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Integration of Local Wisdom and Functional Food Resources in Biology Education: A Strategy Toward Sustainable Learning

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ABSTRACT
ABSTRACT The integration of local wisdom and functional food into biology education serves as a promising strategy to enhance both the relevance of learning and sustainable food security. This study aims to analyze a model of integration between these two aspects and to identify the potential of local resources as tools for both education and nutrition. A systematic literature review method was employed, sourcing articles from Google Scholar (2021–2025) using the keywords "Biology Education", "Local Wisdom", and "Functional Food". The findings reveal that Dadio, tempe koro benguk, and food sources derived from mangroves and macroalgae are effective as instructional media and alternative nutrition sources, despite a noted gap in interdisciplinary approaches. The study concludes with a call for the development of culturally grounded curricula and cross-sectoral collaboration to optimize local resources.

Keywords: Biology Education, Local Wisdom, Functional Food

136 Introduction

The integration of local wisdom into biology education alongside functional food has become a critical issue in response to the growing demand for culturally relevant and sustainable education systems[1]. Previous studies have highlighted the potential of local resources such as Dadio and tempe koro benguk as contextual tools for teaching biology[2];[3]. Meanwhile, functional foods derived from local biodiversity, including mangroves and macroalgae, have been identified as viable solutions for food security[4];[5]. However, the existing literature remains fragmented between the educational and nutritional applications, with a lack of interdisciplinary studies that bridge the two domains[6]. Additionally, some research suffers from methodological limitations, such as insufficient transparency in inclusion criteria for data[7].

In light of these gaps, the aim of this study is to analyze a model for integrating local wisdom and functional food into biology education and to develop curriculum recommendations rooted in biodiversity. The significance of this research lies in its potential to offer a culturally responsive biology education framework, enrich science literacy based on local knowledge, and support the Sustainable Development Goals (SDGs) through the use of renewable resources[8].

137 Literature Review

This study is grounded in the theory of social constructivism (Vygotsky, 1978, as cited in Eilks & Hofstein, 2013), which emphasizes learning within cultural contexts, and the concept of integrated STEM education[9], which aims to bridge scientific knowledge with local practices.

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Previous research has demonstrated that the use of local wisdom such as Dadio in ecosystem learning[1] and the tempe koro benguk module[2] is effective in enhancing students' scientific literacy. On the functional food side, studies on mangroves[4] and macroalgae[5] have identified the potential of local biodiversity as a sustainable source of nutrition. However, critical analysis reveals a disconnect between educational studies and food applications, along with a lack of interdisciplinary approaches that integrate both dimensions[10].

Several previous studies also exhibit methodological limitations, including the absence of clearly defined inclusion-exclusion criteria[7] and a reliance on qualitative data without experimental validation[3]. The research gap lies in the lack of curriculum models that merge local wisdom with functional food biotechnology, as well as the need for sustainability-based evaluation strategies[8]. These findings form the basis for the hypothesis that integrating these two areas can strengthen the relevance of biology education and food security. The objective of this study is to design an interdisciplinary learning framework that utilizes renewable local resources while addressing methodological limitations through a mixed-method (quantitative-qualitative) approach and cross-disciplinary collaboration.

138 Research Methods

This study employed a Systematic Literature Review (SLR) framework to analyze the integration of local wisdom and functional food within the context of biology education. The research questions (RQs) were centered on: (1) How is local wisdom utilized as a source for biology learning? (2) What role does locally based functional food play in supporting sustainability?.

Reference searches were conducted through Google Scholar using the keywords "Biology Education," "Local Wisdom," and "Functional Food." The inclusion criteria were: publication years between 2021–2025, sorted by relevance, all types of journal articles/conference proceedings/theses relevant to the topic, excluding patents, not including citations only, full-text availability, and publications in English. The exclusion criteria included duplicate entries or studies outside the research scope. The analysis was carried out thematically based on categories such as instrument type, instrument purpose, key information about the instrument, and reference type.

139 Result and Discussion

Based on reference searches conducted on May 1, 2025, using criteria set to "any time" range, sorted by relevance, including all types of journal articles/conference proceedings/theses related to the topic, including patents, citations, full-text availability, and publications in English, 29 references were found. After applying exclusion criteria limited to the 2021–2025 period, excluding patents and citations 15 references remained. Table 1 below summarizes information about the instruments used in each of the 15 references identified in the Google Scholar database.

Table 15: Information on Instruments Used in Each Reference

No	Author	Instrument Name	Instrument Purpose	Key Information on Instrument	Type of Reference
1	Ilhami et al. (2024) [1]	Dudie (Local Wisdom)	Local wisdom-based biology learning source	Used to teach ecosystem, biodiversity, and conservation through traditional practices	Journal Article

No	**Author**	**Instrument Name**	**Instrument Purpose**	**Key Information on Instrument**	**Type of Reference**
2	Husain & Rosyid (2023) [11]	Tea Plant (Camellia sinensis)	Documentation of tea use in local culture	Tea is used as medicine, a ritual, and as a functional food in Ngayogjokarto	Conference Proceedings
3	Sosefian et al. (2024) [8]	Local Shutter in Karo Regency Batak Temple	Biotechnology learning module through temple decoration product development	Local shutter columns are used as a learning resource and for microbiology content	Journal Article
4	Mensalia et al. (2024) [12]	Indigenous Plants	Indigenous plants as food sources in Lesua	Food species are important for food security	Journal Article
5	Purwatin et al. (2023) [13]	Balkason with Ferocactus latispinus	Fermented fish preservation from traditional fish processing	Bacteria starter of Balkason contains lactic acid bacteria	Journal Article
6	Fadillah et al. (2023) [9]	F.-Laboratory Guide	Create modules from traditional food commodities	Food modules are applied in science learning	Journal Article
7	Navia et al. (2023) [4]	Tampoi Plants (Baccaurea spp.)	Assess biodiversity and local livelihood impact	Tampoi used as food, medicine, ecological value in South Asia	Conference Proceedings
8	Tiksari et al. (2023) [6]	Mangrove as Food Source	Explore mangrove functional food	Mangrove fruit is processed into food and drinks rich in antioxidants	Journal Article
9	Tauquriy et al. (2024) [5]	Moraceae (Suwece)	Identify plants used as food and medicine in Maluku	Contains minerals, vitamins, and has cancer prevention opportunities	Journal Article
10	Pribadi et al. (2024) [15]	Coffee-based Agroforestry	Developing local culture-based biology learning module	Uses environmental knowledge in coffee-shade agroforestry	Report/Study
11	Zahran et al. (2023) [10]	List of Local Wisdom	Documentation of food and medicine use in Madura	Data obtained from ethnobotanical study	Journal Article
12	Afifah et al. (2021) [7]	Modified Gapoktan Method	Manages suitable environment for Ganderi cultivation	Combines Clonks and Gapoktan Method to increase Ganderi productivity	Seminar Proceedings
13	Handayani et al. (2024) [18]	Indonesian Cinnamon	Analysis of cinnamon's medicinal potential	Contains anti-diabetic and anti-inflammatory compounds	Journal Article

No	Author	Instrument Name	Instrument Purpose	Key Information on Instrument	Type of Reference
14	Kuswantoro (2024) [19]	Adlay Seeds (Coix lacryma-jobi L.)	Comparison of nutritional content and seed germination	Hard seeds have higher protein content	Thesis/Dissertation
15	Aflizar et al. (2021) [20]	Multi Soil Layering (MSL)	Cattle wastewater treatment	MSL effectively reduces organic pollutants	Seminar Proceedings

The references are predominantly journal articles (9), followed by conference or seminar proceedings (4), one thesis/dissertation, and one report/study. This indicates that the topic of "Biology Education," "Local Wisdom," and "Functional Food" is widely researched in formal academic settings, especially through journal publications.

Most studies (e.g., Ilhami et al., 2024[1]; Septiani et al., 2024[2]) used qualitative and experimental methods to explore local wisdom as a source for biology learning and functional food development. These findings align with social constructivism theory, which emphasizes culturally contextual learning (Vygotsky, 1978, in Eilks & Hofstein, 2015[21]). For instance, the use of Dadio[1] as a local ecosystem model enhances student understanding of biodiversity through authentic practices.

Studies such as those by Hapsari & Roziaty (2023)[11] and Aflizar et al. (2021)[20] focused on ethnobotanical documentation and technological applications. Conference proceedings were often used to disseminate preliminary findings or local case studies, which were later expanded into more in-depth research[7]. For example, the geophysical-chemical analysis for mapping Gambir cultivation areas[17] reflects interdisciplinary integration in biology education.

Kuswantoro's (2024)[19] work on adlay seeds exemplifies in-depth research aimed at examining nutritional composition and germination. Theses and dissertations generally contribute to applied scientific development, such as functional foods based on local seeds, consistent with the global trend of sustainable nutrition[8].

The study by Pribadi et al. (n.d.)[15] on coffee agroforestry vegetation has not been published in a journal or conference proceedings but provides raw data on food diversification. Such reports often serve as a basis for follow-up research or local policy[22].

The integration of local wisdom and functional food in studies (e.g., koro benguk tempe by Septiani et al., 2024[2]) supports culturally responsive STEM approaches. According to Novitasari (2023)[23], project-based learning (PjBL) using local materials enhances student engagement and social relevance.

However, references like Pribadi et al. (n.d.), which lack publication year and clear platform, present challenges in assessing credibility. Future research should ensure methodological transparency and data accessibility[7].

140 Conclusion

The analysis results indicate that the integration of local wisdom and functional food into biology education has the potential to enhance learning relevance through contextual and interdisciplinary approaches. The use of local resources such as Dadio, koro benguk tempe, and macroalgae not only enriches scientific literacy but also supports food sustainability. However, some studies show limitations in methodological transparency and data accessibility. Therefore, it is recommended to develop project-based curricula that utilize local resources, enhance teacher training in culturally responsive STEM approaches, and promote further research with

rigorous experimental designs and interdisciplinary collaboration to optimize the use of functional foods rooted in local wisdom.

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