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Enhancing Chemistry Education Through The Integration of Rote Ndao Cultural Practices: An Ethnographic Exploration of Ethnochemistry

Ananta Ardyansyah
Departement of Chemistry Education, Universitas Negeri Malang, Indonesia

*E-mail Corresponding Author: anantaardyansyah@gmail.com

Abstract

This study explores how integrating local cultural practices into chemistry education through ethnochemistry can provide a practical and relevant solution to these challenges. Conducted in Oeseli Village, a seven-day ethnographic study employed observations, interviews, and documentation to identify culturally significant products, such as Rote sugar, sopi (a traditional alcoholic beverage), and fried milk. These products were found to align with key chemistry concepts, including organic chemistry, fermentation, and particle interactions. By embedding these cultural assets into the chemistry curriculum, educators can enhance student engagement, contextualize learning, and overcome barriers imposed by the lack of traditional laboratory resources. The findings highlight the potential for using local traditions to foster a deeper understanding of chemistry while promoting science education that is both accessible and culturally relevant in remote regions like Rote Ndao. This approach encourages the development of a sustainable, localized educational model that can be adapted to other marginalized communities facing similar educational constraints.

Keywords: chemistry learning context; culture; ethnography; ethnochemistry

Abstrak

Studi ini mengeksplorasi bagaimana mengintegrasikan praktik budaya lokal ke dalam pendidikan kimia melalui etnokimia dapat memberikan solusi praktis dan relevan terhadap tantangan-tantangan ini. Dilakukan di Desa Oeseli, studi etnografi selama tujuh hari menggunakan observasi, wawancara, dan dokumentasi untuk mengidentifikasi produk-produk penting secara budaya, seperti gula Rote, sopi (minuman beralkohol tradisional), dan susu goreng. Produk-produk ini ternyata selaras dengan konsep-konsep kimia utama, termasuk kimia organik, fermentasi, dan interaksi partikel. Dengan memasukkan aset budaya ini ke dalam kurikulum kimia, pendidik dapat meningkatkan keterlibatan siswa, mengontekstualisasikan pembelajaran, dan mengatasi hambatan yang disebabkan oleh kurangnya sumber daya laboratorium tradisional. Temuan ini menyoroti potensi penggunaan tradisi lokal untuk menumbuhkan pemahaman yang lebih mendalam tentang kimia sekaligus mempromosikan pendidikan sains yang dapat diakses dan relevan secara budaya di daerah terpencil seperti Rote Ndao. Pendekatan ini mendorong pengembangan model pendidikan lokal yang berkelanjutan dan dapat disesuaikan dengan komunitas marjinal lainnya yang menghadapi kendala pendidikan serupa.

Keywords: budaya; ethnography; ethnochemistry; pembelajaran kimia berbasis kontektual

Introduction

Rote Ndao is a regency in the East Nusa Tenggara region known for its rich natural and cultural tourism potential (Murniasih A et al., 2018). However, positioned in Indonesia's southernmost region, Rote Ndao is one of the most remote areas, which presents challenges in accessing education, food, energy, and other essentials. This isolation, exacerbated by poor transportation, damaged roads, and minimal infrastructure, hinders regional development (Samadara et al., 2019). As a result, Rote faces various issues such as stunting (Susanti et al., 2022) and clean water shortages (Tamelan, 2015).

These infrastructural and geographical barriers also severely affect the education sector. Quality education in Rote is hampered by high distribution costs, leading to suboptimal educational outcomes (Puspitasari et al., 2015). According to 2021 data from the Central Bureau of Statistics, 23.55% of the population has not completed compulsory education, with 7,325 people still illiterate. Furthermore, only 5.81% of Rote Ndao's residents pursue higher education. The education level of a community is a key indicator of regional development, highlighting the need for Rote to become self-sufficient in accessing learning resources despite its geographical and financial constraints. Yet, the path to educational advancement in such remote regions extends beyond merely addressing logistical challenges—it requires a more nuanced approach.

Developing education in remote areas requires adapting to local cultural behaviors and learner needs (Dunbar, 2006). Effective classroom learning integrates local contexts with the curriculum to engage students (Squire, 2009). Context-based learning has been shown to enhance student engagement and interest (King et al., 2008). In addition, context-based activities can provide a more meaningful experience for students, which is a deeper learning experience and relevant to everyday life (Mundy & Nokeri, 2024). As an example, the use of beer, which is part of the culture of many societies, can be utilized as a context for teaching the fermentation process and various principles of organic chemistry and biochemistry (Hamper & Meisel, 2020). A similar approach can be applied in the context of Rote's culture. This not only enhances comprehension but also fosters a deeper connection to their cultural heritage, empowering students to see the scientific relevance of their local environment.

This approach is especially beneficial in subjects like chemistry, which often require special equipment. By integrating local contexts into chemistry lessons, teachers can create effective teaching tools that are both accessible and relatable to students. This approach is recognised as ethnochemistry. Ethnochemistry, which involves incorporating indigenous cultural knowledge into chemistry education, provides an effective way to connect formal science learning with local traditions (Chibuye & Singh, 2024). Ethnochemistry explores various traditional practices such as medicinal plant use, traditional dyes and pigments, Fermentation practices, natural ingredients in cosmetics and skincare, substances used in ceremonial and ritual practices, traditional construction materials, preservation techniques, brewing, distillation, insect repellents, and tanning methods (Semwal & Semwal, 2024). Other research also shows that ethnochemistry is closely linked to food, drink and agriculture (Maedja & Ningsih, 2021). This can be beneficial because incorporating ethnochemical practices in chemistry teaching positively improves students' attitudes towards the subject (Singh & Chibuye, 2016).

In Rote Ndao, where access to laboratory equipment is scarce, the application of ethnochemistry offers an innovative approach to teaching chemistry. Local resources and traditional practices provide practical examples to demonstrate chemical processes, making the subject more approachable and relevant for students. For instance, the fermentation of a local alcoholic beverage (Sopi) involve chemical reactions that can illustrate organic chemistry principles in a culturally familiar context.

Utilizing these everyday activities and the surrounding environment as a natural laboratory can enhance student comprehension, allowing them to connect abstract concepts to tangible experiences (Ültay & Çalık, 2012). This method of contextualizing chemistry education not only makes the subject more comprehensible but also more engaging. Indeed, improved learning outcomes and more positive attitudes have been observed when chemistry is taught within such a relevant context (Majid & Rohaeti, 2018). By leveraging ethnochemistry, educators in Rote Ndao can transform the perceived abstractness of chemistry into a subject deeply rooted in students' daily lives and cultural heritage.

The urgency of developing and implementing this approach becomes even more apparent when considering students' current chemistry proficiency. The concern over chemistry education in Rote Ndao is particularly pressing, as high school students in the region still demonstrate only moderate retention rates in chemistry (Bandu, 2022), a situation compounded by teachers' reliance on lecture-based methods (Ledoh et al., 2020). This underscores the need for educators to integrate local contexts into science education to foster better engagement and understanding (Sotero et al., 2020).

In response to these challenges, this research aims to explore the cultural potential of Rote Ndao for use in ethnochemistry-based chemistry learning. By investigating local practices and resources, the findings can guide educational practitioners in creating more engaging and locally relevant learning experiences helps students connect more deeply with their chemistry education, potentially improving retention rates and overall comprehension of chemical concepts within a familiar cultural context. This approach enables educators to provide meaningful learning experiences without relying on modern lab equipment, promoting sustainable education in remote areas. This approach could serve as a model for other regions facing similar challenges, boosting both cultural awareness and scientific understanding. This research is also essential for supporting the implementation of cultural contexts in learning, which is currently limited due to a lack of studies and data on Indonesian culture from a chemistry perspective (Rahmawati et al., 2017).

Method

The research was conducted in mid-2023 for a week in Oeseli Village, Rote Ndao Regency, East Nusa Tenggara Province. Oeseli Village is the southernmost village in Indonesia which makes this village community difficult to access (ATSEA, 2021). The research method used is ethnography which focuses on describing and interpreting the local culture of a community group (Creswell & Poth, 2018). This methodology provides rich, contextual data that is essential for developing culturally relevant educational materials

The ethnography is well-suited to exploring local cultural insights for chemistry education because it emphasizes an in-depth, culturally sensitive understanding of students' learning environments, social contexts, and personal experiences, all of which are critical for designing effective, culturally relevant chemistry instruction (Fetterman, 2010). In this research, researcher investigate the cultural practices of Oeseli Village and analyze how these practices can be applied in chemistry education. Through the researcher's immersion in the community, the ethnographic method facilitated a comprehensive understanding of cultural resources—like traditional food production—that could be utilized to provide a local context for teaching chemistry concepts.

Data collection was conducted through several steps. First, the researchers identified participants by consulting local villagers, including two local tour guides and the village chief, to understand the cultural uniqueness of Rote. To validate this information, the researchers cross-referenced the villagers' insights with findings from the internet and conducted

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initial direct observations. Next, the research team discussed and decided on the themes to focus on, selecting Rote sugar, Sopi (a traditional alcoholic beverage), and fried milk as the key subjects of the study. Some other items, such as woven cloth, *tilangga* hats, and *sasando* musical instruments, were deemed less relevant by the reseaxrcher and were not included in the focus of the study. Although these are typical products of Rote, their connection to chemistry learning is limited, making them less suitable for the research objectives.

Through purposive sampling, where participants are deliberately selected based on specific criteria, the data obtained becomes more representative of the study's objectives. This method ensures that the participants' expertise and relevance to the research topic align closely with the focus of the study, enhancing the depth and accuracy of the findings.in the purposive sampling technique (Creswell, 2012). Using purposive sampling, participants were chosen based on their occupations and recommendations from local villagers, considering factors such as their reputation, the length of time they had practiced their craft, and their location. In total, seven participants were selected: two Rote sugar makers, three sopi informants, and two fried milk makers. Data was then collected through a combination of observations, documentation, and interviews, all of which were recorded in detailed field notes.

Direct observations were conducted over the course of a week. All members of the research team participated in several observation sessions. For example, we conducted two sessions for Rote sugar, three sessions for *sopi*, and two sessions for fried milk, with each session lasting between 30 to 120 minutes. During these observations, we noted the processes explained by the informants and carefully observed the surrounding environment, documenting everything in field notes. Throughout the observation, we also conducted interviews and documentation. Each informant was interviewed for 15 to 20 minutes, using semi-structured interviews focused on questions such as the processes involved, the community's understanding of the product, and how the product is utilized. The interview results were recorded in field notes, and we also documented the process through photos and videos, capturing the products, the informants during the interviews, and the surrounding environment.

At the end of each day, the research team discussed the findings from the observations, interviews, and documentation to ensure consistency and accuracy. We also cross-checked the information with our local guide. For example, during the Rote sugar observation, we directly observed the production process and interviewed the informant. We compared the data collected during the interview—such as the informant stating that Rote sugar is produced from the *siwalan* plant—with our observation notes and photos of the plant. This allowed us to verify the credibility of the information. We then confirmed this with our local guide. Any inconsistencies or missing information were clarified by re-interviewing the informants.

Then the data was analyzed through content analysis which focuses on understanding the main meaning of the data source (Hsieh & Shannon, 2005). The researcher extracted key meanings from the collected data, including observations, interviews, and documentation. The data were categorized according to the predetermined themes of the study: Rote sugar, *sopi* (a traditional alcoholic beverage), and fried milk. Through content analysis, chemistry-related codes emerged within each of these themes. Codes related to chemistry concepts, such as organic reactions, hydrocarbons, and fermentation, were identified from the data. These codes then formed specific chemistry topics. The relevance of these topics was mapped within the context of national chemistry education, based on the document *"Capaian Pembelajaran Mata Pelajaran Kimia Fase E dan Fase F untuk SMA/MA/Program Paket C"* from the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia. In this way, the cultural practices of Rote were shown to align with the learning outcomes set by the national curriculum. Ultimately, the study highlights how Rote culture can support chemistry education, particularly within the framework of ethnochemistry-based learning.

In collecting and analyzing data on field notes, the researcher was assisted by a team of six people who were directly involved. The research team consisted of six members with varied roles: two person who responsible for coordinating with local guides who facilitated cultural understanding, three data recorders responsible for documenting observations and interviews, and one chemistry educator who helped relate cultural practices to chemistry concepts. The team met daily to review and triangulate the data collected through interviews, observations, and documentation, ensuring that the interpretations were comprehensive and culturally informed. This collaborative approach helped minimize researcher bias and ensured that the findings were accurate and credible. During the week, researchers were also directly involved with the community, so that they could verify the data provided by the community. In addition, Triangulation of interview, observation, and documentation data makes the data presented more comprehensive and credible.

Result and Discussion

The result of this research is an analysis of the culture of the Oeseli community which is then connected in the context of chemistry. The research results are presented in the following sub-sections.

Table 1.
Analysis of Topic Relevance

Culture	Chemistry Topic	Learning Outcomes
Rote Sugar (Borassus Flabellifer Linn Sugar)	hydrocarbon structure and nomenclature, colligative properties of solutions, and colloids, crystallization.	Understanding organic chemistry and its applications in daily life
Sopi (Fermented beverages)	hydrocarbon structure and nomenclature, synthesis of organic compounds, fermentation, boiling points of organic compounds, enzymes, and reaction rates	Understanding organic chemistry and its applications in daily life
Susu Goreng (Fried Milk)	protein, coagulation, mixtures, physical and chemical changes, additives, and colloids.	Exploring the properties, structures, cogalulation, and interactions of particles in forming various compounds.

Rote sugar: Specialty palm sugar from Lontar

Rote sugar is a specialty of the Rote region that comes from palm sap. The sap of the lontar tree (Borassus flabellifer Linn) is cooked using a clay furnace to reduce its water content and turn it into sugar. The three types of sugar are also known as water sugar, plate sugar, and ant sugar (Messakh et al., 2022). All of these sugars are then marketed with simple packaging (Bella & Pollo, 2019). The people of Rote generally produce this sugar from May to November before the rainy season.

Tappers collect sap from palm trees at daybreak to make lontar palm sugar. The fresh sap, called "nira", is quickly filtered to remove impurities. The sap is then put in clay pots and heated in a clay furnace. Then, the sap is cooked for several hours. It is skimmed and churned to get rid of the foam. The liquid gets thinner and thicker, and the water evaporates. The artisan watches the process carefully to make sure it crystallises evenly and doesn't burn. When it's ready, the boiling syrup is poured into moulds and left to cool. It turns into blocks or discs that range in colour from golden to dark brown. The final product has a unique caramel flavour with slight smokey undertones.

In the wider community, sugar derived from palm sap is known as brown sugar (Ledheng & Naisumu, 2020). Palm sugar is one of the popular cultural products in the Southeast and South Asian region and Indonesia is one of the largest producers of palm sugar with various types of palm (Saputro et al., 2019). Rote sugar is a special characteristic of the Rote people because it comes from lontar tree, in contrast to other sources, such as coconut or aren palm (Arenga pinnata L.) (Fahrizal et al., 2019). Thus, it is suitable to be used as a context for chemistry learning in Rote.

Figure 1.
Puck-shaped Rote Sugar (Plate Sugar)

Rote sugar is the local wisdom of the island of Rote which is closely related to the topic about sugar or saccharides. Sugar's molecular structure is linked to organic chemistry. Palm sugar can be used to introduce the classification of sugars as monosaccharides, disaccharides, and polysaccharides. Students can find out how glucose and fructose in the sap make sucrose, a disaccharide. This helps students understand how sugars are structured and classified, which helps them understand organic chemistry. Students can also look at how temperature affects colour and taste.

In addition, broadly in the process of making this sugar students can also learn about colloids and colligative properties. Rote sugar production is explained in physical chemistry using the concepts of evaporation and crystallization. As the amount of water in the sap drops, the concentration of sugar might rise due to evaporation, which occurs when water molecules move from the liquid phase into the gas phase. Crystallization, which produces solid sugar crystals, starts as the sugar solution gets supersaturated. These phenomena are effectively linked to colligative properties, which explain how solutes such as sugar influence the boiling point of sap. In this setting, students can investigate the effect of solutes on boiling point elevation, reinforcing fundamental physical chemistry concepts through real-world applications.

Previous studies have examined the utilization of palm sugar (Arenga pinnata) as a context for science learning (Sumarni et al., 2016). In this study, learning in the context of palm sugar can cover hydrocarbon topics, colloids, colligative properties, structure and order, and macromolecular topics. Based on this research, learning with Rote sugar from palm trees can also be done this way. According to the Ministry of Education and Culture's Independent High School Chemistry Curriculum, the context of Rote sugar can be used to support the learning objective "Understanding organic chemistry and its applications in everyday life". (Kemendikbud, 2022). Thus, Rote sugar can be used as a context for chemistry learning.

Learning that is carried out can be in the form of observations of making Rote

Sugar, group discussions, and experiments related to Rote Sugar. The study of Dindorf et al., (2024) designed learning activities that measure students' decision-making in choosing non-calorie sugar. The learning can be adopted in the context of natural local sugar. Students can be asked to compare several sources of natural sugar in Indonesia and Rote Sugar can be one of them. At the end, students can make a poster with the theme "Comparing palm sugar with brown sugar and white sugar" as in the study of Widanski et al. (2016).

Sopi: Fermented Beverage from Lontar Palm Sap

In addition to Rote sugar, another processed palm sap originating from the Rote community is sopi. Sopi is a drink made from fermented palm sap. Rote people usually drink sopi and typically serve it to guests as a form of welcome. This drink has the appearance of a colorless liquid with a distinctive aroma of liquor. Apart from NTT, this drink is also popular in Maluku (Mahulette, 2021). Sopi is also known as Tuak in other areas (Putri, 2017). Fermented drinks from palm tree sap are very popular in Southeast Asia with a variety of initial preparations, such as Aren (Arenga pinnata Merr), Nipah (Nypa fruticans), and siwalan (Borassus flabellifer) (Wijaya et al., 2024). Alcoholic beverages are closely related to the chemistry and traditions of society (Barth & Benvenuto, 2015). Fermented liquor is one example of the integration of science, local wisdom, and cultural preservation (Utami et al., 2023). In addition, learning chemistry is also considered important as a means of educating about the dangers of alcoholic beverages (Winarni, 2020). Thus, one of the cultural products of Indonesian society is suitable for use as a context for learning chemistry.

The fermentation process involved in making sopi is linked with chemistry concepts, particularly in the fields of biochemistry and physical chemistry. In the process of Sopi production involves the fermentation of lontar sap, where natural sugars in the sap are converted to alcohol through anaerobic respiration. During this process, enzymes catalyze the breakdown of glucose molecules into ethanol and carbon dioxide, a biochemical reaction known as alcoholic fermentation. This is in line with another study that state the process of making sopi through fermentation can be an inspiration for learning the synthesis of chemical compounds and the distillation process can be used as a learning context based on the boiling point in organic chemistry (Suardana, 2014).

The use of Lau which contains enzyme-producing bacteria that accelerate the fermentation process (Rahmawati et al., 2017). Students can learn about enzymes and reaction rates related to this. This reaction provides a practical context for discussing enzymatic catalysis and reaction rates, as enzymes play a key role in accelerating the fermentation process. This aligns with the chemistry topics of reaction kinetics, illustrating how factors like temperature, enzyme concentration, and substrate availability influence reaction rates in biochemical reactions. Additionally, this process offers an opportunity to introduce students to anaerobic respiration as a core concept in biochemistry. By understanding how microorganisms metabolize glucose without oxygen, students gain insight into the broader principles of cellular respiration, which can be further explored in both biological and chemical contexts. Another ethnoscience study also showed that alcohol can be used as a learning context for separation, additives, and biotechnology (Dewi et al., 2022). The use of alcohol as a learning context has been shown to improve student learning outcomes (Godin et al., 2014). Therefore, the use of Sopi as a context for chemistry learning will follow the learning outcome "Understanding organic chemistry and its applications in daily life" (Kemendikbud, 2022).

Integration of alcohol in learning can be done with various activities. The study by Godin et al. (2014), taught alcohol through modules followed by laboratory activities and mathematical calculations. Integration of alcohol with chemistry through a module equipped with practicum activities also showed positive results on student development (Suryelita & Fitriza, 2018). The easiest practicum to implement is the alcohol distillation process (Anggraini & Yusmaita, 2023). This practicum uses simple tools and easily available topics. By adopting the Sopi context, students can compare the boiling point of Sopi with pure palm wine or with other liquids. Another practicum that can be done is the calculation of alcohol content (Patimah et al., 2023). Understanding the limit of alcohol content as a drink is very important to understand, so practicum can also be an option in this ethnochemistry learning. Another learning activity that can be done is a discussion on alcohol-related issues (Rodrigues, 2022). The use of alcohol issues can enhance students' critical thinking. In the context of Sopi, students can discuss how Sopi is present in the culture of society and how it is limited in today's society. Another activity that can be done is a visit to a liquor production site (Gilbert, 2015). Students can visit the place where Sopi is made and make observations, as well as conduct interviews.

The content of learning about alcoholic beverages is not only about the content, but can also be related to history, economic value, hazards, metabolism in the body, taxes, and related regulations (Raymond & Schneider, 2015). However, learning about these beverages also needs to consider age restrictions as the content and practices deepen (Mosher & Trantham, 2015). In addition, educators also need to pay attention to religious aspects in using the Sopi context. Thus, education is expected to direct learning in the Sopi context appropriately.

Fried Milk: Traditional Buffalo Milk Dish from Rote

Fried milk (Susu Goreng) is a typical Rote product derived from buffalo milk. In its production, buffalo milk is added with rote sugar (gula lontar) and then cooked until only the pulp is left. The resulting dregs are referred to as fried milk. Fried milk products also have other variations that are produced by cooking them through a steaming process that produces a pudding-like texture. Fried milk is physically brown with an amorphous shape with a sweet savory taste. Currently, fried milk is classified as a rare food because only a few people make this food. In addition, the basic ingredients of buffalo milk are not always available, making this product increasingly difficult to find. In Rote, fried milk is traditionally processed for consumption needs and traded as a typical souvenir of Rote (Siwe et al., 2011).

Figure 2.
Fried Milk Looks

This traditional food is prepared by heating buffalo milk, often with added starch, until it solidifies into a custard-like consistency, which is then fried to form a crispy exterior. The cooking process provides an ideal context for discussing the chemistry of proteins, emulsions, and chemical reactions involved in cooking, linking culinary practices to scientific learning. In its preparation, fried milk is formed due to the process of protein coagulation in milk (Noach et al., 2023). The coagulation process of fried milk occurs due to the reduction of water content during the cooking process (Lay et al., 2024). As the buffalo milk is heated, the proteins undergo denaturation, meaning they lose their natural structure. This alteration allows the proteins to aggregate, forming a semi-solid structure that can be fried. This process is key in biochemistry, as it shows how heat affects the structure and behavior of proteins. Teachers can use this example to explain how protein denaturation is involved in various everyday food processes, from making yogurt to cooking eggs, making the subject more relatable and memorable for students.

Fried milk has similar characteristics to jenang and dodol. Both use palm sugar, jenang uses palm sugar, while susu goreng uses siwalan sugar. Then, Susu Goreng uses buffalo milk, while Jenang uses coconut milk. Thus, both have similarities. Based on a study, in making jenang, learning in the context of the food can include mixed topics, physical and chemical changes, and additives (Ainuzzahroh et al., 2024). Meanwhile, in another study, it was mentioned that in making dodol (almost similar to jenang) there is colloidal learning. When making colloids there are dispersed substances and dispersing media (Rahmawati et al., 2023). Referring to the curriculum guidelines, fried milk can be used as a learning context for the learning outcome "Exploring the properties, structures, and interactions of particles in forming various compounds." (Kemendikbud, 2022).

Learning activities can be centered on observing the making of fried milk. Students can observe and understand each ingredient used and its role in making fried milk. The organoleptic practicum can also be one of the learning activity options that can be done. Students can compare the texture, flavor, and aroma of different variations of fried milk. The variation can be in the form of initial preparation variation (buffalo milk, cow milk, goat milk) or sugar variation (palm sugar, palm sugar, kitchen sugar). Students can then be asked to discuss to compare their results.

Teaching Implication: The Potential of Ethnochemistry

Teaching ethnochemistry in chemistry helps students understand scientific principles better by linking them to cultural practices. This makes learning more enjoyable and helps students gain a better understanding of science and culture. It enhances students' engagement, students' attitude towards chemistry, cultural identity, and understanding of chemistry concepts (Rahmawati et al., 2017, 2023; Singh & Chibuye, 2016). The context of the discussion is one that is readily comprehensible to students, and thus, they are able to participate more actively in the exchange of ideas (Habig et al., 2018; Tutal, 2023; Willms, 2010). Teaching science in a way that fits with students' lives helps them understand and remember chemical ideas better. This encourages greater involvement and facilitates a deeper understanding of the subject matter. Several studies have shown that ethnochemistry can enhance explanatory quality, foster critical thinking, and strengthen scientific literacy (Heliawati et al., 2022; Rahmawati et al., 2019; Wiratma & Yuliamiastuti, 2023).

Ethnochemistry teaching helps students understand chemical ideas by linking them to cultural practices. The production of Rote sugar, sopi and fried milk show basic chemical concepts like crystallisation, fermentation, protein denaturation and reaction kinetics. Teaching scientific principles in a cultural context helps students understand them better. As an example, when explaining Rote sugar, the teacher can ask students to directly observe its production and then interpret the various principles involved, such as evaporation and crystallization in its making. This approach to learning not only helps students understand more effectively but also addresses various school limitations, such as the absence of a lab, materials, and conventional tools for explaining related processes or concepts. Hence, ethnochemistry is especially useful in places where there are not enough resources for science education

Furthermore, this approach to learning offers a more meaningful experience and ensures that knowledge is more relevant. Ethnochemistry also helps to make education fairer by showing that traditional knowledge can be used in science. This helps students to feel proud of their culture while also learning more about science. This is especially good for communities where traditional ways of life are still important. The approach helps students to feel more confident and to like science more.

However, in implementing ethnochemistry, a number of factors require consideration. For instance, when utilising the Sopi context for learning purposes, educators must take into account the safety, age, and religious affiliation of their students. Alcohol is an unhealthy beverage that poses a risk to health and well-being. Additionally, there are religious traditions that prohibit the consumption of alcohol. Contextual factors that directly contradict or endanger students should be avoided. Even when alcohol is still consumed, teachers must establish clear boundaries to ensure that learning can be carried out without compromising other aspects of students' lives. It's crucial to consider challenges teachers may face adapting to new conditions that require re-observation, including training on curriculum-aligned learning. Additionally, students' prior knowledge may not always match desired outcomes. When implemented correctly, ethnochemistry can significantly enhance the learning process.

Ethnochemistry is an effective way to teach chemistry. It makes the subject more relevant and accessible. It helps students see chemistry as part of their culture. This makes it easier for students from different backgrounds to learn. Nevertheless, a number of factors require further consideration at the implementation stage.

Conclusion

This study highlights the importance of incorporating local cultural practices, such as Rote sugar, sopi, and fried milk, into chemistry education, particularly in remote areas like Rote. These practices offer an engaging and contextually relevant way to teach core chemistry concepts, aligning with national curriculum standards. By integrating local culture into lessons, educators can foster a deeper connection between students and their learning, improving comprehension and engagement. However, careful consideration of social and cultural factors is necessary for successful implementation. Future research should focus on assessing the impact of this approach on student learning outcomes and exploring its broader applicability across different regions and cultures. This research serves as an initial exploration, providing a foundational study that underscores the potential for more comprehensive, implementation-focused research in the future. Similar research that can also serve as a reference, such as study of Irawati et al. (2023), considers various contexts, allowing future researchers to compare the differences in the effects produced. other studies, can also use this research as a basis for developing interactive media, such as previous studies (Heliawati et al., 2022). Furthermore, several other studies have demonstrated that the term 'ethno' can be effectively applied to the domain of science (Wati et al., 2021), thereby reinforcing its potential for future applications.

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