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EXPLORING ETHNO-SCIENCE IN LOCAL TRADITIONAL FOOD: Reconstruction Analysis into Scientific Education Content

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Abstract

This research explores the integration of traditional foods into science education through the analysis of *Cenil*, *Jadah Tempe*, *Gethuk Lindri*, *Geplak*, and *Legomoro*. By investigating the nutritional content, food additives, and cooking processes of these traditional dishes, the study aims to bridge the gap between cultural practices and scientific principles. The research employs qualitative methods, including observation and analysis of traditional food preparation, to uncover the scientific concepts underlying these foods, such as heat transfer, chemical reactions, and physical changes. The findings highlight the educational potential of traditional foods, demonstrating their value as practical examples for teaching scientific concepts and promoting critical thinking. The study also emphasizes the importance of integrating 21st-century skills—critical thinking, collaboration, communication, and creativity—into science education through the exploration of culturally relevant content. This approach not only enhances students' understanding of science but also fosters appreciation for cultural heritage and encourages sustainable practices. The research suggests that incorporating traditional foods into the curriculum can provide a more engaging and meaningful learning experience, supporting both educational and cultural objectives.

Keywords: Ethnoscience; Local Traditional Food; Reconstruction; Science Education

Introduction

Ethno-science occupies a pivotal role at the intersection of cultural heritage and scientific understanding, focusing on how indigenous knowledge systems contribute to our empirical knowledge (Solheri et al., 2022). This approach sheds light on the complex relationships between cultural practices and natural phenomena. Traditional food systems, deeply rooted in local customs, embody unique methods of preparation and preservation honed over generations (Tyas et al., 2020). These practices often align with scientific principles related to nutrition and food chemistry, though expressed within culturally specific frameworks. For instance, research by (Tamang et al., 2016)] has demonstrated that traditional food preparation methods, such as fermentation, align with modern nutritional science. Another study by (Antonelli, 2023; Vijayan et al., 2022) revealed how indigenous food practices can offer insights into sustainable food systems. By integrating cultural and scientific perspectives, researchers can gain valuable insights into nutritional content and the role of food additives, enriching our understanding of traditional foods and their benefits (Ciptasari et al., 2015; Rostikawati & Permanasari, 2016).

The integration of ethno-science into science education is critical in the context of 21st-century learning, which emphasizes skills such as critical thinking, collaboration, communication, and creativity (Thornhill-Miller et al., 2023). Modern science education is increasingly focused on preparing students for a rapidly changing world by integrating real-world contexts and fostering a holistic understanding of scientific concepts (Mukti et al., 2022; Putri et al., 2022; Ruiz-Calleja et al., 2021). Traditional knowledge systems provide a rich source of contextual learning that can enhance students' engagement with science by connecting classroom learning with their surrounding environment (Ciptasari et al., 2015; Solheri et al., 2022). Research by (Hairida, 2016; Kartini et al., 2021) has highlighted how incorporating indigenous knowledge into science curricula can enhance students' critical thinking and problem-solving skills.

Furthermore, integrating traditional food knowledge into science education can promote collaborative learning experiences and creative problem-solving, aligning with the goals of 21st-century education (Kirschner et al., 2018; Tyas et al., 2020). This study addresses the urgent need for educational materials that not only reflect the scientific value of traditional practices but also engage students with their cultural and environmental context. This article seeks to explore how ethno-science can be applied to the analysis of local traditional foods, with the goal of reconstructing traditional knowledge into scientifically valid educational content. By investigating the nutritional and additive properties of these foods through a combined ethno-scientific and scientific approach, the study aims to demonstrate the relevance of integrating traditional wisdom into modern science curricula.

As educational frameworks evolve to meet the demands of a globalized and interconnected world, the incorporation of ethno-science into science education presents an opportunity to create a more inclusive and relevant curriculum (Sudarmin et al., 2017). By bridging the gap between traditional knowledge and modern science, this research can support the development of educational strategies that are both scientifically rigorous and culturally sensitive (Wilujeng et al., 2018). This approach not only preserves and honors cultural heritage but also equips students with a diverse set of skills and perspectives essential for navigating complex global challenges. Integrating traditional food knowledge into science education can lead to a more comprehensive understanding of the interplay between science, culture, and environment, ultimately fostering students' ability to apply their knowledge in innovative and contextually relevant ways (Stave et al., 2015). Thus, this phenomenon is interested to be studied in-depth through ethno-science perspective.

Literature Review

Ethno-science refers to the systematic study of indigenous knowledge systems that have been developed through long-term interactions between communities and their natural environments (Rahman et al., 2023). This body of knowledge encompasses local understandings of food processing, agriculture, health, and environmental management, which are often grounded in empirical observation and practical experimentation across generations (Sudarmin, 2021). Scholars argue that ethno-science represents an alternative epistemology that complements modern scientific knowledge rather than contradicts it.

In the context of science education, ethno-science plays a critical role in contextualizing abstract scientific concepts within learners' sociocultural environments (Solheri et al., 2022). Integrating indigenous knowledge into science learning has been shown to enhance conceptual understanding, promote cultural relevance, and foster students' engagement and critical thinking (Vasileiou et al., 2022). By bridging local wisdom with scientific explanations, ethno-science-based learning supports meaningful learning and epistemological pluralism in science classrooms.

Traditional foods are cultural products that embody local knowledge related to nutrition, food chemistry, preservation techniques, and environmental adaptation (Barriyah et al., 2020). Processes such as fermentation, steaming, boiling, and the use of natural additives reflect sophisticated empirical understandings of microbiology, thermodynamics, and chemical reactions, even though these principles are not formally articulated in scientific terms by local communities (Nisa & Tyas, 2022).

Several studies have demonstrated that traditional food practices align closely with modern scientific explanations (Tyas et al., 2020). For example, fermentation in foods such as tempeh has been scientifically proven to improve protein digestibility, enhance micronutrient availability, and introduce beneficial microorganisms. Similarly, the use of natural colorants, spices, and plant-based packaging materials, such as banana leaves, reflects indigenous knowledge related to food safety, preservation, and sustainability (Sudarmin, 2021). These findings suggest that traditional foods constitute rich ethno-scientific resources that can be reconstructed into scientifically valid learning materials.

Reconstruction is a critical process in ethno-science research, involving the translation of indigenous knowledge into formal scientific concepts without diminishing its cultural meaning. According to (Wilujeng et al., 2024), reconstruction enables educators to map traditional practices onto scientific frameworks such as chemistry, biology, and physics, making them accessible within formal education systems. This process ensures scientific rigor while maintaining cultural authenticity.

In science education research, reconstructed ethno-scientific content has been shown to improve students' understanding of scientific concepts such as heat transfer, phase changes, mixtures, and chemical reactions (Mukti et al., 2022). Moreover, learning activities based on local cultural contexts help students perceive science as relevant to their daily lives, thereby reducing the gap between school science and real-world experiences.

The integration of traditional foods into science education aligns strongly with the goals of 21st-century learning, which emphasize critical thinking, collaboration, communication, and creativity (Hanum et al., 2023). Context-based learning using culturally familiar objects encourages students to analyze problems, design investigations, and communicate findings collaboratively (Trilling & Fadel, 2009). Traditional food analysis, in particular, invites inquiry into nutrition, health, food safety, and sustainability, issues that are highly relevant to contemporary global challenges.

Furthermore, this approach supports Education for Sustainable Development (ESD), which promotes learners' ability to make responsible decisions concerning environmental integrity, economic viability, and social equity (Mukti et al., 2022). Traditional foods exemplify sustainable practices through the use of local resources, minimal processing, biodegradable packaging, and intergenerational knowledge transfer. By examining traditional foods scientifically, students can develop systems thinking and sustainability awareness while appreciating cultural heritage.

Research Methods

This study employs an exploratory research design to investigate the traditional foods *Geplak, Legomoro, Cenil, Jadah Tempe,* and *Gethuk*, focusing on how these foods can be reconstructed into scientifically valid educational content (Singh, 2021). The research aims to explore the potential of these traditional foods as learning resources by analyzing their nutritional and chemical properties through both cultural and scientific lenses.

The research is conducted in Yogyakarta Province, focusing on traditional foods that are locally significant. The foods selected for this study include *Geplak*, a sweet treat made from grated coconut and sugar; *Legomoro*, a type of traditional vegetable dish; *Cenil*, a glutinous rice cake typically served with grated coconut and palm sugar; *Jadah Tempe*, a combination of sticky rice and fermented soybeans; and *Gethuk*, a sweet cassava-based confection. These foods were chosen due to their cultural importance and the potential insights they provide into traditional food preparation and preservation methods. Data collection involves multiple techniques to gain a comprehensive understanding of the selected traditional foods. The methods include:

Direct Observation: observations were conducted to examine the preparation and consumption of the selected traditional foods. This involved visiting local markets, food preparation sites, and community events where these foods are commonly made and consumed. Detailed notes were taken on preparation methods, ingredient use, and serving practices. *Interviews*: semi-structured interviews were conducted with key informants including local food experts, traditional cooks, and community members who have extensive knowledge about the selected foods. The interviews aimed to gather information on traditional preparation techniques, cultural significance, and any scientific knowledge related to the foods. Interview guidelines were developed to ensure consistency and cover relevant topics. *Data Analysis*: the qualitative data from observations and interviews were transcribed and analyzed to identify key themes related to traditional food practices and their scientific implications.

The findings from the scientific analysis were integrated with the cultural insights gained from interviews and observations to reconstruct the traditional knowledge into a scientifically accurate format. This reconstructed content was then evaluated for its potential use as educational material in science curricula, aiming to provide a comprehensive and culturally relevant learning resource.

Results and Discussion

Geplak

Figure 1: *Geplak*, Traditional Food from Yogyakarta
(Source: Author's documentation, 2025)

The exploration of *Geplak*, a traditional food, reveals several key aspects related to its ingredients and preparation process, particularly focusing on food additives such as colorants, salt, and vanilla (Yugatama & Hapsari, 2021). The

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analysis of these components provides valuable insights into their roles in food preparation and their implications for science education.

Table 1. Scientific Reconstruction of *Geplak*

Observed Object	Observed Symptoms	Problem Formulation	Potential Learning Resources
Geplak ingredients	Colorant used, Salt, Vanilli	• What are the basic ingredients used in the food coloring? • What are the negative impacts if you continue to use these dyes? LKPD • Do salt and vanilla have a big effect on the taste of *geplak*?	Food additives
Coloring process	Color content mixed in the dough	• Why is it necessary to add color to *geplak* food? • Why is the colorant mixed evenly? • What causes the dye to last long on *geplak* food?	Food additives

Table 1 highlights the result of *Geplak* scientific reconstruction, that show that *Geplak* is close with food additives topic, especially food colorant. As we all know, shown in Figure 1 that *Geplak* has various colors and looks striking. The first observation highlights the use of colorants, salt, and vanilla in *Geplak*. The problem formulation addresses the nature of these additives, particularly focusing on the basic ingredients of food coloring and the potential negative impacts of continued use (Fardani, 2023; Yugatama & Hapsari, 2021). Food colorants, often added to enhance visual appeal, may have adverse health effects if consumed in large quantities over time (Sudarmin et al., 2017). Educators can utilize this information as a learning resource to discuss the chemistry of food additives, their safety, and their regulatory standards. Salt and vanilla, on the other hand, contribute to the taste profile of *Geplak*. Understanding their impact on flavor can lead to discussions about the roles of different substances in food, how they interact, and their importance in culinary traditions. This analysis can serve as a basis for lessons on food chemistry, encouraging students to think critically about the ingredients in their food and the potential health implications of additives (Hastuti & Putri, 2022).

The second observation focuses on the coloring process itself, where the color content is mixed into the dough. The problem formulation raises questions about the necessity of adding color to *Geplak*, the importance of even mixing, and the reasons for the dye's longevity in the food (Wulandari et al., 2019). These questions open avenues for discussions on the principles of food science, particularly the role of colorants in consumer appeal and the chemical interactions that enable dyes to persist in food products (Coultate & Blackburn, 2018; Gautam, 2016). The even distribution of colorant suggests the importance of mixing techniques and their impact on the final product, which can be related to concepts of homogeneity and solution chemistry (Bourne, 2003). Moreover, the durability of the dye on *Geplak* can lead to explorations of chemical stability and the factors that influence the longevity of food additives. These topics are highly relevant in a science education context, where students can explore the scientific principles underlying everyday food practices (Mwale, 2024; Srivastava, 2013).

The observations and problem formulations from the study of *Geplak* highlight the potential of traditional foods as rich learning resources in the field of science education (Tyas et al., 2020). By examining the use of additives and the processes involved in food preparation, students can gain a deeper understanding of chemistry, nutrition, and the health implications of food choices. Integrating these findings into educational materials not only enhances students' scientific literacy but also connects them with their cultural heritage, making science learning more relevant and engaging (Hayati et al., 2019; Sudarmin et al., 2017).

Legomoro

Figure 2: *Legomoro*, Traditional Food from Yogyakarta
(Source: Author's documentation, 2025)

Table 2. Scientific Reconstruction of *Legomoro*

Observed Object	Observed Symptoms	Problem Formulation	Potential Learning Resources
Legomoro base material	Glutinous rice as the main ingredient	• Why is glutinous rice used as the base for *Legomoro*? • What nutritional content is found in glutinous rice? • What are the benefits of glutinous rice?	• Nutrient content of food • Benefits of nutrients for the body

Observed Object	Observed Symptoms	Problem Formulation	Potential Learning Resources
Kitchen spices	Spices used	• What is the function of the spices used? • Are there any additives used?	Food additives
Chicken meat	Chicken meat boiling process	• What are the physical concepts involved in boiling? • What are the nutrients in chicken meat?	• Changes in the form of substances • Nutrient content
Glutinous rice processing	Glutinous rice steaming process	What physics concepts are involved in the steaming process?	Change in form of substance
Legomoro	Packaging process	• What is the chemical content of banana leaves? • What physical concepts are present in the 3 banana leaf bundles?	Food additives

The analysis of *Legomoro* as shown in Table 2 reveals important connections between cultural practices and scientific concepts that can be leveraged in science education. Glutinous rice, the main ingredient in *Legomoro*, is rich in carbohydrates and essential nutrients (Barriyah et al., 2020; Kuswanto, 2018). This provides an opportunity to discuss the nutritional value of traditional foods in the classroom, helping students understand the significance of nutrition and how it relates to health. The spices used in Legomoro enhance flavor and offer health benefits, introducing students to the role of natural food additives. This can be tied to discussions on food chemistry, where students learn about the properties and effects of these additives.

The boiling of chicken meat illustrates physical concepts such as heat transfer and phase changes. This process can be used to teach students about the science behind cooking and the nutritional content of food, making abstract concepts more relatable. Steaming glutinous rice is a traditional cooking method that preserves nutrients. This process can be used to explore concepts like heat transfer and the efficiency of different cooking methods, linking traditional practices to scientific principles. The use of banana leaves for packaging introduces natural materials' chemical and physical properties. Students can explore sustainable packaging options, connecting lessons in chemistry and environmental science with real-world applications.

The detailed exploration of *Legomoro's* ingredients and preparation processes illustrates how traditional foods can serve as effective learning resources in the science classroom. By connecting cultural practices with scientific principles, students can develop a deeper understanding of the science behind everyday activities. This approach not only enhances students' knowledge of food science but also fosters critical thinking, collaboration, and creativity—key competencies in 21st-century science education (Darling-Hammond, 2006). Teachers play a crucial role in facilitating these connections, guiding students to explore the science embedded in their cultural heritage and applying it to their learning in meaningful ways. Integrating traditional foods like Legomoro into the curriculum can make science education more relevant and engaging, helping students appreciate the scientific knowledge that exists within their cultural context.

Cenil

Figure 3: *Cenil*, a Chewy Traditional Local Food
(Source: Author's documentation, 2025)

The exploration of *Cenil*, a traditional food made from tapioca flour, offers insights into food science that can be connected to Education for Sustainable Development (ESD). By analyzing the ingredients and processes involved in making *Cenil*, students can learn about the science behind traditional foods while also considering the broader implications for sustainability.

Table 3. Scientific Reconstruction of *Cenil*

Observed Object	**Observed Symptoms**	**Problem Formulation**	**Potential Learning Resources**
Tapioca flour	*Cenil* texture when using tapioca flour	• Why does *Cenil* have a chewy texture? • Does tapioca starch make *Cenil* durable?	Food additives
Food Dyes	Striking color on Cenil	• Is the food coloring safe for consumption? • Where does the food coloring come from?	Food additives
Grated Coconut	Grated coconut sprinkled on *Cenil*	• Does the grated coconut on the *Cenil* keep well?	Food additives

Observed Object	Observed Symptoms	Problem Formulation	Potential Learning Resources
Dough Making Process	Coloring the flour mixture, adding boiling water, Forming process of *Cenil*	• What causes the coloring to spread evenly? • Why is it that when the flour mixture is given boiling water, it becomes smooth? • Why can the *Cenil* dough be easily shaped?	Change of Form of Physical Substances

The chewy texture of *Cenil*, due to tapioca flour, offers a way to explore food additives and the physical properties of starches (Gałkowska et al., 2023; Zia-ud-Din et al., 2017). This connects to ESD by encouraging students to consider the sustainability of ingredient sources and the environmental impact of tapioca cultivation (Fernando et al., 2022; Nizzy & Kannan, 2022). The vibrant colors in Cenil raise questions about the safety and origin of food dyes (M. Mwale, 2024). This discussion ties into ESD by promoting awareness of food safety and the environmental impact of synthetic dyes, encouraging exploration of natural alternatives (Novais et al., 2022; Scotter, 2011). The use of grated coconut highlights issues in food preservation. This aspect links to ESD by emphasizing the importance of minimizing food waste and exploring sustainable preservation techniques, blending traditional methods with modern innovations. The process of making Cenil, involving coloring, boiling, and shaping, illustrates the physical state changes in cooking (Zielbauer et al., 2016). ESD considerations include energy efficiency and the use of sustainable resources, encouraging students to adapt traditional cooking methods to modern needs while preserving cultural significance.

Integrating the study of *Cenil* into science education provides a platform for discussing sustainability in food production and consumption. By connecting traditional food practices with scientific concepts and sustainability principles, students can develop a holistic understanding of the environmental, economic, and social aspects of food systems (Antonelli, 2023). This approach aligns with the goals of ESD, which seeks to empower learners to make informed decisions and take responsible actions for environmental integrity, economic viability, and a just society for present and future generations (Leicht et al., 2018). Teachers play a crucial role in facilitating these connections, helping students to see the relevance of their learning to real-world challenges and encouraging them to think critically about their role in creating a sustainable future.

Jadah Tempe

The exploration of *Jadah Tempe*, a traditional Indonesian dish, reveals important links between cultural practices, food science, and educational opportunities. Both *Jadah* and *Tempe Bacem* are rich in nutrients such as carbohydrates, protein, and essential fats (Ayiz & Aryono, 2023; Maskar et al., 2018). Students can investigate the nutritional value of these foods, linking them to broader discussions about balanced diets and the role of traditional foods in maintaining health. This study offers a platform to emphasize the importance of nutritional education in promoting sustainable health practices, encouraging students to appreciate the value of traditional diets while considering their caloric content and portion control.

Table 4. Scientific Reconstruction of *Jadah Tempe*

Observed Object	**Observed Symptoms**	**Problem Formulation**	**Potential Learning Resources**
Jadah	*Jadah* ingredients: Grated half-aged coconut, Coconut milk, Glutinous rice, Salt	• What are the nutrients contained in *Jadah*? • What are the benefits of the nutrients contained in *Jadah* for the body? • How many calories does 1 serving of *Jadah* contain?	Nutrient content of food
		• What ingredients give *Jadah* its savory taste?	Food additives
Jadah making process	Heat transfer in the steaming process of *Jadah*	• How does *Jadah* cook in the steaming process? • What type of heat transfer occurs in the steaming process?	Heat transfer
Tempe Bacem	Ingredients for making tempe bacem: Tempe, Brown sugar, Garlic, Shallots, Coriander, Young coconut water, Bay leaf, Galangal, Granulated sugar Oil	• What are the nutrients contained in *Tempe Bacem*? • What are the benefits of the nutrients contained in *Tempe* for the body? • What is the function of bay leaves in making *Tempe Bacem*? • What is the function of young coconut water in making *Tempe Bacem*? • How many calories are produced in 1 serving of *Tempe Bacem*?	Nutrient content of food
		• What ingredients give *Tempe Bacem* its flavor? • What ingredients give the *Tempe Bacem* its brown color?	Food additives

Observed Object	Observed Symptoms	Problem Formulation	Potential Learning Resources
		• Are there any harmful additives in *Tempe Bacem*?	
Tempe Bacem making process	The process of frying *Tempe Bacem*	• What types of heat transfer occur during the *Tempe Bacem* frying process? • How does the heat from the fire get to the *Tempe Bacem*?	Heat transfer
Jadah Tempe	In 1 serving *Jadah Tempe* has quite large calories	• What is the appropriate portion of *Jadah Tempe* for teenagers and adults? • How to make a balanced portion of nutrients between carbohydrates, protein, and fat in *Jadah Tempe*?	Nutrient content of food

Figure 4: *Jadah Tempe*, Traditional Food from Yogyakarta
(Source: Author's documentation, 2025)

Given that *Jadah Tempe* is high in calories, it presents an opportunity to discuss appropriate portion sizes and how to achieve balanced nutrition between carbohydrates, proteins, and fats (Gush et al., 2021; Jia et al., 2022). This discussion aligns with ESD by encouraging students to think critically about their dietary habits and how they can make informed, sustainable choices that contribute to their overall health and well-being (Leicht et al., 2018). By integrating the study of *Jadah Tempe* into the science curriculum, educators can provide students with a deeper understanding of both the cultural and scientific aspects of traditional foods. This approach not only enhances students' knowledge of nutrition and food science but also promotes critical thinking about sustainable practices in food production and consumption.

Gethuk

Figure 5: *Gethuk Lindri*, a Sweet Traditional Local Food
(Source: Author's documentation, 2025)

Integrating the study of *Gethuk* into science education not only deepens students' understanding of key scientific principles but also connects these concepts to broader themes of sustainability. By examining traditional foods through the lens of ESD, educators can inspire students to appreciate the cultural significance of these foods while also considering their impact on health and the environment (Kopnina, 2013).

Table 5. Scientific Reconstruction of *Gethuk*

Observed Object	**Observed Symptoms**	**Problem Formulation**	**Potential Learning Resources**
Ingredients for making *Gethuk*	Cassava, Half grated coconut, Granulated sugar, Salt	• What are the main nutrients in cassava? • How does the combination of all these ingredients affect the nutritional value of *Gethuk*? • How does the fat content in grated coconut affect health?	Nutrient content of food
Manufacturing process	Texture of cassava after steaming, mixing of sugar and coloring, formation of dough	• How does the length of steaming time affect the texture of cassava? • What is the effect of using excess sugar on the texture and flavor of *Gethuk*? • How to shape the *Gethuk* so that it has a neat shape?	Physical changes Mixtures and Solutions Change of Form of Substance
Steaming process	Color change, Pressure and	• Does the color change of *Gethuk* affect different steaming temperatures?	Chemical reaction

Observed Object	Observed Symptoms	Problem Formulation	Potential Learning Resources
	temperature, Vapor release	• What is the relationship between steaming temperature and the time taken for *Gethuk* to be fully cooked? • How can vapor expulsion affect the consistency of *Gethuk* dough during the steaming process?	
Way of serving	Texture of gethuk, Addition of grated coconut as topping	• Does the texture of *Gethuk* change after refrigeration or storage? • What causes grated coconut to stick to the *Gethuk* as a topping?	Physical changes

The analysis of traditional foods like *Jadah*, *Tempe Bacem*, and *Gethuk* provides valuable insights into scientific concepts and their application in education. This approach not only enriches students' understanding of food science but also integrates key skills essential for 21st-century learning (Darling-Hammond, 2006). Exploring traditional foods connects students with fundamental scientific principles such as nutrition, heat transfer, and chemical reactions. By investigating the nutritional content of ingredients, the effects of food additives, and the physical changes during cooking processes, students apply theoretical knowledge to practical scenarios. This hands-on approach enhances their comprehension of scientific concepts and demonstrates the real-world relevance of these principles (Tyas et al., 2020).

The analysis of traditional foods provides a robust framework for cultivating essential 21st-century skills among students. Critical thinking is fostered as students delve into the roles of various ingredients and cooking methods, questioning their nutritional benefits, safety, and environmental impacts. This investigative approach encourages students to develop a critical mindset towards problem-solving and decision-making (Hastuti & Putri, 2022). Collaboration is promoted through group projects and discussions focused on traditional food preparation and analysis (Thornhill-Miller et al., 2023). Working together to gather data, conduct experiments, and share findings helps students enhance their teamwork skills and appreciate diverse perspectives. Communication is another key skill honed during this process (Thornhill-Miller et al., 2023; Turiman et al., 2012). As students present their findings, they learn to articulate complex scientific concepts clearly and effectively, which is crucial for academic success and future professional roles. Finally, creativity is encouraged through the reconstruction of traditional foods into educational content. This process allows students to creatively integrate traditional knowledge with modern scientific practices, fostering an appreciation for both cultural heritage and scientific innovation (Ergul et al., 2011; Thornhill-Miller et al., 2023). By engaging in these activities, students develop a well-rounded skill set that prepares them for the challenges of the 21st century.

Incorporating traditional foods into science education supports a holistic learning experience (Tyas et al., 2020). It bridges the gap between cultural practices and scientific inquiry, making lessons more engaging and relevant (Wilujeng et al., 2024). By connecting traditional knowledge with modern scientific concepts, educators can create meaningful learning experiences that prepare students for future challenges. Overall, the study of traditional foods provides a rich context for teaching and learning science (Hastuti & Putri, 2022). It helps students develop essential 21st-century skills while deepening their understanding of both cultural and scientific aspects of food. This approach not only enhances their scientific literacy but also promotes a broader appreciation of the role of traditional practices in contemporary life.

Beyond enhancing conceptual understanding and 21st-century skills, the findings of this study reveal a consistent pattern showing that traditional foods function as epistemic tools for learning science (Tyas et al., 2020). The systematic mapping of ingredients, preparation techniques, and observable changes onto scientific concepts demonstrates that traditional foods are not merely contextual examples, but structured learning resources capable of supporting curriculum-aligned scientific inquiry. Moreover, the reconstruction process employed in this study clarifies the mechanism through which cultural knowledge is transformed into scientific knowledge (Wilujeng et al., 2024). By translating community-based practices into observable variables, guiding questions, and learning indicators, the study demonstrates how ethno-scientific knowledge can be systematically aligned with scientific reasoning (Sarkingobir & Bello, 2024; Solheri et al., 2022).

Conclusion

The exploration of traditional foods such as *Jadah, Tempe Bacem*, and *Gethuk* demonstrates the valuable intersection between cultural practices and scientific principles. By analyzing the nutritional content, food additives, and cooking processes involved in these traditional dishes, students gain a deeper understanding of both food science and cultural heritage. The study reveals that traditional foods are not only a source of nutritional knowledge but also a practical application of scientific concepts such as heat transfer, chemical reactions, and physical changes. This research presents several key implications, including:

Educational Enhancement. Integrating traditional foods into the science curriculum enriches the learning experience by providing real-world applications of scientific principles. This approach makes science education more relevant and engaging, helping students to connect theoretical knowledge with practical examples.

Development of 21st-Century Skills. The analysis fosters critical thinking, collaboration, communication, and creativity among students. These skills are essential for navigating the complexities of the modern world, and their development through food science projects prepares students for both academic and professional challenges.

Cultural Appreciation and Sustainability. By examining traditional foods, students not only learn about the nutritional and scientific aspects but also gain an appreciation for cultural heritage. This approach promotes respect for traditional practices and encourages sustainable food choices, aligning with broader goals of environmental stewardship and cultural preservation.

Curriculum Integration. Educators can use the study of traditional foods to create interdisciplinary learning experiences that bridge science with cultural studies. This integration supports a holistic approach to education, addressing multiple learning objectives and fostering a comprehensive understanding of both scientific and cultural contexts.

In summary, the study of traditional foods offers significant benefits for science education, contributing to a richer, more applicable learning experience. It supports the development of crucial 21st-century skills and promotes a deeper appreciation for cultural and scientific intersections, ultimately enhancing students' educational journeys and preparing them for future success.

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