a "princess" who must be treated gently and patiently [42], a belief also shared by traditional societies in Flores [43].

From an ecological perspective, the Jambi Tulo community demonstrates a deep understanding of the sugar palm's life cycle and its relationship with the environment. For example, the taboo against tapping male inflorescences (bluluk) reflects an ecological practice that ensures the tree's regeneration. Their observation that the height of sugar palms adjusts to surrounding vegetation illustrates how empirical ecological knowledge is formed through repeated observation. Haryoso et al. [1] similarly noted that the Sasak people in Lombok rely on naturally growing palm populations for both reproduction and distribution—showing that tradition-based conservation practices are adaptive strategies refined across generations.

In addition, the community understands the interdependence between animals and plant regeneration. The awareness that wild boar populations influence palm seedling growth reveals a nuanced ethnoecological insight into ecosystem balance. Comparable observations were recorded among the Cipanggulaan people in West Java [3], where locals protect young sugar palms around their farms as a form of natural conservation.

The technical knowledge of the Jambi Tulo people regarding sap tapping and processing also embodies elements of applied science. The practice of striking the male flower stalk (manggar) before tapping stimulates sap production. Bamboo containers are used and sterilized with smoke (ukup) during the boiling process—an example of traditional sterilization techniques. The Malay community of Bangka also continues to use natural bamboo molds [42]. Bamboo ladders are employed to climb tall trees, and the community's empirical understanding that tightly sealed sap containers may explode due to fermentation demonstrates a local comprehension of biochemical processes. People also differentiate sap quality by color—good sap being tea-colored, while poor-quality sap appears whitish—reflecting a grasp of fermentation, hygiene, and food quality control.

In the social sphere, the sugar palm functions as a marker of identity, status, and cultural value. The ability to tap sugar palms is a crucial requirement for men seeking to marry local women in Jambi Tulo, just as women are expected to possess weaving skills. Tappers are considered individuals of moral worth, particularly honesty, as the sustainability and volume of sap produced are believed to depend on the tapper's sincerity and integrity. Thus, tapping practices extend beyond economic activity to shape ethical and social structures. The tradition embodies values of hard work, discipline, and spirituality, as the yield is also perceived as dependent on divine will [43].

Oral and symbolic traditions further reinforce the ethnoscientific dimension of sugar palm use. The recitation of pantun (traditional poetic verses) to "persuade" the tree to release its sap illustrates how language, culture, and empirical practice intertwine. Similar traditions are found among the Gayo Lues community in Aceh [44], where tappers must chant mantras and maintain good conduct to ensure optimal sap yield—revealing the interconnectedness of symbolism, mysticism, and ecological understanding.

Socioeconomic changes have brought new dynamics to the traditional management of sugar palms in Jambi Tulo. Whereas sugar palms were once used mainly for household needs, tapping has now become either a supplementary or primary livelihood. Some farmers continue to uphold cultural taboos by refusing to sell sap, while others have adopted modernized practices. Certain traditional elements, such as the use of bamboo containers and pantun, are gradually disappearing. Modernization and market pressures have shifted the palm's role from a cultural symbol to an economic commodity, altering values and traditions surrounding its management [3].

The sugar palm tradition in Jambi Tulo thus illustrates the tight integration between local knowledge, ecology, processing techniques, social norms, and spirituality. Altogether, these practices represent a rich ethnoscientific framework that is both culturally and scientifically meaningful. Integrating ethnoscience into education can serve as a bridge between modern science and local culture, fostering contextual learning and enhancing students' critical thinking abilities [45].

Development of Ethnoscience-Based Biology Learning on the Enau Palm (Arenga pinnata)

The traditional management of the sugar palm (A. pinnata) in Jambi Tulo represents a highly potential contextual learning resource for supporting biology education in schools. The ethnoscientific values embedded within it encompass various biological aspects relevant to the curriculum, such as plant structure and function, reproductive systems, life cycles, ecological interactions, and the sustainable use of biological resources. By integrating this local knowledge, biology learning becomes more meaningful because it is rooted in the students' own life realities. In the context of biology education, practices such as sap tapping, palm sugar processing, and sugar palm ecology can serve as local-based science learning case studies. For instance, the sap-tapping process can be linked to the topic of plant reproduction, particularly the differentiation between male and female flowers in monoecious species. Students can directly observe flower morphology, understand the physiological processes behind sap flow, and analyze environmental factors influencing sap production rates.

Furthermore, the fermentation of sap into vinegar or traditional beverages can be used to illustrate microbiological concepts—such as the activity of microorganisms and fermentation processes—as well as traditional biotechnology. Learning activities may take the form of mini-projects in which students compare fermentation rates based on variables such as time, temperature, or natural additives. Through such experiential learning, students not only comprehend biological concepts theoretically but also practice scientific methods within a local cultural context. The traditional utilization of other parts of the sugar palm—such as leaves for roofing, fibers (ijuk) for brooms, and trunks for building materials—can also be linked to topics on plant morphological diversity, tissue structure, and adaptation to tropical environments. Through field observations and community interviews, students can identify how plant organ structures and functions meet human needs while maintaining ecological balance.

This approach aligns well with inquiry-based learning, in which students are encouraged to formulate scientific questions such as:

- How do the structures of male and female flowers differ in the sugar palm?
- Why is the sugar palm monocarpic, and what are the implications for its life cycle?
- What are the effects of microbial contamination during palm sugar production?
- What roles do microorganisms play in the process of producing palm vinegar?

These questions stimulate students' critical thinking, observational skills, and scientific attitudes. Such an approach is also expected to improve scientific literacy, considering that students' scientific competencies in Indonesia generally remain low [46].

Beyond biological content, integrating local wisdom values from sugar palm management also strengthens values-based learning. For example, the Jambi Tulo community practices principles of balance, mutual cooperation (gotong royong), and

sustainability in sap tapping—values that can be transformed into classroom discussions on environmental ethics and biodiversity conservation. This aligns with 21st-century learning competencies, which emphasize the importance of ecological awareness [47].

Several biology topics and corresponding learning activities that can be applied in schools are presented in Table 1.

Table 1. Biology Topics and Learning Activities Based on the Enau Palm Context

No.	Biology Topics	Enau Palm Tradition Context	Learning Activity Format
1	Plant reproduction	Differences between male and female flowers of the enau palm	Observation of flower morphology and structure
2	Plant physiology	The process of sap secretion and environmental influences	Experiment on measuring the rate of sap dripping
3	Microbiology & Biotechnology	Fermentation of sap into vinegar or traditional beverages	Simple hands-on experiment on natural fermentation
4	Ecology & Adaptation	Growth of enau palms in moist and shaded environments	Observation of enau habitat conditions
5	Structure and function of plant tissues	Utilization of plant parts (leaves, stems, fibers)	Anatomical and functional analysis of plant tissues
6	Biodiversity	Variations of enau palm types and supporting plants	Inventory and identification of local species
7	Environmental ethics & conservation	Sustainable management of enau palms by the community	Discussion of local values and conservation projects

Through the integration of these topics, biology learning is not only focused on scientific concepts but also grounded in real socio-cultural contexts within students' environments. Consequently, the enau palm tradition serves as a bridge connecting modern scientific knowledge with the living traditional wisdom of local communities.

CONCLUSIONS

The management of enau palm (A. pinnata) among the people of Jambi Tulo reflects a rich and complex system of local knowledge that embodies a harmonious relationship between humans, nature, and cultural values. Practices such as sap tapping, sap processing, and the accompanying rituals and taboos demonstrate empirical understandings that align with modern biological concepts, including plant physiology, fermentation processes, and ecological conservation principles. This local knowledge and tradition possess interrelated scientific, ecological, social, and spiritual values.

Integrating the ethnoscientific values of the enau palm into contextual biology learning can serve as an effective strategy to bridge modern science and local wisdom. Through this approach, students not only comprehend biological concepts theoretically but also connect them with real phenomena and local practices. Enau-based ethnoscience learning has the potential to enhance scientific literacy, foster ecological awareness, strengthen cultural identity, and promote meaningful and transformative learning aligned with the demands of contemporary education.

Moreover, preserving the local knowledge of Jambi communities regarding the enau palm has significant implications for biodiversity conservation and the safeguarding of intangible cultural heritage. Therefore, the documentation, revitalization, and integration of enau ethnoscience knowledge into education and conservation programs must continue to be developed. Such efforts not only enrich scientific and pedagogical resources but also

contribute to achieving the Sustainable Development Goals, particularly in the areas of education, climate action, and terrestrial ecosystems.

ACKNOWLEDGMENT (IF ANY)

This work was supported by reseacrch grant provided by Master's Program in Science Education Basic Research Scheme, University of Jambi, Number 576/UN21.11/PT.01.05/SPK/2025.

AUTHOR CONTRIBUTIONS

Conceptualization: B.H; Methodology, B.H. Formal Analysis, B.H.; Investigation, A.T., W.K., C.M., R.D., D.m., F.A., and I.T.; Resources, W.K.; Data Curation, F.A.; Writing – Original Draft Preparation, F.A.; Writing – Review & Editing, B.H.; Visualization, D.M.; Project Administration, I.T.; Funding Acquisition, R.D.

CONFLICT OF INTEREST

The authors declare no conflict of interest. The funding sponsors had no role in the design of the study, collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

REFERENCES

1. Haryoso A, Amzu E, Hikmat A, Sunkar A, Darusman D. Ethnobotany of sugar palm (Arenga pinnata) in the sasak community, Kekait village, West Nusa Tenggara, Indonesia. Biodiversitas Journal of Biological Diversity, 21(1). 2020.
2. Azhar I, Risnasari I, Srena MF. The utilization of sugar palm (arenga pinnata) by the people around Batang Gadis Nasional park area. IOP Conference Series: Earth and Environmental Science. 2019;305(1):12016.
3. Gunawan R, Ramadhan UG, Iskandar J, Partasasmita R. Local knowledge of utilization and management of sugar palm (Arenga pinnata) among Cipanggulaan People of Karyamukti, Cianjur (West Java, Indonesia). Biodiversitas Journal of Biological Diversity. 2018;19(1):93–105.
4. Mogea J, Seibert B, Smits W. Multipurpose palms: the sugar palm (Arenga pinnata (Wurmb) Merr.). Agroforestry Systems. 1991;13:111–129.
5. Has DH, Marpaung SSM, Jati ED, Hartati BR, Fitrianto I, Yulianti I, Nugroho SPA, Rahmila YI, Rahmayanti FD, Fadilah R. Ethnobotany of Food Plants in The Penghulu Tribe Community in Sarolangun, Jambi. Jurnal Penelitian Pendidikan IPA. 2023;9(9):7705– 7712.
6. Santosa TA, Agustina N, Yulianti S. Jenis Tumbuhan Liar Dalam Upacara Adat Kenduri Seko Di Kerinci. Pendekar: Jurnal Pendidikan Berkarakter. 2020;3(1):6–10.
7. Framita RM, Alamsyah Z. PENETAPAN HARGA DAN NILAI TAMBAH GULA AREN DI MUARA BULIAN KABUPATEN BATANGHARI. Journal of Agribusiness and Local Wisdom. 2021;4(1):26–36.
8. Marwoto M, Nurmansah R, Sitorus AS. Analisis Strategi Pemasaran Dalam Meningkatkan Penjualan Gula Aren di Desa Jambi Tulo Kecamatan Maro Sebo Provinsi Jambi. Jurnal MeA (Media Agribisnis). 2025;10(1):120–129.
9. Susilawati SHK. SEJARAH INDUSTRI GULA AREN DI DESA PULAU MENTARO KECAMATAN KUMPEH KABUPATEN MUARO JAMBI TAHUN 1980–2010. Istoria: Jurnal Ilmiah Pendidikan Sejarah Universitas Batanghari. 2022;5(2):40–51.
10. Hutami R, Pribadi MFI, Nurcahali F, Septiani B, Andarwulan N, Sapanli K, Zuhud EAM, Al Manar P, Ichsan N, Wahyudi S. Proses produksi gula aren cetak (Arenga pinnata, Merr) di Indonesia. Jurnal Ilmiah Pangan Halal. 2023;5(2):119–130.
11. Adom D. Inclusion of local people and their cultural practices in biodiversity conservation: lessons from successful nations. American Journal of Environmental Protection. 2016;4(3):67–78.

12. Merçon J, Vetter S, Tengö M, Cocks M, Balvanera P, Rosell JA, Ayala-Orozco B. From local landscapes to international policy: contributions of the biocultural paradigm to global sustainability. Global Sustainability. 2019;2:e7.
13. Mistry J, Berardi A. Bridging indigenous and scientific knowledge. Science. 2016;352(6291):1274–1275.
14. Pejchar L, Jeffrey J. Sap-feeding behavior and tree selection in the endangered Akiapolaau (Hemignathus munroi) in Hawaii. The Auk. 2004;121(2):548–556.
15. Sylvana S, Nurlaila A, Deni D. Analisis Potensi Dan Pemanfaatan Tanaman Aren (Arenga Pinnata Merr.) Oleh Masyarakat Di Desa Tundagan Kecamatan Hantara Kabupaten Kuningan. Journal of Forestry And Environment. 2022;5(2):66–75.
16. Lempang M. Pohon aren dan manfaat produksinya. Jurnal Penelitian Sosial Dan Ekonomi Kehutanan. 2012;9(1):37–54.
17. Sibarani R. The local wisdom on Aren (Arenga pinnata) palm tree in Toba Batak tradition of North Sumatera at Lake Toba Area. Journal of Physics: Conference Series. 2018;1116(5):52060.
18. Mansyur S, Ririmasse MNR, Handoko W, Fadillah MA, Djindar NI, Naping H, Hijjang P, Arifin A. Mappatettong Ale', Manno Salo, and Mattu'bang Ale': Agriculture, Rituals, and Ecological Symbols in Baringeng, Soppeng Regency, South Sulawesi Indonesia. IOP Conference Series: Earth and Environmental Science. 2024;1430(1):12026.
19. Mazzocchi F. Western science and traditional knowledge: Despite their variations, different forms of knowledge can learn from each other. EMBO Reports. 2006;7(5):463–466.
20. Mandikonza C. Integrating indigenous knowledge practices as context and concepts for the learning of curriculum science: A methodological exploration. Southern African Journal of Environmental Education, 35. 2019.
21. Sotero MC, Alves, Â. G. C., Arandas JKG, Medeiros MFT. Local and scientific knowledge in the school context: characterization and content of published works. Journal of Ethnobiology and Ethnomedicine. 2020;16:1–28.
22. Halim A. The Indonesian curriculum: Does it retain culturally responsive teaching? Journal of English Language and Culture, 11(1). 2022.
23. Sleeter CE. Confronting the marginalization of culturally responsive pedagogy. Urban Education. 2012;47(3):562–584.
24. El Yazidi R, Rijal K. Science learning in the context of'indigenous knowledge'for sustainable development. International Journal of Ethnoscience and Technology in Education. 2024;1(1):28–41.
25. Rahmawati Y, Ridwan A, Cahyana U, Wuryaningsih T. The integration of ethnopedagogy in science learning to improve student engagement and cultural awareness. Universal Journal of Educational Research. 2020;8(2):662–671.
26. Mulyono Y, Sapuadi S, Yuliarti Y, Sohnui S. A framework for building scientific literacy through an inquiry learning model using an ethnoscience approach. International Journal of Advanced and Applied Sciences. 2024;11(8):158–168.
27. Sari SP, Mapuah S, Sunaryo I. Pembelajaran ilmu pengetahuan alam berbasis etnosains untuk mengembangkan kemampuan berpikir kritis siswa sekolah dasar. EduBase: Journal of Basic Education. 2021;2(1):9–18.
28. Sari FP, Maryati M, Wilujeng I. Ethnoscience studies analysis and their integration in science learning: literature review. Jurnal Penelitian Pendidikan IPA. 2023;9(3):1135–1142.
29. United Nations. The 17s Goals. https://sdgs.un.org/goals. n.d.
30. Johnson AT, Mbah MF. (Un) subjugating indigenous knowledge for sustainable development: considerations for community-based research in African higher education. Journal of Comparative and International Higher Education. 2021.
31. Sumida Huaman E, Valdiviezo LA. Indigenous knowledge and education from the Quechua community to school: beyond the formal/non-formal dichotomy. International Journal of Qualitative Studies in Education. 2014;27(1):65–87.
32. Creswell JW, Poth CN. Qualitative inquiry and research design: Choosing among five approaches. Sage publications. 2016.
33. Ahmad M, Wilkins S. Purposive sampling in qualitative research: A framework for the entire journey. Quality & Quantity, 1–19. 2024.

34. Ting H, Memon MA, Thurasamy R, Cheah, J.-H. Snowball Sampling: A Review and Guidelines for Survey Research. Asian Journal of Business Research Volume, 15(1). 2025.
35. Roque A, Wutich A, Brewis A, Beresford M, Landes L, Morales-Pate O, Lucero R, Jepson W, Tsai Y, Hanemann M. Community-based participant-observation (CBPO): A participatory method for ethnographic research. Field Methods. 2024;36(1):80–90.
36. Ebidor, L.-L., Ikhide IG. Literature review in scientific research: an overview. East African Journal of Education Studies. 2024;7(2):211–218.
37. Reyes-García V, Huanca T, Vadez V, Leonard W, Wilkie D. Cultural, practical, and economic value of wild plants: a quantitative study in the Bolivian Amazon. Economic Botany. 2006;60(1):62–74.
38. Moriolkosu AD, Handayani SSD, Sunarso A. Ethnomathematics and ethnoscience analysis of Aru culture related to mathematics and science concepts at elementary school. Educational Management. 2020;9(2):163–171.
39. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006;3(2):77–101.
40. Birt L, Scott S, Cavers D, Campbell C, Walter F. Member checking: a tool to enhance trustworthiness or merely a nod to validation? Qualitative Health Research, 26(13), 1802–1811. 2016.
41. Rahmawati Y, Taylor PC. “The fish becomes aware of the water in which it swims”: revealing the power of culture in shaping teaching identity. Cultural Studies of Science Education. 2018;13:525–537.
42. Fitri G, Irwanto R, Akbarini D, Henri H. Etnobotani Tumbuhan Aren (Arenga pinnata (Wurmb) Merr) pada Suku Melayu Bangka Desa Sungkap, Bangka Tengah. BIOMA: Jurnal Biologi Dan Pembelajarannya. 2025;7(1):25–38.
43. Raho B, Jebadu A, Juhani S. Kokor Gola Kolang: Pesan-Pesan Kearifan Tradisi Pante Pembuatan Gula Aren (1st ed.). Penerbit Ledalero. 2020.
44. Surya E, Ridhwan M, Armi A, Jailani J, Samsiar S. Konservasi Pohon Aren (Arenga Pinnata Merr) Dalam Pemanfaatan Nira Aren Terhadap Peningkatan Ekonomi Masyarakat Di Desa Padang Kecamatan Terangun Kabupaten Gayo Lues. Jurnal BIOnatural, 5(2). 2018.
45. Pieter J, Risamasu PVM, Gunada IW. Penerapan Model Contextual Teaching and Learning Berbasis Etnosains Jayapura Terhadap Penguasaan Konsep dan Kemampuan Berpikir Kritis Peserta Didik. Jurnal Ilmiah Profesi Pendidikan. 2025;10(2):1640–1648.
46. Kurniasih W, Wulan AR, Nuraeni E. Profil awal kompetensi abad ke-21 peserta didik SMA dalam keterampilan mengevaluasi dan merancang penyelidikan ilmiah pada konten COVID- 19. Seminar Nasional Sains & Entrepreneurship, 1(1). 2021.
47. Nugraha D, Octavianah D. Diskursus literasi abad 21 di indonesia. Jurnal Pendidikan Edutama. 2020;7(1):107–126.