



## Biology Learning Meets Local Wisdom: Exploring the Ethnopedagogical Value of Bengkulu's Fermented Culinary Tradition "Lemea" for Biology Topics

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**Abstract:** The Merdeka Curriculum can potentially improve educational standards by fostering appreciation for regional culture and local wisdom. Indonesia's rich cultural heritage offers opportunities to integrate indigenous knowledge into biology education, yet local wisdom remains underexplored in scientific education. This study focuses on the Lemea fermentation tradition of the Rejang Lebong community in Bengkulu, a unique example of local wisdom applicable to the biology curriculum. Using ethnopedagogy, the study bridges the gap between Indigenous and scientific knowledge, aligning with the Merdeka Curriculum's emphasis on character education and cultural appreciation. This literature review, supported by interviews with local experts, examines the scientific relevance of the Lemea fermentation process in topics such as biotechnology, metabolism, bacteria, etc. Interviews with teachers also highlight challenges and opportunities in implementing Lemea as a learning resource. The findings show that the Indigenous knowledge behind Lemea fermentation can be transformed into scientific concepts, supporting high school biology learning outcomes in Phases E and F. This research contributes to the development of ethnopedagogy as an innovative approach and model in science education and offers a model for curriculum design under the Merdeka Curriculum, aligning educational practices with local cultural values to create meaningful and contextual learning experiences.

**Keywords:** ethnopedagogy; fermentation; lemea Bengkulu; local potential; merdeka curriculum

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### INTRODUCTION

Education is a fundamental pillar in national development, significantly influencing societal progress and character formation. According to the National Education System Law No. 20 of 2003, one of the primary objectives of national education is to shape the character of the younger generation. Character education must be implemented systematically to foster positive attitudes and behaviors, ensuring that students develop both strong academic abilities and moral integrity aligned with the noble values of national culture and religion (Fua, 2015; Raharjo, 2010). Integrating character education into the curriculum is essential, as it helps cultivate responsible, ethical, and socially aware individuals who contribute positively to society. Various studies highlight the role of education in shaping students' character through culturally embedded learning approaches (Tilaar, 2016; Sugara & Sugito, 2022). Thus, character education should not only be a theoretical concept but also a practical and contextualized effort that incorporates local wisdom to strengthen students' moral values and national identity, contributing to the advancement of educational science.

Education that originates from the noble values of the nation's culture is commonly referred to as local wisdom, an invaluable cultural heritage, and knowledge that contributes to national development and progress (Supriadi, 2004; Rahyubi, 2016). Local wisdom reflects a region's traditions and cultural identity, serving as a crucial foundation for character education. The decline in students' moral and ethical values highlights the urgency of strengthening school character education. Recognizing this issue, the Indonesian government has continuously tried to enhance education quality, with the Merdeka Curriculum as one of its key initiatives (Kemendikbud, 2022). This curriculum aims to align learning with societal and workforce needs while granting schools greater flexibility in designing student-centered education. One of the most suitable approaches for integrating character education with local wisdom is ethnopedagogy, which bridges cultural heritage and modern education, thereby expanding scientific knowledge in pedagogy. By incorporating local cultural values into learning, ethnopedagogy fosters students' appreciation for their heritage while enhancing their academic and moral development (Hasanah et al., 2021).

Ethnopedagogy-oriented learning is fundamental to implement, considering that Indonesia is a pluralistic country of various ethnic groups and ethnicities with different cultures. Secondly, globalization and technological developments can cause cultural changes in Indonesian society. Ethnopedagogy positively affects physical, emotional, and communication development (Abdurrahman et al., 2020). Ethnopedagogy can be an effective tool to connect science with culture. Ethnopedagogy can help students develop the right attitude toward the value of national culture (Rahmawati et al., 2020). The Merdeka curriculum, which is currently being

echoed in the world of education, also demands the integration of ethnopedagogy in the context of learning. This aligns with the objectives of the Pancasila Student Profile Strengthening Project (P5), which aims to cultivate students with strong character under Pancasila values, demonstrating an innovative approach to culturally embedded learning. The themes of the profile project are designed contextually to address local issues specific to each region (BSKAP, 2022). Therefore, a learning approach that attracts students' interests, is relevant to their daily lives, and incorporates local cultural themes is necessary while meeting the curriculum demands through P5 learning.

Tilaar (2015) explains that local wisdom has pedagogical value in regulating behavior that is beneficial to the common interests of society. This study is under the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 79 of 2014 article 2 paragraph (2) explains that local content is taught to equip students with attitudes, knowledge, and spirituality in their area. Another goal is to preserve and develop regional excellence and wisdom that are useful for themselves and their environment to support national development. One approach to addressing this need is a local wisdom-based learning approach, which strengthens cultural appreciation and contributes to interdisciplinary educational research. A local wisdom-based learning approach integrates cultural values, traditions, and local wisdom into the learning process. This approach recognizes the uniqueness of local community culture and integrates it into learning (Amaliyah et al., 2023). Learning based on local potential will introduce students to the potential of a region so that students will be more familiar with the region's culture, and the region's potential can be maintained and passed down from generation to generation (Drani & Susanti, 2022). Efforts can be made to introduce culture as a science learning material by reconstructing indigenous knowledge into scientific knowledge.

Numerous studies have explored the impact of local wisdom-based learning in enhancing students' academic and character development. For example, Putra (2019), on the Development of Teaching Materials Based on Local Wisdom through Higher-Order Thinking in Student Character Building, shows that student character increases when treated with learning actions that relate to local wisdom, especially in science subjects, so that students increase their curiosity character, love their own culture, and can think critically and systematically. Other research results also show that implementing local wisdom-based learning positively impacts learning interest (Amaliyah et al., 2023). Students show greater enthusiasm for learning when they see the relevance of learning materials to their daily lives and the cultural values introduced. In addition, local wisdom-based learning also has a significant effect on students' science process skills (Sriyati et al., 2021), students' environmental literacy skills (Sriyati et al., 2022) and encourages students to improve concept understanding and provide meaningful experiences (Wilujeng et al., 2020).

However, these studies primarily discuss the general impact of local wisdom-based learning without providing a detailed and structured framework for integrating specific cultural practices into science education. Furthermore, most research lacks a strong connection between ethnopedagogy and the demands of the Merdeka Curriculum, particularly in contextualizing Indigenous knowledge within modern biological concepts. Additionally, limited research specifically explores how indigenous fermentation practices, such as Lemea, can be systematically applied in biology learning, especially in microbiology and biotechnology topics. Despite various efforts to integrate local wisdom into education, research connecting Indonesian cultural traditions with specific biological concepts remains limited (Sriyati et al., 2023). This research gap indicates the need for a focused study on how a particular local wisdom-based practice can be systematically implemented in biology education.

From the background of the problems described earlier, exploring local wisdom and integrating it into biology learning is essential. One of the aspects of local wisdom that can be utilized is traditional food processing. In many communities, traditional food is not only a valuable local resource but also a cultural identity and a source of pride for the people of a particular region (Suhandi et al., 2019; Wati & Hidayat, 2021). One example of a unique traditional food in Bengkulu Province that involves fermentation is Lemea. This dish is made from young bamboo shoots cut into small cubes, mixed with fish, and then fermented for approximately 5–7 days (Oktarianto & Widawati, 2017; Nugroho et al., 2020). The fermentation process in Lemea provides an opportunity for indigenous knowledge with scientific concepts in biology education, particularly in topics related to biotechnology, microbiology, and food preservation. The fermentation process of Lemea provides a novel perspective in integrating indigenous knowledge with scientific concepts, making a significant contribution to ethnoscience research.

The theme of ethnopedagogy is still relatively new and continues to seek the most effective framework for its implementation in learning. This aligns with Sriyati et al. (2023), who emphasizes that the demand of the Merdeka Curriculum to integrate local wisdom into learning presents a gap, particularly the limited research connecting Indonesian cultural traditions with science education and curriculum analysis. To address this gap, this study presents an innovative framework that describes the concept of ethnopedagogy through the local potential of Lemea, a fermented culinary tradition of the Rejang Tribe in Bengkulu Province, and its potential application in biology learning under the Merdeka Curriculum framework. This study provides a novel contribution by integrating traditional fermentation practices with modern scientific concepts, particularly in

microbiology and biotechnology. Unlike previous studies that focus on general ethnopedagogical approaches, This study proposes a structured model that aligns with the objectives of the Merdeka Curriculum, ensuring that character education and scientific inquiry are interwoven through culturally relevant and contextual learning approaches.

By positioning ethnopedagogy as an innovative educational strategy, this research expands its application beyond theoretical discussions and into practical curriculum design. Integrating local cultural values, such as Lemea fermentation, into science education fosters a holistic learning experience where students not only grasp biological concepts but also develop a deeper appreciation for indigenous knowledge systems. The novelty of this research lies in its interdisciplinary approach, integrating ethnoscience, biology, and pedagogy to develop a culturally embedded learning model. By comprehensively reviewing theoretical foundations and empirical findings, this research provides valuable insights for educators, researchers, and policymakers on how local wisdom can be effectively integrated into science learning. Through an ethnopedagogical approach, this study bridges cultural values with modern education, ensuring that traditional food processing knowledge, such as Lemea, is preserved and contextualized within a scientific framework relevant to students' lives. Using a literature review with content analysis from various scientific sources, this research will examine crucial aspects of ethnopedagogy related to the Lemea fermentation process. Specifically, this study aims to answer the following questions: 1) How does the ethnoscience study of Lemea as local wisdom contribute to understanding biological concepts? 2) How can the biological concepts within the fermented culinary tradition of Lemea be systematically mapped and integrated into the Merdeka Curriculum for biology learning?"

## **METHODS**

This study employs a qualitative descriptive approach, which is commonly used to explore and describe phenomena based on the perspectives and experiences of participants (Creswell, 2013). This approach enables an in-depth exploration of the implementation of local wisdom in biology education, particularly within the context of Lemea fermentation. It is well-suited for capturing teachers' and Indigenous communities' understanding, experiences, and perspectives regarding integrating Indigenous knowledge and scientific concepts in biology learning, including the extent of its application and the challenges encountered in the integration process. By combining qualitative descriptive methods with a literature review and interviews, this research aims to comprehensively examine the local potential of Lemea as a reflection of indigenous science and its relevance to scientific knowledge in biology education. The research process involves six structured stages: (1) emerging questions and procedures; (2) collecting data in the participant setting; (3) analyzing the data inductively; (4) building from particulars to general themes; (5) making interpretations of the meaning of data; and (6) the final written report has a flexible writing structure (Creswell & Creswell, 2018).

The literature review is a critical component of this study, focusing on collecting, evaluating, and synthesizing relevant academic resources. A literature review allows researchers to identify existing theories, develop analytical frameworks, and bridge the gap between theoretical knowledge and practical applications (Rowley & Slack, 2004; Bettany-Saltikov, 2012). The process involves systematically identifying and analyzing scientific articles, journals, and books discussing traditional fermentation practices, indigenous knowledge, and their connections to biological concepts. These resources provide a foundation for comparing, validating, and expanding upon the indigenous science observed in the Lemea fermentation process, linking it to established scientific frameworks such as microbiology and biotechnology.

To obtain primary data, this study employs semi-structured interviews (Creswell & Creswell, 2018) with a native Bengkulu expert who has extensive experience in making Lemea. The interviews explore various aspects of indigenous knowledge, including ingredient selection, preparation methods, fermentation techniques, and storage practices. These insights highlight the indigenous science behind Lemea, revealing the biological mechanisms involved in the fermentation process and its cultural significance. Additionally, biology teachers are interviewed to assess how local wisdom has been integrated into biology education, particularly in biotechnology topics. These interviews investigate whether indigenous knowledge like Lemea fermentation has been included in the curriculum and identify challenges in incorporating local wisdom into biology learning under the Merdeka Curriculum. The semi-structured nature of the interviews allows for flexibility in responses while maintaining a structured framework for data collection.

The data analysis follows a thematic approach, where findings from the literature review and interviews are categorized into key themes relevant to ethnopedagogy and biology learning. This includes data reduction, where relevant information is selected and organized; data display through thematic categorization, such as microbial activity in fermentation, enzymatic processes, and cultural values; and conclusion drawing to establish connections between indigenous knowledge and biological concepts. This analysis provides a comprehensive understanding of how Lemea fermentation can be integrated into biology learning in alignment with the Merdeka Curriculum. By integrating findings from the literature review and interviews, this study bridges the gap between Indigenous science and modern biological frameworks, ensuring that Indigenous knowledge is preserved and

applied in an educational context. The comparative analysis highlights the alignment of Lemea fermentation with biological concepts such as bacterial metabolism, enzymatic activity, and the role of microorganisms in food processing.

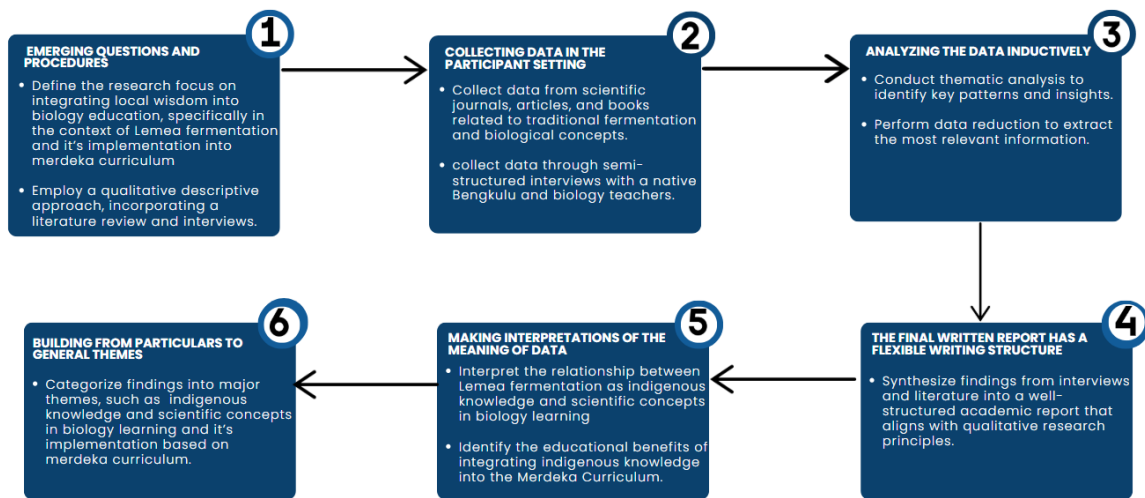


Figure 1. Research Flowchart

## RESULT AND DISCUSSION

Ethnopedagogy reflects local learning content, commonly called local wisdom-based learning. Utari et al. (2016) generally explain that local wisdom has distinct characteristics and functions, including serving as a marker of community identity, acting as a cohesive element of social integration, and representing cultural elements that grow, exist, and develop organically within society rather than being imposed from above. It also brings a sense of togetherness to specific communities, transforms the mindset and reciprocal relationships of individuals and groups by placing them on equal footing, and fosters appreciation, unity, and collective mechanisms to protect against potential threats to group solidarity as a whole and to maintain an integrated community (Turyani et al., 2024). The diversity of local wisdom in Indonesia is immense. The context of this study, Lemea, serves as an example of ethnopedagogy that demonstrates how Indigenous knowledge is intertwined with scientific concepts in biology. This study fills an important research gap by systematically mapping the biological aspects of Lemea and integrating them into the Merdeka Curriculum, making it a valuable educational resource for contextual learning.

Traditional food is a cultural heritage passed down from generation to generation. It encompasses knowledge, production techniques, local raw materials, and the cultural values embedded within it (Rocillo-Aquino et al., 2021). Three main features characterize traditional food: it is consumed continuously, deeply rooted in the daily lives of specific communities, and possesses distinctive characteristics (Ivanova et al., 2015). The Rejang tribe, one of the oldest tribes in Sumatra, resides in Bengkulu Province and is spread across five regencies: Rejang Lebong Regency, Lebong Regency, Kepahiang Regency, Central Bengkulu Regency, and North Bengkulu Regency (Yunus et al., 2020; Apindis et al., 2018). The Rejang tribe has a traditional food that meets the three main characteristics: Lemea, which is consumed continuously, deeply rooted in the daily habits of the Rejang community and distinguished by its unique taste and aroma. Despite its cultural significance, Lemea has not been widely recognized as a potential teaching material for biology education. This study highlights its relevance in bridging ethnoscience with education, especially in biology learning.

One of the local culinary potentials of Bengkulu Province is Lemea. Lemea is a traditional food made from fermented chopped bamboo shoots and fish. It is a traditional food of the Rejang tribe in Bengkulu, Sumatra. Lemea is not eaten raw due to its strong flavor and aroma but is cooked with simple spices and served with fish or shrimp. Lemea is usually cooked into sambal Lemea and served as a dish with rice (Utama et al., 2023). Lemea is not consumed raw due to its sharp taste and aroma but must be cooked first with the addition of simple spices (Nuryani et al., 2012). Lemea is generally processed into a Sambal Lemea as a side dish with rice. Combining the distinctive taste and aroma of Lemea with chili sauce and other spices can arouse and increase appetite (Dewi et al., 2014).

The main raw material for Lemea fermentation is young bamboo or bamboo shoots. All types of bamboo shoots can be used as ingredients for making Lemea, but two types of bamboo shoots are preferred for use as Lemea ingredients: bamboo shoots from Betung bamboo (*Dendrocalamus asper*) and Mayan bamboo (*Gigantochloa robusta*) (Oktarianto & Widawati, 2017). Both bamboo shoots were chosen because the quality of Lemea produced was better and preferred by consumers. Furthermore, the fish raw materials commonly used in traditional Lemea making are river fish and fish cultivated in freshwater ponds, while marine fish are not

widely used. Comparison of the use of freshwater fish with marine fish in making Lemea has been carried out in several studies. The use of Manyung fish (*Arius thalassinus*) and Mujair fish (*Oreochromis mossambicus*) as raw materials in making Lemea affects the pH of Lemea products and the organoleptic test of Lemea sauce. Lemea, with manyung fish raw material, has a higher pH than the pH of tilapia Lemea. The results of the organoleptic test on Sambal Lemea showed that manyung fish Lemea was preferred compared to tilapia Lemea (Oktarianto & Widawati, 2017). The manufacturing process starts with (1) the preparation of bamboo shoot raw materials, starting with stripping first and then washing until clean, (2) the bamboo shoots are chopped or cut into small cubes, (3) the bamboo shoots that have been diced are then fermented for 3 days; (4) then mixed with river fish or sea fish that have been cleaned in a certain amount and then fermented for 5-7 days, (5) Lemea is ready to be processed further into a mature culinary that can be consumed (Okfrianti et al., 2018). According to Zuidar et al. (2019), the quality of Lemea fermentation results is influenced by the preparation of raw materials, the type of fish mixture used, the length of fermentation, and the use of fermentation containers.

The local culinary potential of Lemea fermentation can be applied in biology learning by linking activities that involve making Lemea fermentation into the context of biology learning. Local wisdom-based learning is learning that integrates certain cultures into education. Local wisdom-based learning makes learning more meaningful because students easily find real examples in the surrounding environment, and the information can be known easily (Sunaryati et al., 2024). Integrating local wisdom also encourages students to be more enthusiastic and can prevent abstract learning because the objects studied can be found around (Samaduri, 2022). This article will discuss more details related to Indigenous or community science, scientific science, and its potential relation to biological materials. Then, it will discuss the relationship between learning outcomes and objectives under the Merdeka curriculum of Lemea ethnopedagogy learning based on local wisdom. This study extends prior research by identifying Lemea's potential for educational integration and answering the research problem of how ethnoscience studies of Lemea contribute to understanding biological concepts.

Table 1 presents an analysis of the Lemea-making process, drawing from indigenous community knowledge and scientific perspectives. This comparison underscores how traditional practices correspond with formal scientific understanding, thereby facilitating the connection to biological concepts in the context of the Merdeka curriculum. It demonstrates how local wisdom and scientific knowledge complement one another, fostering a more contextualized and culturally relevant approach to biology education. Additionally, the relationship between learning outcomes and objectives in the Merdeka curriculum for ethnopedagogy based on Lemea's local wisdom will be explored. This study extends existing research by identifying the educational potential of Lemea and addressing the research question of how ethnoscience studies of Lemea contribute to the comprehension of biological concepts. Lemea Fermented Food is examined from indigenous to scientific science and its relation to Biology materials, presented in Table 1.

**Table 1.** Indigenous Science, Scientific Science of Lemea Fermented Food and its Relation to Materials of Biology Subject

Activity	Indigenous Science	Scientific Science	Biological Material
The processes of peeling, thin slicing, washing up to seven times, and fermentation are carried out.	A hereditary recipe passed down through generations, deeply rooted in tradition. The process of washing the ingredients seven times is believed to contribute to the success of the Lemea fermentation process.	Various methods for processing bamboo shoots include slicing, peeling, soaking, cooking, boiling, baking, fermentation, drying, and canning. During fermentation, hydrogen cyanide is easily soluble in water and is reduced by up to 99.96%. The reduction in HCN levels may be attributed to the volatile nature of taxiphyllin (Novelia et al., 2019; Sarangthem, 2010)."	Fermentation, Evaporation, and Food Processing.
Bamboo shoots are chopped until small (diced).	A hereditary recipe passed down through generations, deeply rooted in tradition. The chopping process accelerates the maturation (fermentation) process.	Processing the main ingredients by cutting them into smaller pieces accelerates the fermentation process. The smaller the size of the fermentation material, the greater the surface area, which facilitates faster microbial contact with the bamboo shoots. This enhances the rate of microbial degradation (starch hydrolysis), thereby accelerating the fermentation process (Afriani, 2010; Akbar & Yuniata, 2014)	Metabolism; Principles of Fermentation (Conventional Biotechnology).

It is forbidden to speak much during the process of making Lemea	Excessive talking may hinder the fermentation process. It is considered disrespectful to the ancestors and is believed to impart negative energy to the Lemea being prepared.	The mouth serves as a breeding ground for bacteria; therefore, wearing a mask and minimizing talking during food processing is essential. Droplets and invisible saliva can contaminate the food (Mawarsari et al., 2015). Saliva produced during talking activities can introduce microbiological contaminants into food processes, potentially affecting the quality of the food (Christiva et al., 2020)	Digestive System (Digestive Organ Hygiene)
Bamboo Shoot Fermentation Process	Bamboo shoots are fermented to enhance their texture, making them softer and easier to process in cooking and improving their nutritional content and flavor.	Fermented bamboo shoots offer the advantage of higher protein and fiber content compared to unfermented bamboo shoots. Fermentation also aids in the digestion of nutrients, improving the bioavailability of carbohydrates in the food (Saputri et al., 2019).  During fermentation, lactic acid production leads to the linearization of amylopectin. This transformation of complex molecules into simpler forms makes them easier to digest. These changes result in a softer texture as bamboo shoots' more complex structural components break down (Saputri et al., 2019)."	Fermentation, Digestive System, Food Nutrition, Lactic Acid Bacteria
Addition of Fish to Lemea	Adding fish to Lemea enhances its distinctive aroma and flavor while extending the fish's shelf life for up to 28 days, especially when there is a larger harvest.	Lactic Acid Bacteria (LAB) are the primary microorganisms involved in the fermentation process of Lemea. These bacteria, a large group of microorganisms, produce lactic acid as their main metabolite. LAB are naturally present in many foods and in the gastrointestinal and urogenital tracts of humans and animals (Kurnia et al., 2020).  The fermentation process in fish aids in preservation, extending the shelf life and preventing spoilage. The microorganisms involved in fermentation produce antimicrobial compounds and organic acids that inhibit the growth of pathogenic microorganisms, thereby enhancing the safety and longevity of the fish (Kurnia et al., 2020).	Metabolism; Fermentation Process, Lactic Acid Bacteria, Food Preservation
Addition of Salt to the Fermentation Process	Adding salt to the fermentation process enhances the flavor and helps preserve Lemea.	In food fermentation, Natrium Chloride (NaCl) plays a crucial role in limiting the growth of spoilage organisms and preventing the proliferation of undesirable microbes. The salts in the solution of the food substrate help suppress the activity of certain microorganisms, such as Lactic Acid Bacteria, by limiting available water, dehydrating protoplasm, and inducing plasmolysis (Amalia et al., 2016).  The presence of salt also causes the withdrawal of water from the fermented fish meat and bamboo shoots, which is then utilized as a substrate for bacterial growth during the fermentation process (Oxtariani, 2022).	Fermentation, Microbiology, and Food Preservation Processes

Storage of Lemea Fermentation	Lemea should be stored in a sealed, dark cabinet to maintain quality. The jar lid must be securely closed, and it is recommended that a plastic bulkhead be used to reinforce the seal, ensuring that the fermentation process remains intact and the Lemea yield is successful.	Fermentation typically lasts for 3 to 7 days and is conducted under anaerobic conditions by tightly sealing each container to prevent exposure to air, which can promote the growth of toxic proteolytic bacteria (Amalia et al., 2016).  Sunlight, particularly ultraviolet (UV) light, can degrade sensitive nutrients such as vitamins and antioxidants in fermented raw materials. Storing the fermentation process in a dark environment helps preserve the integrity of these nutrients (Kurnia et al., 2020).	Fermentation Process, Aerobic Bacteria
The fermentation process is carried out in two stages: bamboo shoots are fermented for 2 to 3 days, followed by the fermentation of fish for an additional 2 to 3 days.	When bamboo shoots and fish are fermented, spoilage may occur, resulting in fermentation failure. Marinating the bamboo shoots first and adding the fish improves the flavor and enhances the overall fermentation process.	During the pre-fermentation of bamboo shoots, the microorganisms present can produce compounds that enhance the complexity of the taste and aroma of the final product. When fish is added to this pre-fermented environment, the interaction between the microorganisms in the bamboo shoots and the fish results in a more diverse and flavorful end product (Oxtariani, 2022). Furthermore, pre-fermenting the bamboo shoots before adding the fish initiates the fermentation process naturally, establishing an optimal environment for the growth of beneficial microorganisms (Novelia et al., 2019).	beneficial bacteria
The Health Benefits of Bamboo Shoots	The Rejang community believes Lemea fermentation can help treat gout and high blood pressure and support dietary health.	Bamboo Shoot Extract from <i>Schizostachyum brachycladum</i> Kurz reduces serum uric acid levels in male white mice following the administration of the bamboo shoot extract. This effect is believed to be attributed to the presence of phenolic compounds found in bamboo shoots. Compounds such as tannins, flavonoids, polyphenols, and ellagic acid can inhibit the xanthine oxidase enzyme. The ethanol extract from bamboo shoots has demonstrated antihyperuricemia activity at 25 mg/kg (Alen et al., 2017; Sumiwi & S, 2020).  The types of bacteria found in Lemea include <i>Lactobacillus plantarum</i> C410L1 and <i>Lactobacillus rosiiae</i> LS6. This study suggests that Lemea has potential as a probiotic fermented food native to the Rejang Tribe, particularly as a producer of angiotensin-converting enzyme inhibitors with anti-hypertensive properties. These bacteria have shown resistance to acids and bile salts, indicating their survival ability in the gastrointestinal tract (Okfrianti et al., 2018).	Food Sources and Substances, Digestive System, Enzymes, Bacteria

The fermentation process of Lemea reflects indigenous knowledge passed down through generations by the Rejang Lebong community, aligning with scientific concepts in the field of biology. This tradition demonstrates a profound understanding of how indigenous communities utilize abundant natural resources to create a food product with enhanced nutritional value, extended shelf life, and sustainable food practices. This study highlights integrating the Lemea fermentation process in biology education to bridge local wisdom with scientific concepts. The Lemea fermentation process, a traditional food preservation method from the Rejang tribe, provides a unique opportunity to connect cultural practices with biological principles, such as microbial

fermentation, metabolic processes, and food preservation. The data analysis results demonstrate that this integration addresses a significant gap in the literature, which has relied mainly on common examples like yogurt or cheese to teach biotechnology concepts but has not utilized indigenous food practices to the same extent. The integration of Lemea into biotechnology education presents an opportunity to link indigenous knowledge with scientific principles. The fermentation process aligns with biological concepts such as biotechnology, metabolism, bacteria, etc. Through the strategic application of ethnopedagogy, cultural value-based education can be implemented within the teaching framework as a cultural activity and the culture of teaching (Muzzakir, 2021).

The results of data analysis show that integrating the Lemea fermentation process into biotechnology education provides a concrete example of microbial activity in food processing. This approach effectively answers the research problem by demonstrating the application of indigenous knowledge in science education. Unlike other studies focusing on common fermented foods such as yogurt and cheese, this study emphasizes local wisdom and its application in formal education, bridging indigenous science with modern biological frameworks. A key novelty of this study lies in its focus on incorporating the Lemea fermentation process as a direct example within the biology curriculum. While other studies have explored the use of fermented general foods, this research emphasizes the application of local wisdom in formal education, providing students with a concrete, culturally relevant example of microbial activity in food processing. By linking traditional food practices with scientific knowledge, this study enhances students' understanding of biology and promotes cultural appreciation and sustainability. This unique approach offers students a more engaging and relatable learning experience, as they can directly relate scientific principles to the food they consume daily. Table 2 further outlines how the fermentation of Lemea aligns with specific biology learning phases.

**Table 2.** Biology learning outcomes in Phase E – Phase F and integration of Lemea Local Potential

Learning Outcomes	Learning Objectives
At the conclusion of Phase E, students will have thoroughly understood measurement systems, alternative energy, ecosystems, <i>biotechnology</i> , biodiversity, atomic structure, chemical reactions, fundamental chemical laws, and climate change. This foundational knowledge equips them to respond proactively and contribute effectively to addressing both local and global challenges. These efforts are aligned with the overarching objective of advancing the Sustainable Development Goals (SDGs)	<ul style="list-style-type: none"> <li>• Students can explain the concept of conventional biotechnology by studying Lemea's culinary potential.</li> <li>• Students can apply the principles of conventional biotechnology through experiments on the fermentation process of Lemea's local culinary potential.</li> <li>• Students can explain the role of biodiversity (various types of bamboo) in supporting local food resources and promoting sustainable resource use.</li> <li>• Students can explain the connection between local ecosystems and traditional food production and the importance of sustainable practices.</li> <li>• Students can conduct laboratory activities to measure pH, analyze the compounds produced during fermentation, and relate them to the concept of food chemistry.</li> <li>• Students can explain the role of local wisdom in promoting climate-resilient practices and reducing dependence on imported or processed foods.</li> </ul>
After Phase F, students are expected to demonstrate a comprehensive understanding of cellular structures, the bioprocesses occurring within them, and the interconnectedness of organ systems in responding to internal and external stimuli. Furthermore, students should be able to explain the inheritance of traits, the processes of growth and development as they manifest in daily life, and the principles underlying the theory of evolution. Mastery of these concepts will enable students to effectively apply their scientific inquiry skills to analyze and address real-world challenges.	<ul style="list-style-type: none"> <li>• Students can analyze eukaryotic and prokaryotic cells, including bacterial cells.</li> <li>• Students can identify the role of Lactic Acid Bacteria (LAB) in the fermentation process of Lemea.</li> <li>• Students can describe the structure of organs in the digestive system and their interrelationships in maintaining hygiene and health.</li> <li>• Students can identify the nutritional content present in Lemea, a fermented culinary product.</li> <li>• Students can classify the types of foods and their respective functions in Lemea fermented culinary products.</li> <li>• Students can distinguish between beneficial and harmful bacteria involved in the Lemea fermentation.</li> <li>• Students can relate the anaerobic respiration process to the fermentation process of Lemea.</li> <li>• Students can design and conduct Lemea fermentation experiments, modifying variables such as bamboo shoot type, fermentation time, or fermentation containers.</li> </ul>

The fermentation process of Lemea exemplifies the practical application of local wisdom, which can be integrated with modern scientific knowledge to support education, cultural preservation, and sustainability. This

approach provides holistic benefits to both the community and the surrounding environment. From the results of the scientific review science and links to biological materials, it then needs to be adjusted to the learning outcomes and objectives. The potential of Lemea fermentation can be linked to class X and class XI Biology materials and sub-materials. Specifically, in class X, it can be incorporated into microbial metabolism and biotechnology lessons, while in class XI, it aligns with discussions on enzymatic activity and food preservation.

The ethnopedagogy approach enables students to understand that scientific knowledge is not solely derived from modern science but also from Indigenous knowledge that has evolved over centuries. This knowledge has been passed down across generations and is a fundamental aspect of daily life (Andayani et al., 2021; Ramadhani et al., 2024). The fermentation process of Lemea exemplifies the practical application of local wisdom, which can be integrated with scientific knowledge to support education, cultural preservation, and sustainability. Besides narratives, the findings are supported by data in tables to illustrate key aspects of the fermentation process and its relevance to biology education. This research contributes to developing contextual learning models that integrate local wisdom into biology education, supporting the Merdeka Curriculum's goal of fostering culturally relevant and scientifically grounded learning experiences. By incorporating ethnopedagogy, this study demonstrates that integrating Indigenous knowledge into formal education enriches students' understanding of both scientific and cultural perspectives, fostering holistic and meaningful learning experiences.

Despite its potential as a rich educational resource, the integration of Lemea fermentation into biology education remains largely unexplored, particularly in regions where traditional food practices are deeply rooted in local culture. The fermentation of traditional food in Bengkulu Province, particularly in Lebong Regency, represents a local practice within one of Indonesia's 3T areas (Disadvantaged, Frontier, and Outermost regions). In this region, the utilization of local potential, such as Lemea, remains limited to fulfilling the community's food needs and small-scale trade activities. However, the integration of Lemea as a learning resource has rarely been implemented. Based on preliminary studies conducted through interviews with teachers from two local schools and observations of Lemea's traditional food processing, the following points were identified: (1) The integration of local potential into biology education, particularly in the context of traditional food production like Lemea, has never been applied to students. This lack of integration has resulted in students having a limited understanding of the Lemea production process and unaware of its significance as part of their regional identity. (2) In teaching biotechnology, teachers often rely on common examples, such as yogurt, cheese, and cassava tape production. While these examples are relevant to daily life, they do not explore the connection to local potential. Linking biotechnology to the production of traditional foods like Lemea would allow students to better understand the relationship between biology and everyday life while fostering an appreciation for local culture; (3) Teaching methods predominantly involve lectures, presentations, and textbook assignments, which are less supportive of student-centered learning approaches; (4) Biotechnology is identified as a subject with low mastery levels among students; (5) The lack of adequate laboratory facilities, often repurposed as classrooms and limited instructional time hinder practical biotechnology activities. Consequently, students must conduct experiments independently and present their finished products at school, making it difficult for teachers to assess the quality of their work effectively.

However, the fermentation process of Lemea presents a significant opportunity to be dominantly integrated into biotechnology topics. This is because the process involves microorganisms, particularly lactic acid bacteria, which can be a tangible and relatable example for students. This study provides a novel perspective by demonstrating how integrating local potential into biotechnology education enhances conceptual understanding and cultural awareness. By incorporating Lemea fermentation into lessons, students would better understand microorganisms' role in fermentation and appreciate their cultural and scientific relevance. This approach would bridge the gap between theoretical knowledge and practical application, enhancing engagement and mastery in biotechnology while promoting local wisdom and sustainability. Additionally, this research contributes to the advancement of contextualized learning by emphasizing how local food resources can serve as effective teaching materials in science education. Furthermore, integrating local potential in learning can be an effective tool to connect scientific knowledge with culture. Learning can help students develop the proper attitudes toward the values of a nation's culture (Rahmawati et al., 2020).

By analyzing these biological properties, this study systematically maps the biological concepts within Lemea fermentation and integrates them into the Merdeka Curriculum. Through the integration of Lemea into the biotechnology curriculum, students could explore various learning objectives related to the topic. They would study the role and characteristics of microorganisms, such as lactic acid bacteria, in food fermentation processes, including how these microorganisms contribute to food preservation, flavor development, and nutritional enhancement. Additionally, students would learn about the conditions necessary for microbial growth, such as pH, temperature, anaerobic environments, and the biochemical processes involved in lactic acid fermentation. This hands-on learning experience could also deepen students' understanding of the applications of biotechnology in daily life, including its role in sustainable food production and preservation. By providing a

direct link between biology concepts and indigenous knowledge, this study offers a practical framework for integrating local wisdom into the formal curriculum, aligning with the broader educational goals of fostering scientific literacy, cultural appreciation, and environmental sustainability. Furthermore, by linking Lemea production to broader concepts like microbial biotechnology, environmental sustainability, and cultural preservation, students would develop critical thinking and problem-solving skills while recognizing the interdisciplinary nature of biology. This study highlights the practical implications for educators by encouraging using regionally relevant materials in teaching biotechnology, which could improve student engagement and knowledge retention.

Based on the analysis conducted in Table 2, it is obtained that the description of the process of making Lemea fermentation culinary is related to the Learning Outcomes (CP) in the Biology subject in phase E and phase F. This will make it easier for teachers to make links between Biology concepts and the Lemea fermentation process. With the CP connection in the content of the Lemea fermentation process, teachers and students make the process a contextualized learning resource for students. This implementation will help students to appreciate the values of local wisdom and culture, which are also the demands of the redesigned curriculum and the substance and objectives of national education. Providing learning materials related to traditional values, norms, or local culture in the student environment is one of the ways that teachers can support curriculum policies. In the Merdeka curriculum, which is still being implemented, teachers are given the freedom to design learning, so teachers are expected to integrate learning materials with the culture of the student environment. Meanwhile, many teachers in the learning process have not been able to link Biology material with local wisdom in the surrounding environment, which is said to be ethnoscience. [Rikizaputra et al. \(2021\)](#) found that in Pekanbaru city, in general, teachers have not been able to integrate ethnoscience into science learning, especially biology teachers. This study contributes significantly to developing contextualized learning models integrating local wisdom into science education. The ethnopedagogical approach in this study demonstrates how integrating cultural practices into formal curricula can foster a deeper connection between students and the material they learn. Integrating Lemea fermentation into biology lessons supports the objectives of the Merdeka Curriculum, which aims to make learning more culturally relevant and scientifically grounded. By emphasizing local food practices, this research strengthens students' understanding of scientific concepts and encourages them to appreciate their cultural heritage, promoting a sense of pride and identity.

## CONCLUSION

This study highlights the importance of integrating local wisdom, particularly the Lemea fermentation process, into biology education through an ethnopedagogical approach. The findings indicate that Lemea, a traditional food of the Rejang Tribe, serves as a medium for connecting indigenous cultural practices with scientific principles, particularly in biotechnology, metabolism, and bacterial activity. By incorporating local knowledge into the curriculum, this study proposes a novel pedagogical framework aligned with the Merdeka Curriculum, specifically addressing high school learning objectives in Phases E and F. Integrating Lemea fermentation into formal education not only enhances student engagement but also cultivates a deeper appreciation for cultural heritage and promotes sustainability. Moreover, this approach fosters critical thinking by encouraging students to analyze the intersection of science, culture, and practical applications. The findings contribute to advancing ethnoscience-based pedagogical models, which can be adapted across diverse educational contexts to foster a more inclusive and contextually relevant approach to science education. Ultimately, this study underscores the transformative potential of integrating Indigenous knowledge into contemporary curricula, bridging traditional wisdom with modern scientific paradigms, and reinforcing the objectives of the Merdeka Curriculum in promoting holistic and meaningful learning experiences.

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