

Exploring the Ethnoscience of the Rago Ball in the Traditional Game of *Sepak Rago Tinggi* as a Source for Contextual Chemistry Learning

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ABSTRACT

This study aims to explore the ethnoscience of the rago ball in the traditional game *Sepak Rago Tinggi* in Kopah Sub-district, Kuantan Singingi Regency, as a source of contextual chemistry learning. This study employs a qualitative approach with an ethnographic design to uncover the community's indigenous science regarding the selection of materials, processing techniques, and physicochemical characteristics of the rago ball. Data were collected through participant observation, in-depth interviews, and documentation. The results indicate that the potential of rago balls as an innovative learning resource can transform abstract chemical concepts into tangible phenomena. Integrating ethnoscience into learning can enhance science literacy, foster students' epistemic engagement, and strengthen the repository of local wisdom within a meaningful, culture-based modern chemistry curriculum

INTRODUCTION

Chemistry is a branch of natural science that studies matter, encompassing its properties, structure, and changes in matter and energy (Jusniar et al., 2020). Chemistry plays a vital role in daily life, although in high school it is often perceived as difficult by students because many chemical concepts are abstract and cannot be directly observed (Defista & Aznam, 2024). This situation leads to low interest in learning, which negatively impacts motivation and results in poor conceptual understanding among students (Hakim et al., 2024; Osborne et al., 2003; Gazali & Andriani, 2025). Therefore, an approach is needed that links chemistry concepts to real-life contexts so that learning becomes more meaningful, contextual, and fosters students' sustainability awareness (Gilbert, 2006; Minata et al., 2022 ; Inayah et al., 2022)

One approach that can be used is contextual learning. Contextual learning is a method that links subject matter to real-world situations so that students can connect their knowledge to its application in daily life (Nababan & Sipayung, 2023) . Contextual chemistry learning helps students understand that chemistry concepts are not only studied in the laboratory but are also present in daily life and community culture (Junaidi et al., 2025; Daulay, et al., 2025; Hidayati et al., 2025; Sutrisno et al., 2020) .

Context-based learning approaches have been shown to improve students' conceptual understanding, science literacy, and motivation to learn (Dewi, 2021; Imansari et al., 2018). Additionally, through a contextual approach, chemistry learning can also be integrated with the local culture and traditional knowledge of the community (Lestari, 2025; Novitasari & Raida, 2025). Local culture and traditional knowledge are integral parts of community life, encompassing knowledge, values, skills, and practices passed down through generations (Haryanto, 2014). The integration of local wisdom into science education is known as the ethoscience approach (Mukti et al., 2022; Ismail et al., 2024; Septina, 2025; Arma, 2024). Sutrisno et al., (2020) emphasize that integrating local wisdom into the chemistry curriculum can enhance students' conceptual understanding and scientific attitudes.

The ethoscience approach is based on knowledge that has evolved from the cultural practices of communities, which inherently contain scientific values and concepts, even though such knowledge is not always formally explained within the framework of modern science (Septina, 2025; Budiarti et al., 2025; Ismail et al., 2024; Zidny et al., 2020). In the world of education, ethnosience serves as a bridge between the science taught in schools and the social and cultural realities in society, thereby not only enhancing students' science literacy but also strengthening their cultural identity (Rahmawati & Ridwan, 2019).

One form of regional art containing elements of ethnosience is the *Sepak Rago Tinggi* art form, originating from the Kopah Sub-district, Kuantan Singingi Regency, Riau, Indonesia. *Sepak Rago Tinggi* is a traditional game using a ball made of woven rattan, played in groups to keep the ball from falling to the ground. This art form incorporates various scientific concepts, such as natural materials and their processing, energy, motion, and bodily metabolism. These concepts can be examined from a scientific perspective, particularly chemistry,

such as the concept of natural polymers in rattan, physical changes during the drying process of natural materials, chemical energy in bodily metabolism, and electrolyte solutions in sweat.

Therefore, the art of *Sepak Rago Tinggi* has the potential to serve as a source of contextual chemistry learning based on ethnoscience. However, research examining ethnoscience in traditional arts and integrating it into chemistry education remains limited. Most ethnoscience research still focuses on general science education and has not specifically examined its integration into chemistry education.

This study investigates the relationship between the traditional art of *Sepak Rago Tinggi* and chemical concepts through an ethnoscience approach. This research focuses on how cultural practices in *Sepak Rago Tinggi* contain scientific values that can be examined and integrated into chemistry education. Specifically, this study is formulated into the following three research questions:
RQ 1. To explore the ethnoscience in the art of *Sepak Rago Tinggi*
RQ 2. To identify chemical concepts found in the art of *Sepak Rago Tinggi*
RQ 3. Integrating the art of *Sepak Rago Tinggi* into contextual chemistry learning.

This study aims to achieve three main objectives. First, to explore the elements of ethnoscience found in the art of *Sepak Rago Tinggi* as part of local wisdom that holds scientific value. Second, to identify various chemical concepts contained within the practice of this art form, such as the concepts of natural materials, energy, solutions, and changes in matter. Third, to develop strategies for integrating the art of *Sepak Rago Tinggi* into contextual chemistry learning so that the learning becomes more relevant to daily life and can enhance students' conceptual understanding and active engagement.

In addition, this study also contributes to the development of context-based education by emphasizing that local wisdom not only holds cultural value but is also a potential source of scientific learning. By integrating the art of *Sepak Rago Tinggi* within an ethnoscience framework, this study is expected to enrich chemistry learning practices, strengthen the preservation of local culture, and create learning that is more contextual, meaningful, and sustainable.

LITERATURE REVIEW

Ethnoscience

Ethnoscience is a learning approach that uses local knowledge as a source or object of learning integrated into instruction and presented contextually (Wae & Kaleka, 2022). Ethnoscience examines indigenous knowledge systems that have evolved through human interaction with the environment, society, and cultural practices containing scientific values. The concept of ethnoscience emphasizes that knowledge does not originate solely from modern science but can also be found in the daily lives of communities, passed down through generations. Such knowledge is often not formalized into scientific theories but contains scientific principles that can be academically analyzed (Aikenhead, 2006; Ogawa, 1995). This perspective demonstrates that science is contextual, influenced by the culture and social environment of a community.

Various studies indicate that integrating ethnoscience into science education can enhance students' conceptual understanding and scientific literacy (Selviana et al., 2026; Djarwo et al., 2025; Putra & Wahyuni, 2025; Nazara et al., 2025). Ethnoscience serves as a bridge between academic science and the socio-cultural reality of the community, enabling students to connect scientific concepts with real-life experiences they encounter, while strengthening their cultural identity and fostering pride in local wisdom (Rahmawati & Ridwan, 2019). Through the ethnoscience approach, students can understand that scientific concepts are not merely abstract but are closely intertwined with daily life; thus, the application of ethnoscience is crucial for creating contextual, meaningful, and culturally relevant learning (Aldiansyah et al., 2023).

Activities in Ethnoscience Studies

Ethnoscience reflects various community activities that indirectly contain scientific concepts, such as cultural practices, traditional games, and daily activities involving the utilization of natural resources (Anwar, 2025). Examples include ethnoscience studies of the Naga village culture (Azzahra et al., 2025), the bekarang tradition (Hasanah et al., 2025), the mercon tradition (Khoriyah, 2025), and the process of making pendap (Sodiqin, 2025). Community activities in ethnoscience studies can be analyzed through the use of natural materials, processing methods, energy interactions, and material transformations. Such activities, such as the use of natural materials containing specific chemical compounds, involve processes like drying, burning, or fermentation that reflect concepts of physical and chemical changes. Furthermore, ethnoscience acknowledges that cultural objects, such as traditional tools, games, and crafts, contain scientific concepts that can serve as learning resources. Teachers, as educators, can analyze and connect scientific concepts with cultural practices, thereby making learning more contextual and easier for students to understand.

Using a local knowledge approach as a learning context enables students not only to understand scientific concepts theoretically but also to see the relevance of science in real life and to value culture as a source of knowledge. This approach aligns with the contextual education paradigm, which emphasizes that knowledge is more easily understood when linked to students' social and cultural experiences (Banks, 2008); thus, community activities in the study of chemoscience hold significant potential to serve as a foundation for developing contextual, culture-based science learning that is oriented toward strengthening local identity. Therefore, activities in the study of chemical ethnoscience can be understood through six main forms (NRC, 2012; Imansari et al., 2018), which collectively represent the relationship between local knowledge and modern scientific concepts of chemistry, namely:

1. Selecting materials: choosing materials based on desired physical and chemical properties, such as strength, elasticity, aroma, color, water absorption, or resistance to weathering.
2. Processing materials: modifying material properties through physical or chemical treatments, such as heating, cooling, soaking, fermentation, smoking, drying, or mixing.

3. Designing structures: arranging materials to produce specific shapes, functions, and stability.
4. Testing and evaluating: assessing material quality based on empirical experience, such as strength, elasticity, color, odor, texture, durability, or response to the environment.
5. Preserving materials: maintaining the stability of materials to ensure their longevity through natural protection or traditional techniques.
6. Explaining phenomena: constructing explanations for changes in materials or natural phenomena based on cultural experience.

These six activities demonstrate that communities have intuitively applied chemical principles in daily life, even though they are not formulated as formal theories, such as selecting materials based on flexibility and strength related to the molecular structure of the material; processes of soaking or heating related to changes in intermolecular interactions; traditional preservation techniques related to preserving materials by inhibiting chemical degradation; while communities' explanations regarding changes in color, strength, or durability of materials reflect a form of empirical reasoning regarding the chemical transformation of materials (Cajete, 2000; Imansari et al., 2018). These chemical ethnosience activities serve as a conceptual bridge connecting indigenous knowledge with scientific knowledge in contextual chemistry learning grounded in local culture.

Chemistry and Its Connection to Ethnosience

Contextual chemistry learning is an educational approach that links chemical concepts to phenomena occurring in daily life. This approach aims to help students understand chemical concepts more meaningfully and connect them to real-world experiences. Contextual learning enables students to develop a deeper conceptual understanding and enhance their critical thinking and problem-solving skills (Gilbert, 2006; Bennett, 2003). In chemistry education, many concepts are abstract and difficult to grasp when presented theoretically; therefore, an approach is needed that connects these concepts to real-world situations. Contextual learning provides students with the opportunity to see the relevance of chemistry in daily life, thereby increasing their motivation to learn and their understanding of concepts.

The relationship between chemistry and ethnosience is evident in the many cultural practices that indirectly incorporate chemical concepts. The selection of materials based on their physical and chemical properties, color changes due to oxidation, texture changes due to heating, the degradation of organic materials, the interaction of water with materials, and a material's resistance to the environment are phenomena that can be explained through chemical principles. An ethnosience approach in chemistry education allows students to learn chemical concepts through cultural phenomena they are familiar with. When concepts such as changes in matter, material structure, properties of natural compounds, oxidation reactions, or molecular interactions are linked to local cultural practices, students will more easily grasp the relevance of chemistry in real life, thereby ensuring that the integration of chemistry and ethnosience not only strengthens conceptual understanding but also makes

learning more contextual, meaningful, and capable of fostering awareness of the importance of preserving local culture as a source of scientific knowledge.

***Sepak Rago Tinggi* as a Cultural Artifact and Source of Ethnoscience**

The game of *Sepak Rago Tinggi* is a traditional game that has been played since ancient times by ancestors, particularly those from the Kopah Village, Kuantan Tengah Subdistrict, Kuantan Singingi Regency, Riau, Indonesia. Throughout its history, this tradition has been passed down from generation to generation to the present day. The background of the *Sepak Rago Tinggi* game actually stems from an agreement reached during a community meeting of the Kopah traditional community in the past. The game

Sepak Rago Tinggi has grown and evolved as part of the local cultural heritage and is rich in social values, aesthetics, sportsmanship, and a philosophy of togetherness. The game is believed to have existed since 1833, and some sources even suggest that *Sepak Rago Tinggi* originated in the Sultanate of Malacca around the 15th century AD. At that time, *Sepak Rago Tinggi* was played exclusively by the royal family.

The traditional game of *Sepak Rago Tinggi* is a game against the pharaoh or evil, symbolized by the high-flying rago ball representing the pharaoh's eye or the devil. However, in modern times, *Sepak Rago Tinggi* can now be played by the general public across diverse age groups, ranging from the elderly to children alike. This game is played in groups using a woven ball typically made from rattan or other natural fibers, and is played using the feet, knees, chest, head, or other parts of the body-without using the hands. For the Malay community, *Sepak Rago Tinggi* is not merely viewed as a form of traditional entertainment but also as a medium for social interaction, strengthening solidarity, agility training, and a symbol of harmony in community life. This traditional art form embodies values such as cooperation, balance, concentration, discipline, and respect for tradition, which are integral to the practice of the game.

The traditional art of *Sepak Rago Tinggi* represents the local community's knowledge in utilizing natural resources. The game ball (rago), made from rattan, is selected based on specific characteristics such as flexibility, fiber strength, impact resistance, light weight, and ease of weaving into a stable spherical shape. The selection of these materials demonstrates the community's empirical knowledge regarding the properties of natural materials. Scientifically, rattan is a lignocellulosic biomaterial composed of cellulose, hemicellulose, and lignin, which provide mechanical characteristics such as flexibility, tensile strength, and resistance to deformation. It is this chemical structure of rattan that allows the material to possess both elastic and strong properties, making it suitable as the primary material for crafting the rago ball.

Ethnoscience activities can be observed in the rago ball-making process, which is rich in scientific concepts. The stages of rattan selection, cleaning, drying, fiber preparation, weaving, and storage to prevent the material from rotting easily are cultural practices that involve various scientific principles, particularly in materials chemistry. The drying process involves reducing moisture content through evaporation, which affects the material's strength and stability; changes in rattan color during storage are related to oxidation reactions;

rattan's interaction with air humidity relates to the material's hygroscopic properties; while the weave's resistance to mechanical stress is influenced by the molecular structure of the fibers and intermolecular interactions within the biomaterial. The existence of cultural practices in rago production is, in fact, a form of applying experience-based scientific knowledge that has developed within the community.

From a scientific perspective, elements of ethnoscience can be observed when the ball is played, where various interactions of matter and energy occur, such as friction between the foot and the ball's surface, momentary shape changes due to impact, material elasticity, the effect of humidity on the ball's mass and texture, and material degradation resulting from repeated use—phenomena involving the material's physicochemical properties. A concrete example of chemistry in this traditional art form is the change in material properties due to heat, humidity, oxidation, and weathering. This demonstrates that *Sepak Rago Tinggi* not only holds cultural significance but also possesses great potential as a source of contextual learning in chemistry education.

Sepak Rago Tinggi, as a source of ethnoscience, has strong relevance for integration into chemistry education grounded in local cultural contexts. Concepts such as natural biomaterials, the structure of organic compounds, material properties, the interaction of water with materials, oxidation, the degradation of organic compounds, changes in material properties, and the relationship between material structure and function can be explored through cultural contexts closely tied to students' daily lives. This approach enables chemistry learning to become more contextual, authentic, and meaningful, while simultaneously fostering students' appreciation for local wisdom as a valuable source of scientific knowledge.

METHODOLOGY

This study employs a qualitative ethnographic approach to explore the dimensions of ethnoscience in the rago ball used in the traditional game of *Sepak Rago Tinggi* in the Kopah sub-district, Kuantan Singingi Regency, Riau. Based on ethnographic principles, this approach emphasizes the researcher's deep engagement with the community's cultural practices to uncover the connections between local knowledge, the rago ball-making process, and the chemical concepts embedded within it (Anriana et al., 2023; Imansari et al., 2018; Sumarni et al., 2022; Robert & Bybee, 2014). Data analysis was conducted through the stages of data reduction, data presentation, and concluding as outlined by Creswell and Poth (2016). This research design was developed to achieve three main objectives, namely: (1) to identify the ethnoscience knowledge embedded in the rago ball-making process, (2) to reconstruct this local knowledge into scientific chemical concepts, and (3) to analyze the pedagogical relevance of the rago ball as a source of contextual chemistry learning based on local wisdom.

Researcher's Position and Sampling Technique

The principal investigator is a native of Kuantan Singingi Regency who shares a close cultural connection with the Malay community in the Kopah village. The researcher possesses a strong contextual understanding of cultural

values, local practices, and the meanings embedded in the *Sepak Rago Tinggi* tradition. This cultural affinity enables the researcher to gain deeper access to local knowledge regarding the making of the rago ball, the cultural philosophy behind it, and the traditional practices passed down through generations. However, to minimize interpretive bias, data analysis was conducted reflectively through theoretical triangulation and academic discussions with experts in chemistry education, ethnoscience, and local culture, ensuring that data interpretation is not solely based on an emic perspective but is also reinforced through an analytical etic perspective.

This study employed *purposive sampling*, involving informants selected based on their knowledge, experience, and direct involvement in the *Sepak Rago Tinggi* tradition. This study involved 11 key informants, including traditional leaders, traditional players, local cultural figures, and educators who understand the relevance of local culture in science learning (Table 1). The involvement of these various groups of informants aimed to obtain rich, in-depth, and comprehensive data regarding the dimensions of ethnoscience contained in the rago ball as both a cultural artifact and a source of contextual chemistry learning.

Table 1. Research Subjects

No	Respondent (Pseudonym)	Role
1	Rio Kasyterwandra, S.Sos., MM	Chair of Pusako
2	Pili Amri	Member of Pusako
3	Suparmi	Member of Pusako
4	Fendri Friadi (Adek)	Traditional performer
5	Alhairi	Traditional player
6	Balkis Saputri, S.Pd	Teacher/Educator
7	Delta Marlina, S.Pd	Teacher/Educator
8	Jusi Putri Ardini, S.Pd	Teacher/Educator
9	Weria Julia Asmi	Student
10	Yessa Aliya	Student
11	Jumatul Dwi Fitri	Student

The head of the heritage group and members, teachers, and students as presented in Table 1 were selected using purposive sampling to ensure the representation of informants who possess in-depth knowledge, experience, and understanding of the rago ball-making process, the cultural values within the *Sepak Rago Tinggi* tradition, and its relevance as a source of contextual chemistry learning.

Data Collection Procedures

This study employed a triangulation approach to data collection—specifically, participatory observation, semi-structured interviews, and document analysis—to obtain comprehensive data and ensure methodological rigor. During the fieldwork process, the researcher conducted in-depth observations of all stages of rago ball production, from the selection of rattan

types, the stripping process, soaking or boiling, layered weaving techniques, smoking, to ball quality testing.

These observations were conducted to document the ethnoscience practices that naturally emerge in the process of making this cultural artifact. The observations were supplemented by semi-structured interviews with key informants focused on:

- a) The community's local knowledge regarding material selection and rattan processing techniques,
- b) The cultural meanings and philosophy inherent in the *rago* ball within the *Sepak Rago Tinggi* tradition,
- c) The community's understanding of material characteristics, ball durability, and traditional preservation practices passed down through generations.

This interview approach allows the researcher to explore new themes that emerge during the study without straying from the research focus. To enrich data interpretation, the researcher also analyzed *rago* balls still in use by the community, visual documentation of the production process, local cultural records, and archives related to the *Sepak Rago Tinggi* tradition. This analysis of the documentation provides a multidimensional understanding of the relationship between local knowledge, cultural practices, and the chemical concepts embodied in the *rago* ball. This integrated data collection strategy ensures synchronization between field observations, community narratives, and documentary evidence, resulting in a holistic interpretation of the significance of ethnoscience in the *rago* ball as both a cultural artifact and a source of contextual chemistry education.

Data Analysis and Methodological Rigour

This study employs an iterative analysis approach based on the qualitative data analysis framework by Miles, Huberman, and Saldaña (2018), which comprises three main stages: data reduction, data presentation, and drawing conclusions. In the data reduction stage, interview transcripts, field observation notes, visual documentation, and cultural artifacts were systematically analyzed and coded to identify themes of ethnoscience related to the *rago* ball-making process, the community's local knowledge, and the chemical concepts embedded within it.

The data presentation stage involves organizing the data into categorization matrices, concept maps, and scientific reconstruction models to visualize the relationships between cultural activities, indigenous science, and scientific science from a chemical perspective. Furthermore, in the conclusion-drawing stage, the research findings were synthesized and mapped against the research objectives to reveal the interrelationship between the cultural practice of making *rago* balls, material chemistry concepts, and its potential as a source of contextual chemistry learning.

To ensure methodological rigor, this study adheres to the trustworthiness criteria of Lincoln and Guba (1985), which include credibility, transferability, and dependability. Credibility is achieved through the researcher's intensive engagement with the local cultural context, triangulation of sources and techniques, and member checking with informants to validate interpretive

outcomes. Transferability is strengthened through the presentation of rich contextual descriptions of the *Sepak Rago Tinggi* tradition and the process of making rago balls, ensuring that the research findings are relevant to other local cultural contexts with similar characteristics. Dependability is maintained through an audit trail consisting of systematic documentation of the data analysis process, methodological decisions, and the researcher's interpretive reflections, which are subsequently reviewed through academic discussions with experts in chemistry education and cultural studies. This approach ensures that the research findings on the ethnoscience of the rago ball are not only academically robust but also remain aligned with the living cultural meanings within the Kuantan Singingi Malay community.

RESEARCH RESULT

Chemical Representations in the *Rago Ball*

Chemical representations in the *rago ball* can be categorized into six main groups: biomaterial composition, molecular interactions, chemical transformations during processing, material chemical properties, material protection, and material degradation. This categorization aims to systematically map the relationship between the local community's knowledge in *rago ball* production and the chemical concepts embedded within it. The presence of natural biomaterial components, chemical changes resulting from traditional treatments, and modifications in material properties indicate that the *rago ball* is a cultural artifact rich in representations of chemical ethoscience. A summary of these findings is presented in Table 2.

Table 2. Chemical Composition of Rago Balls

No	Category	Chemical Representation	Location/Part on the Rago Ball
1	Biomaterial Composition	Cellulose	Main Rattan Fiber
		Hemicellulose	Rattan fiber matrix
		Lignin	Rattan cell wall
2	Molecular Interactions	Hydrogen bonds	Between cellulose chains
		Intermolecular forces	Fiber structure
3	Chemical transformation	Water evaporation	During drying/smoking
		Lignin oxidation	Rattan surface (brown color)
		Deposition of phenolic compounds	Outer layer resulting from <i>smoking</i>
4	Chemical Properties of the Material	Hygroscopicity	All ball fibers
		Elasticity	Weave Structure
		Impact resistance	Ball frame
5	Material protection	Natural antimicrobial	Smoke/phenolic coating
		<i>Natural coating</i>	Ball surface
6	Material degradation	Biodegradation	Old/decayed fibers
		Biomass combustion	During thermal treatment

Table 2 shows that the *rago* ball, as a cultural artifact of the Malay community of Kenegerian Kopah, Kuantan Tengah Subdistrict, Kuantan Singingi Regency, Riau, Indonesia, contain various chemical representations, ranging from the lignocellulosic structure of rattan, hydrogen bonds within the cellulose matrix, the material's hygroscopicity, lignin oxidation, the deposition of phenolic compounds due to smoking, to the modification of the biomaterial's surface through natural coating. Scientifically, these components contribute to the flexibility, tensile strength, elasticity, moisture resistance, and mechanical stability of the *rago* ball. The relationship between the chemical structure of the biomaterial and the performance of this cultural artifact demonstrates that the local community's knowledge in selecting (Figure 1) and processing rattan empirically has a strong scientific basis from a materials chemistry perspective.



Figure 1. Searching for Rattan in the Forest by the Chair and Members of Pusako



Figure 2. A Brown Rago Ball

These statements indicate that the community has empirically understood the changes in material properties resulting from the traditional treatment applied to *rattan* balls. The smoking process involves reducing moisture content through evaporation, the deposition of phenolic and carbonyl compounds from combustion smoke onto the rattan fiber surface, and chemical modifications of the biomaterial's surface that enhance the material's resistance to moisture and microbial attack. Meanwhile, the change in color of the *rago* ball to dark brown (Figure 2) and its increased luster after a certain period of use can be explained by the oxidation of lignin, the interaction of phenolic compounds with the fiber

surface, and the possible formation of a *natural coating* that affects the optical properties of the material's surface.

The presence of chemical concepts in the *rago* ball-making process was also confirmed by several informants. One of the chemistry teachers, Mrs. Balkis Saputri, stated:

"Chemical concepts in rago balls can be observed in the smoking process after weaving. This smoking is usually done over a low flame so that the rago balls last longer, have a nice color, and do not mold easily. Furthermore, rago balls that have been used for a long time usually turn dark brown and appear more glossy."

In line with this, Mr. Riokasyter emphasized:

"If not smoked, the ball quickly becomes damp, rots easily, and its fibers are less strong compared to those that have been smoked. The dark brown color of the rago ball indicates that it is fully cured, harder, and generally of better quality."

This statement indicates that the community has empirically understood the changes in material properties resulting from the traditional treatments applied to *rago* balls. The smoking process involves reducing moisture content through evaporation, the deposition of phenolic and carbonyl compounds from combustion smoke onto the surface of rattan fibers, and chemical modifications of the biomaterial's surface that play a role in enhancing the material's resistance to moisture and microbial attack. Meanwhile, the change in color of the *rago* ball to dark brown (Figure 2) and its increased luster after use over a certain period can be explained by the oxidation of lignin, the interaction of phenolic compounds with the fiber surface, and the possible formation of a *natural coating* that affects the optical properties of the material's surface.

The woven pattern of the *rago* ball (Figure 2) consists of interlacing, circular, and interlocking rattan fiber coils, forming a dense, balanced, and elastic spherical structure. This coiling pattern indicates that the fibers are not arranged randomly but follow a regular pattern that results in an even distribution of pressure across the entire surface of the ball. The shape of the *rago* ball plays a crucial role in enhancing the ball's *tensile strength, impact resistance, and structural elasticity* when subjected to kicking forces.

The presence of a winding pattern in the *rago* ball weave was also confirmed by several informants. One local player, Fendi (adek), stated:

"The weave of the rago ball is created by winding and layering the fibers to ensure a strong bond, preventing it from coming apart easily, and keeping the ball flexible during use."

A similar point was emphasized by the head of the heritage group, Mr. Riokasyter, who explained:

"If the winding is loose, the ball easily changes shape. If the winding is tight and balanced, the ball will be sturdier, more durable, and have good bounce."

These statements indicate that the community empirically understands the relationship between the weaving pattern and the performance of the *rago* ball material. Scientifically, the interlocking arrangement of the weaves creates an interlocking fiber structure that is, the interconnection between fibers that strengthens the structural integrity of the biomaterial. This fiber-to-fiber interaction is supported by hydrogen bonds between cellulose microfibrils, the

structural rigidity of lignin, and mechanical forces between fibers, resulting in a combination of strength, flexibility, and resistance to deformation.

Chemical Ethnoscience Activities on *Rago* Balls

Chemical ethnoscience activities in *rago* balls are based on the view that science is a human activity that develops through cultural interactions with materials and the environment. Chemical ethnoscience activities are evident in various stages of *rattan* ball production, including *selecting materials, processing materials, designing structures, testing and evaluating, preserving materials, and explaining phenomena*. The activity of selecting materials is seen when the craftsman determines the appropriate type of *rattan* based on its flexibility fiber strength, and natural moisture content.

The activity of processing materials occurs during the processes of peeling, soaking, boiling, and smoking, which aim to modify the physical and chemical properties of the material. Meanwhile, the activity of designing structures is evident in the techniques of coiling and layered weaving, which produce a ball that is sturdy, balanced, and elastic.

The *rattan* selection process is not only based on practical considerations but also reflects the community's empirical understanding of the natural biomaterial's characteristics related to lignocellulosic structure, fiber flexibility, and the material's resistance to mechanical stress. The smoking process is not merely understood as a traditional technique but also involves chemical transformations such as moisture reduction, the deposition of phenolic compounds, and surface modifications of the biomaterial that enhance the ball's resistance to moisture and biological degradation. These six chemical ethnoscience activities are clearly evident throughout the entire process of making and using the *rago* ball, demonstrating that this cultural artifact represents a close relationship between local knowledge and scientific chemical concepts.

The Potential of Ethnoscience in *Rago* Balls for Contextual Chemistry Education

To explore the potential of ethnoscience embedded in the *rago* ball as a source of contextual chemistry learning, the researcher conducted interviews with one chemistry teacher and three students. The interviews were conducted at a time mutually agreed upon with the informants. The interview with the teacher focused on identifying the chemical concepts contained in the materials that make up the *rago* ball, the manufacturing process, and changes in material properties during use. In general, the interview results showed that the teacher had a good understanding of the relationship between the *rago* ball and various chemical concepts, particularly regarding natural biomaterials, polymers, intermolecular bonds, chemical changes, and materials chemistry. This was expressed by one of the chemistry teachers, Ms. Balkis Saputri, who stated:

"Rago balls contain many chemical concepts that are relevant to students' daily lives, ranging from their constituent material – rattan, which is rich in cellulose and lignin – to the soaking process that affects the flexibility of the fibers, and the smoking

process that alters the material's properties to make it more durable, resistant to mold, and with a better color."

Similar views were expressed by Ms. Jusi and Ms. Delti, who explained that *rago* balls can be used to contextualize chemistry concepts that have previously been studied abstractly in the classroom. They said:

"With rago balls, students can directly observe how the structure of natural materials influences material properties. Rago balls also help students understand chemical changes through the smoking process, color oxidation, and the interaction of materials with air humidity. This makes chemical concepts more tangible and easier to understand."

In addition to highlighting material composition and chemical changes, the teachers also emphasized the structural aspects of the *rago* ball's weaving, which relate to material performance. The interlocking layered weaving technique is understood as a representation of the relationship between material structure and mechanical properties, such as elasticity, tensile strength, and impact resistance. One of the chemistry teachers, Ms. Balkis Saputri, explained:

"The arrangement of the weaves on the rago ball demonstrates that structure significantly determines a material's properties. The tighter and more balanced the weave, the better the strength, elasticity, and durability. This can be linked to the structure-property relationship in materials chemistry."

Interviews with students also revealed positive responses to the use of the *rago* ball as a learning context. Students stated that chemistry lessons became more engaging because the material studied could be directly linked to the local culture they are familiar with. In addition to enhancing conceptual understanding, using the *rago* ball as a learning medium also fosters appreciation for local wisdom and strengthens the connection between science, culture, and daily life. Based on the information above, the traditional art of the *rago* ball serves a dual function: as a cultural artifact of the Kuantan Singingi Malay community and as a source of contextual chemistry learning capable of bridging abstract chemical concepts with students' real-world experiences. The integration of ethoscience through the *rago* ball opens opportunities for the development of chemistry learning that is more meaningful, relevant, and rooted in local culture.

DISCUSSION

The traditional game of *Sepak Rago Tinggi* in Kenegerian Kopah, Kuantan Singingi Regency, Riau, Indonesia, is one of the cultural heritages that has survived to this day and is rich in the values of togetherness and local wisdom of the Malay community. In practice, the *Sepak Rago Tinggi* game differs from sepak takraw because *Sepak Rago Tinggi* is played within a circular line surrounded by coconut leaves, with an umbrella placed upside down at the exact center of this circular line. Thus, the umbrella serves as the target for the *rago* ball, or the place where the *rago* ball is aimed. (Figure 3).

Sepak Rago Tinggi players kick the *rago* ball with their feet to keep it in the air and direct it into the umbrella. This game bears similarities to sepak takraw but has its own distinctive characteristics, particularly in its gameplay patterns, target, and movement elements that resemble silat. *Sepak Rago Tinggi* was

traditionally played in teams, but this is no longer the case today. Each game of Sepak Rago Tinggi is played by 7 to 15 people.

From approximately 1883 to 1962, the umbrella used today actually served as a replacement for the previous tool because it was considered more practical; prior to using the umbrella, people used to make their own umbrellas from a single piece of bamboo or aur that had been split on each side. That bamboo serves the same function as the current umbrella, which catches the high *rago* ball. Its purpose was to determine whether or not the ball was successfully thrown into the circle formed by the bamboo. The bamboo, whose ends were shaped like an umbrella, was positioned upside down so that it could catch the ball, just like a single bamboo pole. It was only from 1962 until the present that the people of Kopah replaced the old tool with an umbrella.



Figure 3. The Complete Formation of the Traditional Game of *Sepak Rago Tinggi*



Figure 4. Players Performing the Wudu Ritual Before the Game Begins

Before the game begins, players are required to perform a purification ritual (Figure 4), which aims to maintain team cohesion and ensure the ball stays in the air and does not fall.

The *Sepak Rago Tinggi* game is accompanied by traditional Rarak Godang music (Figure 5) and played while wearing traditional Malay attire. *Sepak Rago Tinggi* is generally held on specific occasions, such as harvest season and major religious holidays, and involves traditional leaders and the local community.



Figure 5. Traditional Musical Accompaniment During the *Sepak Rago Tinggi* Game



Figure 6. A Communal Meal After the *Sepak Rago Tinggi* Game Concludes

However, *Sepak Rago Tinggi* does not merely highlight the game itself; it also reflects social values such as mutual cooperation, sportsmanship, and togetherness. After the game concludes, the community usually gathers for a communal meal as a way to strengthen social bonds (Figure 6).

The food served is often rich in cultural significance, such as *konji berayak* (Figure 7). The existence of *Sepak Rago Tinggi* is vital as a regional cultural identity that must be preserved. This tradition serves not only as entertainment but also as a means of passing down cultural values to the younger generation.



Figure 7. *Konji Berayak* is One of the Traditional Dishes Served After the *Sepak Rago Tinggi* Game and *Kopah* Traditional Hall

Venue for the *Sepak Rago Tinggi* Game

Before the *Sepak Rago Tinggi* game begins, an announcement is made throughout the village via *canang* to invite everyone to attend and watch the traditional *Sepak Rago Tinggi* performance. The game is held in front of the traditional community hall or the "rumah godang" in the Kopah region (Figure 8) or in an open field where it will be watched by many people. Whenever the *Sepak Rago Tinggi* game is held, the organizers are required to invite the *Penghulu*, the elders (Ninik-mamak), the wise men (Cerdik pandai), and the *menti* or *Dubalang* from the four clans in the Kopah region (Malay, Patopang, Chaniago, Paliang). The *Sepak Rago Tinggi* game begins after the elders have deliberated to determine the prizes for the players who successfully kick the ball into the umbrella the most times or prevent the ball from falling to the ground. The prize for the winner is usually a sarong set complete with a cap.

The *Rago* Ball as a Representation of Ethnoscience and Indigenous Chemistry

Research findings indicate that the *Rago* ball in the *Sepak Rago Tinggi* tradition is not merely a traditional game tool but a cultural artifact containing local scientific knowledge that has evolved through the empirical experiences of the Malay community over generations. This local knowledge is reflected in the community's ability to select suitable types of rattan, determine the material's flexibility, apply processing techniques to enhance fiber flexibility, use smoking as a natural preservation method, and design a weaving structure that achieves a balance between strength, elasticity, and shape stability. These practices demonstrate that the community has intuitively understood the characteristics of natural materials and their interaction with the environment, even though this knowledge is not articulated within a formal scientific theoretical framework.

Local knowledge in the art of *Sepak Rago Tinggi*, viewed from an ethnoscience perspective, constitutes a form of *indigenous science*—a knowledge system arising from human interaction with the natural environment, built through repeated observation, direct practice, and empirical reflection passed down across generations. In the *rago* ball, this *indigenous science* can be reconstructed into scientific chemical concepts such as lignocellulose structure, properties of natural polymers, hydrogen bonding, material hygroscopicity, lignin oxidation, deposition of phenolic compounds, and surface modification of biomaterials due to thermal treatment. These local cultural artifacts not only hold traditional value but also serve as a repository of valid scientific knowledge worthy of academic study.

Reconstructing Local Knowledge into Scientific Chemical Concepts

One of the main contributions of this study is the reconstruction of indigenous knowledge into scientific chemical knowledge. The Malay community traditionally selects rattan that is "tough," "not easily broken," and "easy to shape," which, from a scientific perspective, relates to the composition of cellulose, hemicellulose, and lignin within the lignocellulosic structure (Ridha et al., 2025). The practice of boiling and soaking, believed to make rattan more flexible, can be scientifically explained by the increased mobility of polymer

chains and the weakening of some interchain hydrogen bonds in cellulose, making the material more plastic.

Similarly, the practice of smoking—culturally understood as a way to make the balls more durable and resistant to insect damage—can be reconstructed as a material chemical process involving the deposition of antimicrobial phenolic compounds, reduction of moisture content through evaporation, and modification of the lignin structure that enhances the material's resistance to biological degradation. Such reconstructions demonstrate that local knowledge is not an irrational practice, but rather a form of empirical science grounded in scientific principles that can be explained using modern chemical theory.

Rago Balls as a Context for Contextual Chemistry Learning

Research findings indicate that the *rago* ball holds significant potential as a source for context-based chemistry learning rooted in local culture. According to Anggraeni et al. (2020) in their systematic review, context-based chemistry learning has positive impacts on students' cognitive, affective, and psychomotor aspects. Many abstract chemical concepts can be directly linked to this cultural artifact, such as the structure of natural polymers, lignocellulosic biomaterials, hydrogen bonding, physical changes due to evaporation, oxidation reactions, the biodegradation of organic materials, surface chemistry, and the application of phenolic compounds as natural preservatives. These concepts have often been taught symbolically and abstractly, making them difficult for students to grasp. When these concepts are linked to real objects familiar within local culture, students can more easily build meaningful conceptual understanding, which can enhance pride in local culture and foster scientific curiosity (Rahmawati & Ridwan, 2017).

Additionally, using the *rago* ball as a learning context also enables a *contextual chemistry learning* approach, which connects scientific concepts with students' real-world experiences. This approach can improve science literacy, critical thinking skills, the ability to connect macroscopic phenomena with microscopic representations, and reinforce the relevance of chemistry in daily life. Integrating local culture into chemistry education also makes learning more inclusive, humanistic, and closely aligned with students' cultural identities.

Contribution to the Preservation of Local Wisdom

This study also makes a significant contribution to the preservation of local culture. Modernization and changes in people's lifestyles have led to traditional games, including *Sepak Rago Tinggi*, being played less frequently, and knowledge of *rago* ball making has begun to diminish and is not being passed down to younger generations. Yet, behind these cultural artifacts lies complex material knowledge, ecological adaptation, and local technology that has evolved through the community's long-standing experience.

By documenting the manufacturing process, material characteristics, and reconstructing local knowledge within a modern scientific framework, this research not only contributes to the development of chemistry education but also serves as a scientific effort in the conservation of local knowledge. Integrating the

rago ball into learning can transform local culture not merely into a heritage to be remembered but also into a living, relevant, and continuously evolving source of learning within the educational world.

CONCLUSIONS AND RECOMMENDATIONS

The exploration of ethnoscience in the *rago* ball within the traditional *Sepak Rago Tinggi* game in Kopah Village reveals that this cultural artifact contains local knowledge rich in scientific dimensions, particularly in the field of materials chemistry. The community's knowledge, reflected in the selection of rattan types, the soaking process, steeping or boiling, layered weaving techniques, smoking (*salai*), and product quality testing, demonstrates the existence of an empirical knowledge system that has evolved through generations and possesses a strong scientific foundation. Reconstructing this local knowledge within modern chemical concepts reveals connections to lignocellulosic structure, natural polymer properties, hydrogen bonding, hygroscopicity, lignin oxidation, phenolic compound deposition, and surface modifications of biomaterials that influence the mechanical properties, durability, and stability of the *rago* ball.

The findings of this study confirm that the *rago* ball not only holds cultural value as a traditional artifact of the Malay community but also possesses educational value as a source of contextual chemistry learning. Various chemical phenomena inherent in the material, manufacturing process, and characteristics of the *rago* ball can serve as a learning context to connect abstract chemical concepts with students' real-world experiences. The integration of ethnoscience into chemistry education through the *rago* ball has the potential to enhance conceptual understanding, scientific literacy, critical thinking skills, and appreciation for local wisdom. Therefore, the *rago* ball can be positioned as a bridge between local knowledge and modern science in efforts to achieve contextual, relevant, and culturally grounded chemistry education.

ADVANCED RESEARCH

This study is limited to the qualitative exploration of ethnoscience concepts within the *Rago* ball's material and manufacturing process, without conducting empirical laboratory testing on its chemical properties. Additionally, the field observation was restricted to a specific local community, which may not capture regional variations in *Sepak Rago Tinggi* traditions. Future research should integrate quantitative laboratory analysis to verify the exact chemical compositions of the *Rago* ball materials. Furthermore, developing and testing a structured chemistry module based on these findings in actual classrooms is highly recommended to measure its impact on student engagement.

REFERENCES

- Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. Teachers College Press.
- Aldiansyah, Jessica Indriyani Pasa, Muhammad Rijal Muttaqin, Nabila Nailah Awaliyah, & Farah Erika. (2023). Literature Review: The Relationship Between Chemistry Learning and the Ethnochemistry Approach in Indonesia. *Literature Review: The Relationship Between Chemistry Learning and the Ethnochemistry Approach in Indonesia*, 7(2), 238–246.
- Anggraeni, A. Y., Wardani, S., & Hidayah, A. N. (2020). Profile of improvements in students' chemistry literacy skills through contextual guided inquiry-based learning. *Journal of Chemistry Education Innovation*, 14(1), 2512–2523.
- Anriana, R., Witri, G., Putra, Z. H., Fendrik, M., Dahnilsyah, & Aljarrah, A. (2023). An ethnomathematics study on measurement practices in the Bengkalis Malay community as a resource for elementary school mathematics. *Ethnography and Education*, 18(3), 299–322.
- Anwar, S. (2025). *Innovations in Integrated Science Education Based on Ethnoscience*. Indonesia Emas Group.
- Arma, O. P. (2024). The Role of Local Wisdom in the Science Learning Process. *Proceedings of the National Seminar on Biology Education*, 10(1), 11–31.
- Azzahra, U., Hamdu, G., & Putri, A. R. (2025). A Study of the Ethnoscience of Kampung Naga Culture as a Source of Science Learning in Elementary Schools. *Pendas: Scientific Journal of Basic Education*, 10(03).
- Budiarti, I. S., Frank, S. A. K., & Lumbu, A. (2025). *Asmat Ethnoscience*. CV Pajang Putra Wijaya.
- Banks, J. A. (2008). Diversity, group identity, and citizenship education in a global age. *Educational Researcher*, 37(3), 129–139.
- Bennett, W. L. (2003). The burglar alarm that just keeps ringing: A response to Zaller. *Political Communication*, 20(2), 131–138.
- Cajete, G. (2000). *Little Bear, L. Native Science: Natural Laws of Interdependence*. Clear Light Books: Santa Fe, NM, USA.
- Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.
- Daulay, R. A., Syafitri, A., Aulianti, D., Azhari, S. W., & Simaremare, H. G. M. (2025). Integration of Ethnochemical Concepts in Redox Reaction Learning.

Lavoisier: Chemistry Education Journal, 4(2), 77–83.

- Defista, C., & Aznam, N. (2024). Chemistry-focused conceptual understanding research trends: A systematic review. *Journal of Science Education Research*, 10(4), 180–187.
- Dewi, C. C. A., Erna, M., Haris, I., & Kundera, I. N. (2021). The effect of contextual collaborative learning based on ethnoscience on increasing students' scientific literacy ability. *Journal of Turkish Science Education*, 18(3), 525–541.
- Djarwo, C. F., Inggamer, M. M., Rumbapuk, A. J., & Astuti, N. (2025). Analysis of ethoscience-based digital literacy in chemistry instruction to enhance students' conceptual understanding and learning motivation. *Indonesian Journal of Science Education and Learning*, 15(1), 62–77.
- Gazali, Z., & Andriani, R. (2025). Integration of Ethnochemistry in Science Teaching: A Systematic Literature Review on Local Wisdom-Based Approaches in High School. *Journal of Science Education*, 15(4), 1843–1853.
- Gilbert, M. (2006). *A theory of political obligation: Membership, commitment, and the bonds of society*. OUP Oxford.
- Hakim, E., Astafani, A., & Resmawati, R. F. (2024). Systematic Review of Factors Contributing to Learning Difficulties in Chemistry. *Journal of*, 18(2), 81–88.
- Haryanto, J. T. (2014). Local Wisdom Supporting Religious Harmony in the Tengger Community of Malang, East Java. *Analisa Journal of Social Science and Religion*, 21(2), 201–213.
- Hasanah, Z., Hariyadi, B., & Sukmono, T. (2025). A Study of Ethnoscience in the Bekarang Tradition to Support Biology Learning. *Journal of Educational Theory and Practice Studies*, 6(2).
- Hidayati, H., Damris, M., Asrial, A., & Hasibuan, M. H. E. (2025). A Thematic Review: Ethnochemistry in Secondary Schools. *Proceedings of the International Conference on Social Science, Humanities, Education, and Society Development (ICONS)*, 2, 67–84.
- Imansari, M., Sudarmin, S., & Sumarni, W. (2018). Analysis of students' chemical literacy through guided inquiry learning with an ethno-science component. *Journal of Chemistry Education Innovation*, 12(2).
- Inayah, S., Dasna, I. W., & Habiddin, H. (2022). Implementation of green chemistry in chemistry education: A literature review. *Hydrogen: Journal of Chemistry Education*, 10(1), 42–49.

- Ismail, I. A., Mawardi, M., Kurniawati, D., & Arif, K. (2024). *From ancestral heritage to modern laboratories: Ethnoscience enriches science education*. LPPM AAI.
- Junaidi, E., Sudatha, I. G. W., Suartama, I. K., & Santosa, M. H. (2025). Ethnochemistry in Chemistry Learning: Insights from Indonesian Local Wisdom. *Journal of Science Education*, 26(3), 1642–1658.
- Jusniar, Effendy, Budiasih, E., & Sutrisno. (2020). Misconceptions in Rate of Reaction and their Impact on Misconceptions in Chemical Equilibrium. *Eur. J. Educ. Res.*, 9(2): 1405–1423.
- Khoriyah, F. A., Fawaida, U., Bella, S., Fauziah, I., & Rahmawati, A. I. (2025). Ethnoscience exploration of the meron tradition in Sukolilo subdistrict, Pati regency. *Jurnal Tarbiyatuna: Journal of Islamic Education Studies, Thought, and Development*, 6(1), 39–57.
- Lestari, W. Y. (2025). Understanding scientific concepts through an ethoscience approach: a qualitative study on science education in remote areas. *Journal of Social Sciences and Education*, 5(6), 1418–1424.
- Lincoln, Y. S., & Guba, E. G. (1988). *Criteria for Assessing Naturalistic Inquiries as Reports*.
- Lumadya, S.A., Wiyarsi, A. (2024). Identification of acid-base misconceptions using a three-tier multiple-choice test with the certainty response index. *Journal of Chemistry Learning Research*, 9(2), 93–99.
- Miles, M. B., A. M. Huberman, and J. Saldaña. 2018. *Qualitative Data Analysis: A Methods Sourcebook*. California: Sage Publications.
- Minata, Z. S., Rahayu, S., & Dasna, I. W. (2022). Context-based chemistry learning: A systematic literature review. *Journal of Science Education*, 23(4), 1446–1463.
- Mukti, H., Suastra, I. W., & Aryana, I. B. P. (2022). Integration of Ethnoscience in Science Education. *JPGI (Indonesian Journal of Teacher Research)*, 7(4), 356–362.
- Nababan, D., & Sipayung, C. A. (2023). Understanding the contextual learning model within the Contextual Teaching and Learning (CTL) model. *Journal of Social and Humanities Education*, 2(2), 825–837.
- National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. In *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. The National Academies Press. <https://doi.org/10.17226/13165>.

- Nazara, R. G., Fatimah, W. S., Wardani, E. K., Pramesti, S. D., Hidayati, W., & Daeli, M. (2025). The role of ethnoscience in strengthening STEM learning to develop science literacy based on local culture in elementary schools. *Walada: Journal of Primary Education*, 4(3), 127-135.
- Novitasari, M. A., & Raida, S. A. (2025). Integration of the Local Wisdom of Kayangan Api in Bojonegoro into Contextual Science Learning at the Junior High School/MTs Level. *PSEJ (Pancasakti Science Education Journal)*, 10(2), 117-127
- Ogawa, M. (1995). Science education in a multiscience perspective. *Science Education*, 79(5), 583-593.
- Osborne, J., Simon, S., & Collins, S. (2003). Attitudes toward science: A review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049-1079.
- Putra, B. P., & Wahyuni, S. (2025). Integrating local wisdom into science education to enhance students' science literacy: A literature review. *Kalam Cendekia: Journal of Educational Sciences*, 13(2).
- Rahmawati, Y., & Ridwan, A. (2017). Empowering students' chemistry learning: The integration of ethnochemistry in culturally responsive teaching. *Chemistry: Bulgarian Journal of Science Education*, 26(6), 813-830.
- Rahmawati, Y., Ridwan, A., Rahman, A., & Kurniadewi, F. (2019, January). Chemistry students' identity empowerment through ethnochemistry in culturally responsive transformative teaching (CRTT). In *Journal of Physics: Conference Series* (Vol. 1156, No. 1, p. 012032). IOP Publishing.
- Ridha, M. R., Lestari, Y. P. I., Khatami, M. R., & Putri, A. A. (2025). Study: Content of Alpha-Cellulose, Lignocellulose, and Hemicellulose in Aquatic Plants and Their Applications in Pharmaceutical Science. *Scientific Journal of Pharmacy, Jember Academy of Pharmacy*, 8(1).
- Roberts, D. A., & Bybee, R. W. (2014). Scientific literacy, science literacy, and science education. In *Handbook of research on science education, Volume II* (pp. 545-558). Routledge.
- Selviana, R. M., Setyawan, D. N., Septiani, D., & Ernawati, T. (2026). Analysis of the Application of Ethnoscience-Based Science Learning on the Science Literacy of Junior High School/MTs Students. *Journal of Science Education*, 16(1), 74-81.
- Septina, E. A. (2025). The Correlation Between Culture, Local Potential, and Local Wisdom in Ethnoscience-Based Science *JOSERI*, 1(1), 25-32.

- Sodiqin, M. S. (2025). *Identification of ethnoscience values in the pendap-making process as an integration of science learning media at SMP IT Iqra' Kota Bengkulu*. UIN Fatmawati Sukarno Bengkulu.
- Sutrisno, H., Wahyudiati, D., & Louise, I. S. Y. (2020). Ethnochemistry in the chemistry curriculum in higher education: exploring chemistry learning resources in Sasak local wisdom. *Universal Journal of Educational Research*, 8(12), 7833-7842.
- Utami, S. H. A., Marwoto, P., & Sumarni, W. (2022). Analysis of science literacy skills among elementary school students from the perspectives of content, process, and scientific context. *Indonesian Journal of Science Education*, 10(2), 380-390.
- Wae, V. P. S. M., & Kaleka, M. B. U. (2022). Implementation of ethoscience in science education to realize independent learning in Ende Regency. *OPTIKA: Journal of Physics Education*, 6(2), 206-216.
- Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, 29(1), 145-185