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Ethnochemistry of Kampung Naga: Local Wisdom as Green Chemistry Learning in E-Book Form

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ABSTRACT

This study explores the local wisdom of Kampung Naga as a source of ethnochemistry-based green chemistry learning through an e-book. The research focuses on forest conservation, waste management, natural architecture, water systems, and traditional agricultural and food practices. This study employed a descriptive qualitative approach using an ethnographic method to explore the local wisdom of the Kampung Naga community in relation to ethnochemistry and green chemistry concepts The research target were members of the Kampung Naga community selected through purposive sampling. Data were collected through observation, interviews, questionnaires, and documentation, and analyzed descriptively. The findings show that local wisdom of Kampung Naga encompasses ethnochemical practices that are relevant to chemical concepts. These practices align with the principles of green chemistry, particularly in waste reduction, the use of renewable materials, and energy efficiency. Although challenges remain, such as the open burning of plastic, which poses pollution risks the community's approach to maintaining harmony with nature offers a strong framework for developing chemistry education based on ethnoscience.

INTRODUCTION

Education plays a crucial role in cultural preservation while also driving transformation toward more innovative ways of life. The current wave of globalization has shifted many local cultural values in Indonesia (Sumarni et al., 2020). As a result, much traditional knowledge has been lost due to a lack of awareness regarding the importance of its preservation, even though authentic scientific knowledge includes facts and practices that emerge and develop within society (Jon et al., 2023; Khusniati et al., 2023). The relationship between scientific knowledge and traditional knowledge is known as ethnoscience, with ethnochemistry representing one of its specific branches.

Ethnochemistry is a branch of ethnoscience that examines chemical practices embedded within cultural traditions. This knowledge is derived from generational experience and local wisdom, facilitating contextual scientific learning that is aligned with students' cultural environments (Irawati et al., 2023; Khusniati et al., 2023). By presenting chemical concepts through authentic cultural practices, ethnochemistry offers a meaningful approach that enriches learning experiences and enhances cultural relevance (Aldiansyah et al., 2023).

Local wisdom constitutes a system of knowledge and practices passed down across generations, playing a vital role in maintaining cultural identity and enabling communities to adapt to their environments (Suttrisno & Rofi'ah, 2023). Kampung Naga, located in Tasikmalaya Regency, is a traditional community known for its strong adherence to ancestral traditions despite ongoing modernization. The community's daily practices reflect several ethnochemical concepts that naturally align with green chemistry principles, including waste reduction, the use of natural materials, and environmentally friendly production processes (Ardani et al., 2023; Syabriyana et al., 2023). Although previous studies have explored Kampung Naga's local wisdom—particularly in relation to cultural preservation and social adaptation—no prior research has integrated Kampung Naga ethnochemistry with green chemistry principles in the form of an e-book as a learning resource (Yasri et al., 2024). This gap highlights the significance and originality of the present study.

The integration of ethnochemistry and green chemistry offers a highly relevant and contextual approach to chemistry education. Green chemistry emphasizes the design of chemical processes and products that are environmentally responsible (Aisah & Mitarlis, 2023). When combined with the traditional practices of Kampung Naga, these concepts enable students to understand chemical principles while simultaneously appreciating local cultural values and sustainable practices.

To support learning in the digital era, this study translates its findings into an ethnochemistry-based e-book that serves as a flexible, accessible, and interactive digital learning resource aligned with contemporary educational needs (Afifah & Mulyani, 2022; Nadhifah, 2022). E-books promote independent learning and facilitate efficient instruction, both of which are essential in competency-based curricula (Karmadi et al., 2023). Preliminary interviews with schools revealed a significant demand for such resources: teachers reported that no existing e-books address ethnochemistry integrated with green chemistry principles, and most expressed the need for contextual digital materials that connect chemistry to students' lived experiences.

Furthermore, questionnaire results indicated that the developed e-book achieved a practicality score of 87% from experts and 93% from students, demonstrating that it is highly practical, user-friendly, and effective. Features such as clear language, contextual explanations, environmental relevance, and engaging visuals help students better understand chemical concepts and relate them to everyday life. The e-book also promotes environmental awareness by highlighting how traditional practices in Kampung Naga reflect sustainable principles, thereby encouraging students to value ecological conservation and cultural heritage.

This integration aligns closely with the Chemistry Education Curriculum, particularly the Merdeka Curriculum, which emphasizes chemical literacy, contextual learning, project-based learning, and sustainability. By connecting cultural practices with scientific principles, the e-book supports learning outcomes that require students to analyze the relationships between chemistry, culture, and the environment, and to apply chemical concepts in real-world contexts. Therefore, this study is significant not only for addressing a clear research gap but also for providing a practical digital learning resource that enhances chemical literacy, strengthens environmental awareness, and supports curriculum-based competencies in modern chemistry education.

METHODS

Research Design

This study employed a descriptive qualitative approach using an ethnographic method to explore the local wisdom of the Kampung Naga community in relation to ethnochemistry and green chemistry concepts. The research was conducted on February 26–27 and April 27, 2025, in Kampung Naga, Neglasari Village, Salawu Subdistrict, Tasikmalaya Regency, West Java, Indonesia.

Research Target

The research target were members of the Kampung Naga community selected through purposive sampling. Informants included customary leaders, local residents, tour guides, and housewives who possess direct knowledge and experience of traditional practices related to environmental management and daily life.

Research Data

The study collected both qualitative and supporting quantitative data. Qualitative data were obtained through observations, semi-structured interviews, and documentation, focusing on traditional environmental practices, food processing, agriculture, architecture, and water management. Quantitative data were collected through validation questionnaires distributed to education experts and students to assess the feasibility and practicality of the developed e-book.

Research Instruments

Research instrument were collected through field observations, interviews, and documentation.

Data analysis

Qualitative data were analyzed using descriptive qualitative analysis, involving data reduction, data display, and conclusion drawing. Questionnaire data were analyzed using descriptive statistics in the form of percentages.The trustworthiness of the qualitative data was ensured through source and method triangulation, as well as member checking with selected informants. Expert validation was also conducted to confirm the accuracy, relevance, and educational suitability of the e-book content.

RESULTS AND DISCUSSION

The e-book was developed using a Research and Development (R&D) approach, consisting of the stages of needs analysis, design, development, expert validation, and revision. The validation process involved chemistry education experts and students as test subjects. The results showed that the e-book achieved feasibility scores of 87% from experts and 93% from students, indicating that it is highly suitable as a contextual learning resource integrating ethnochemistry and green chemistry principles. The ethnochemistry e-book, as the product of this research, discusses the following topics:

1. **Forest Conservation and Its Ecological Functions**

   Kampung Naga serves as a prime example of an indigenous community that continues to maintain ecological balance through local wisdom in environmental management. The village is relatively remote from major roads, which contributes to its pristine condition and freedom from environmental degradation caused by industrial activity. Kampung Naga is surrounded by two types of forests: prohibited forest (*hutan larangan*) and cultivated forest (*hutan garapan*), both of which functionally contribute to the preservation of the surrounding environment. The prohibited forest holds a sacred value and is strictly protected from any form of exploitation, serving as a natural barrier against illegal logging and pollution. This prohibition indirectly preserves the chemical stability of essential elements in the soil and water, such as nitrogen and phosphorus, which are crucial for maintaining soil fertility and ensuring ecosystem sustainability (Arba et al., 2023). Cultivated forest refers to forests that can be utilized for agricultural purposes.

   Forests act as natural recyclers of carbon dioxide in the atmosphere. Well-preserved forest vegetation also functions as a carbon dioxide (CO_2) sink, contributing to the reduction of air pollutants. Carbon dioxide is the largest contributor to greenhouse gas emissions, as it is closely linked to various human economic activities (Sasmita & Fatatulkhairani, 2019).

Carbon dioxide emissions affect air quality; as the concentration of carbon dioxide in the atmosphere increases, more heat waves reflected from the Earth's surface are absorbed by the atmosphere (Pakaya et al., 2024).

Figure 1. Cultivated forest

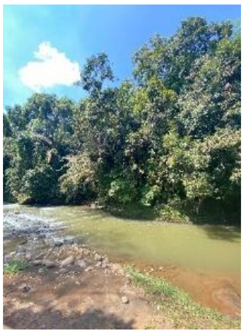

Figure 2. Prohibited forest

Carbon dioxide absorption occurs through the process of photosynthesis. Photosynthesis is the primary mechanism by which trees and plants in forests absorb carbon dioxide from the atmosphere. During this process, carbon dioxide is converted into sugars and oxygen, where the sugars serve as a source of energy for the plants, and oxygen is released back into the atmosphere (Ningsih, 2024). Carbon is absorbed and stored in plant biomass, including stems, branches, leaves, and roots. Therefore, the older and larger the tree, the greater the amount of carbon it can absorb. (Ningsih, 2024).

The Kampung Naga community conserves forests while utilizing bamboo from cultivated forests as a multifunctional plant that plays an important role in daily life, serving as material for construction, household tools, and handicrafts. The dense root system of bamboo is capable of absorbing rainwater, reducing surface runoff, preventing erosion and landslides, and sustaining spring water during the dry season. Bamboo can grow without the need for chemical fertilizers or pesticides (Rahmadani, 2023).

Forest management by the Kampung Naga community reflects ethnochemical practices, which involve the application of local knowledge embedded in local culture without the intervention of modern technology. The concept of the sacred forbidden forest serves as a form of environmental conservation and an ecological mechanism for maintaining soil chemical stability and water quality, grounded in spiritual and social values. They also understand the ecological functions of bamboo in maintaining environmental balance. This conservation perspective is related to several principles of green chemistry, namely waste prevention, design for degradation, design for energy efficiency, and the use of renewable resources.

2. Traditional Architecture Based on Natural Materials as a Reflection of Environmental Adaptation in Kampung Naga

A. Traditional Architecture of Kampung Naga’s Vernacular Houses

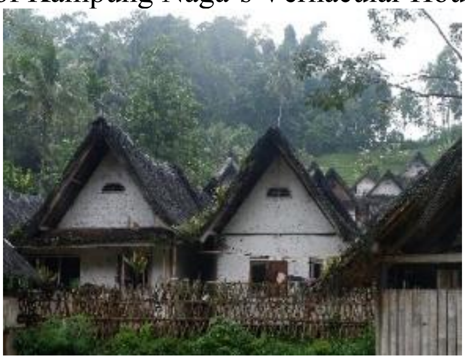

Figure 3. Traditional house of Kampung Naga

The houses in Kampung Naga represent the local community's ecological adaptation to their surrounding environment through the use of natural materials. The houses are built in the form of stilt houses with triangular roofs, utilizing materials sourced from nature such as wood, bamboo, *biik* (woven bamboo), as well as *ijuk* (sugar palm fiber) and *tepus* leaves for the roof covering. The roof structure is designed with two layers: the outer layer is made of *ijuk* from sugar palm trees, known for its abundance of fine fibers (*harupat*), while the inner layer uses *tepus* leaves.

Ijuk has a long lifespan and can last up to 40 years (Putrasusila, 2021). The use of *ijuk* affects the indoor air conditions. Houses with *ijuk*-thatched roofs tend to remain cool during the day and distribute warmth at night (H.H & Lapisa, 2019). *Tepus* leaves can last up to three years if preserved through a process of soaking for three days followed by thorough drying (Novitasari, Nuri & Pradipto, 2023). *Tepus* leaves possess heat-resistant properties and provide warmth during cold weather (Kusumawati, Tri. Anisa, Purwantiasning, 2017).

This combination not only enhances the roof's durability against weather conditions but also improves its water resistance and extends its lifespan without the need for synthetic chemicals. This reflects an ethnochemical practice. The community has, through generations, understood the physical and chemical properties of the materials used—such as *ijuk*'s ability to repel water and the durability of *tepus* leaves after undergoing preservation processes. The treatment of *tepus* leaves prior to use, including drying and softening, demonstrates a simple form of chemical technology aimed at increasing the durability of natural materials. The Kampung Naga community also recognizes that using plant-based natural materials avoids reliance on industrial products that may pollute the environment. *Ijuk* and *tepus* are renewable resources that can be replanted and regrown without contaminating soil and water, thereby aligning with the green chemistry principle of utilizing renewable raw materials.

The traditional houses of Kampung Naga demonstrate a form of construction technology that is entirely based on the use of local materials. The roof framework consists of *reng* and *usuk* (roof battens and rafters), made from bamboo and tied together using cords derived from the fibers of mature young bamboo. The bamboo fibers are selectively chosen to achieve optimal strength in binding. Bamboo at the mature young stage possesses maximum elasticity, making it ideal for structural applications (Yasin et al., 2023). Young bamboo does not yet contain sufficient lignin and crystalline cellulose, making it too soft and prone to breaking. In contrast, older bamboo contains excess lignin, which makes it overly hard and more likely to crack. Lignin and cellulose are natural polysaccharides that provide mechanical strength to bamboo (Illya & Bali, 2021).

The Kampung Naga community preserves the wood and bamboo used for building houses by soaking them in water and mud for three months. Soaking bamboo in stagnant water and mud can reduce termite attacks, depending on the duration of the immersion. Moreover, the length of the soaking period can influence the physical and mechanical properties of the bamboo (Teknik et al., 2015). In Kampung Naga, houses are painted using lime mixed with water. When lime is combined with water, the resulting solution can be applied to walls as paint. The lime reacts with carbon dioxide (CO_2) in the air and transforms into calcium carbonate ($CaCO_3$), which is hard, durable, and possesses antiseptic properties (Silva et al., 2021).

The traditional houses of Kampung Naga reflect ethnochemical practices based on local wisdom that align with the principles of green chemistry. The use of natural materials such as wood, bamboo, *ijuk*, and *tepus* leaves demonstrates a generational understanding of the physical and chemical properties of these materials. The preservation processes—soaking and drying *tepus* leaves, as well as immersing bamboo and wood in mud for three months—represent simple chemical technologies that effectively enhance material durability without the use of synthetic chemicals. All of these practices embody the principles of green chemistry, including the use of renewable raw materials, the synthesis of non-hazardous substances, energy-efficient design, and design for degradation.

B. Use of traditional tools without electricty

The Kampung Naga community consistently preserves local wisdom by refraining from accessing electricity, in accordance with deeply respected customary traditions. The use of electronic devices is extremely limited and includes only mobile phones, radios, and flashlights powered by batteries. The use of mobile phones began during the COVID-19 pandemic, when the need for online learning prompted the community to selectively adapt to modern technology. For charging mobile phones, residents rely on small shops outside the village area as charging stations.

At night, household lighting relies on traditional tools such as *petromaks* (pressurized kerosene lamps) and *semprongan* (oil lamps), which operate through the combustion of kerosene. For outdoor activities at night, people use flashlights. These flashlights are powered by batteries.

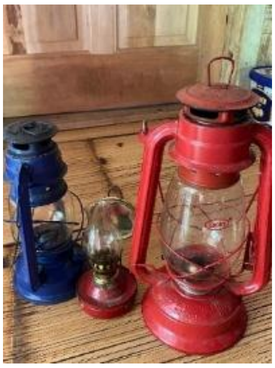

Figure 4. Petromaks and Semprongan

A battery is a collection of electrochemical cells used to store chemical energy and convert it into electrical energy. Inside the battery, a redox (reduction–oxidation) reaction occurs, which is a fundamental process where electrons move to produce an electric current. In dry cell batteries, the reaction involves zinc (Zn) as the negative electrode (anode), a carbon rod (C) as the positive electrode (cathode), and a paste of MnO_2 and NH_4Cl that acts as the electrolyte (Nasution, 2021).

$$Zn(s) + 2MnO_2(s) + 2NH_4^+(aq) \rightarrow Zn^{2+}(aq) + Mn_2O_3(s) + 2NH_3(s) + H_2O(l)$$

Figure 5. Charcoal iron

Figure 6. Hawu

In household activities, the community still uses a charcoal iron for smoothing clothes and a *hawu* (traditional clay stove) as a substitute for modern stoves. The charcoal iron operates based on the combustion reaction of wood charcoal (carbon), which produces heat through an exothermic reaction:

$$2CO(s) + O_2(g) \rightarrow 2CO(g) + Heat$$

This reaction results from incomplete combustion (B.R. Purba & Sirajuddin, 2021). Incomplete combustion produces carbon monoxide (CO), due to insufficient oxygen during the burning process (Fajri & Ghofur, 2021).

The *hawu*, used as a substitute for modern stoves, is made from clay—a material with high thermal stability that can withstand extreme temperatures without deformation (Muin et al., 2023). In addition to clay, the community mixes coconut husk fibers and wood ash into the clay during the making of the *hawu*. Coconut husk serves as an environmentally friendly binder. It contains about 75% fiber and 25% pitch, which acts as a natural adhesive between fibers. The lignin and cellulose content strengthens the soil mixture (Widianti, 2022). Ash improves the physical and mechanical properties of the clay and enhances its stability (Yusuf & Zava, 2019). The combination of coconut husk and combustion ash increases the structural stability of the clay, making it more heat resistant and less prone to cracking (Widianti, 2023).

The Kampung Naga community uses batteries, oil lamps, and charcoal irons as alternatives to electricity. This reflects a local understanding of chemical energy derived from materials such as charcoal and kerosene, which produce heat and light through combustion. Chemical reactions—such as the oxidation of charcoal and electrochemical processes in batteries—are applied in a practical manner without necessarily understanding the theoretical chemical concepts. These practices demonstrate that the community possesses intuitive knowledge of material properties and energy transformation, which is a fundamental aspect of ethnochemistry.

The construction of *hawu* from clay mixed with coconut fiber and wood ash reflects local knowledge of material properties and thermal resistance. Ash, which contains compounds such as silica and carbonates, enhances the strength and heat resistance of the *hawu*, while coconut fiber adds flexibility and prevents cracking. This represents traditional material engineering based on experiential knowledge, which is an essential component of ethnochemical practices.

Traditional energy practices in Kampung Naga naturally reflect several principles of green chemistry, including waste prevention, design for energy efficiency, the use of renewable raw materials, and design for degradation.

3. Water System in Kampung Naga

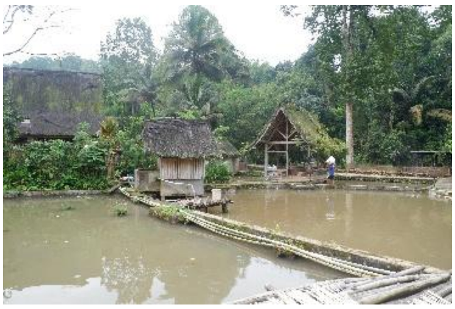

Figure 7. Water System in Kampung Naga

The Kampung Naga community utilizes water sources selectively according to their purpose. Water from the Ciwulan River is directed to the rice fields and the Cigarunggang channel, where it is naturally filtered by rocks and grasses before entering a storage tank. Spring water sources are used exclusively for cooking and drinking, as they have been naturally filtered by tree roots upstream (S et al., 2024).

Each house does not have a private bathroom; instead, residents use communal bathing facilities built above fish ponds (bathing over the pond). Wastewater from bathing and washing undergoes biological filtration: it is first filtered through the feeding activity of the fish, then flows into a holding pond filled with aquatic plants (water grasses), before finally being discharged back into the river.

Rainwater from rooftops is channeled through drainage ditches between buildings toward the rice fields. In the short term, this rainwater serves irrigation purposes, while in the long term, it contributes to maintaining groundwater balance through infiltration.(Syabriyana et al., 2023). Overall, water use in Kampung Naga is continuous and systematic: clean water is naturally filtered and reused alternately for irrigation, bathing and washing facilities (MCK), and fish ponds, while organic wastewater is utilized as nutrients before being returned to nature.

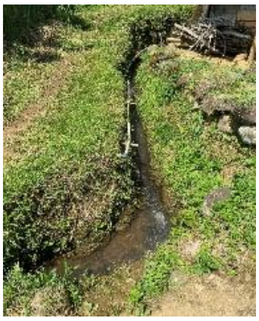

Figure 8. Drainage flow

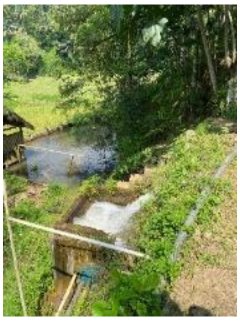

Figure 9. Irrigation flow

From an ethnochemical perspective, this water management system illustrates the integration of simple chemical knowledge into cultural traditions. One unique practice is the communal bathing facility built directly above fish ponds (for local fish cultivation). This design ensures that human waste enters the fish pond, where organic nutrients are used by fish for growth, simultaneously acting as the first biological filtration basin. Subsequently, a retention pond containing aquatic plants adds an additional layer of biological filtration before the water is discharged into the river.

The rivers flowing around Kampung Naga have maintained their ecological quality, with water still suitable for domestic and agricultural use. The community manages irrigation and water usage wisely, without disrupting the natural balance. In addition to serving as an irrigation source, the drainage channels around the settlement also function as a natural runoff management system, helping to prevent erosion and reduce the risk of harmful chemical compounds leaching into water bodies. This pattern demonstrates that the Kampung Naga community has developed a holistic and sustainable approach to water resource management that aligns with the principles of ecohydrology and environmental conservation.The principles of green chemistry related to water management in Kampung Naga include waste prevention, the use of renewable feedstocks, and design for degradation.

4. Waste Management and Local Fermentation

Waste management practices in Kampung Naga reflect an integration of local wisdom, environmental awareness, and traditional chemical knowledge, making them a concrete example of ethnochemistry in daily life. Most household waste consists of items such as used cooking oil plastic containers, food wrappers, vegetable scraps, animal bones, and broken glass. The community collectively manages this waste using bamboo-woven trash bins distributed throughout the village, and disposes of waste at designated burning areas.

Individual responsibility in regularly burning waste and participation in weekly communal clean-up activities (*Jumat Bersih*, or "Clean Friday") demonstrate the presence of strong social and spiritual values that reinforce environmentally friendly behavior.

A. Management of inorganic waste

One of the key aspects of environmental sustainability in Kampung Naga is how the community manages inorganic waste, particularly plastic waste and broken glass. Despite being located in a traditional environment far from modern waste management facilities, the Kampung Naga community demonstrates a systematic waste management pattern based on collective awareness. Plastic waste such as used cooking oil containers or food wrappers is typically burned in designated burning areas, while broken glass is separated and buried in specific locations to prevent harm to humans and animals.

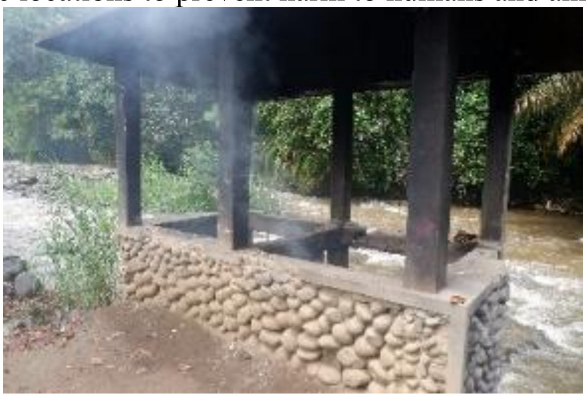

Figure 10. Public Waste Burning Area

Waste burning in Kampung Naga is conducted openly at communal incineration sites. This process produces emissions from waste combustion that contain gases such as carbon monoxide (CO) and methane (CH_4), which can potentially pollute the environment and pose negative health impacts (Napid et al., 2021). The combustion of plastic waste involves the burning of complex organic compounds composed of carbon- and hydrogen-based polymer chains. Common types of plastic such as polyethylene (PE) and polypropylene (PP) are widely used (Verma et al., 2016). In Kampung Naga, there is sufficient oxygen available to support combustion, with the general reaction as follows:

$$C_nH_n + 2O_2 \rightarrow 2CO + 2H_2O + \text{Heat}$$

Although air quality in Kampung Naga is generally very good and oxygen levels in the environment are relatively high, open burning of plastic still produces harmful compounds such as carbon monoxide (CO), soot (carbon particulates), and volatile organic compounds (VOCs), which have toxic potential (Napid et al., 2021). This is due to the incomplete combustion process caused by limited oxygen supply and unstable temperatures.

This practice reflects the community's limited access to more environmentally friendly waste treatment technologies. Although in principle, burning waste is not an ideal method for managing solid waste, the Kampung Naga community adopts this approach as an adaptive solution that aligns with local conditions—including resource availability and traditional values. This activity is carried out with continued consideration for environmental cleanliness and ecological balance, in line with long-standing environmental preservation practices passed down through generations.

B. Organic Waste Management Through Local Fermentation

In Kampung Naga, organic waste is managed through a simple yet effective approach based on local wisdom. Organic waste such as vegetable scraps, fruit peels, and animal bones is typically separated from inorganic waste. Some community members utilize this organic waste to make compost by placing it into soil pits or closed containers and allowing it to decompose naturally. The resulting compost is then reused as a natural fertilizer to support household farming and gardening.

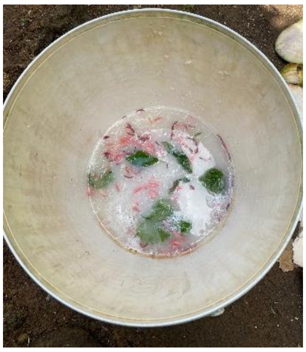

Figure 11. Microorganism Local (MOL)

The Kampung Naga community also independently produces a local microorganism solution (MOL), locally referred to as *empa*. This solution is made from naturally available materials such as coconut water, palm sap, rice-washing water, and organic kitchen waste. Coconut water and palm sap serve as sources of glucose, providing nutrients for bacterial growth. Rice-washing water also contributes glucose, while the bacterial sources are derived from leftover food waste (Rainiyati et al., 2019). The process of making *empa* involves anaerobic fermentation for approximately three months, allowing the growth of natural decomposer microorganisms. Once it reaches maturity, the solution is used to accelerate the decomposition of organic materials, resulting in natural fertilizer that enhances soil fertility.

Local Microorganisms (MOL) are fermentation-based liquid solutions made from various natural resources and can be used as liquid fertilizer. MOL not only contains essential macro and micronutrients but also harbors beneficial bacteria capable of breaking down organic matter, stimulating plant growth, and acting as biological agents for pest and disease control. Therefore, MOL can function as a decomposer, biofertilizer, and organic pesticide—particularly as a fungicide (Rainiyati et al., 2019). Although not scientifically formulated, the composting practices of the Kampung Naga community reflect local understanding of decomposition cycles and soil fertility. This knowledge is part of ethnochemistry. The community recognizes that food waste is not merely trash, but can be transformed into fertilizer that benefits their land. The relevant green chemistry principles include waste prevention, energy efficiency, the use of renewable feedstocks, and design for degradation.

5. Management of Traditional Cuisine and Agriculture in Kampung Naga

A. Angeun gembrung as a traditional dish from Kampung Naga

Angeun Gembrung is a traditional dish unique to Kampung Naga that not only holds significant cultural value but also offers potential for contextual chemistry learning. This dish is typically served during religious and customary events, such as the commemoration of the Prophet Muhammad's birthday (*Maulid Nabi*) and the eve of Eid al-Fitr or Eid al-Adha. Etymologically, the name "Angeun Gembrung" derives from *angeun*, meaning "vegetable soup," and *gembrung*, referring to a traditional musical instrument commonly used in religious ceremonies.

Figure 12. Angeun Gembrung

The preparation of Angeun Gembrung uses locally available natural ingredients such as torch ginger flower (*bunga kecombrang*), tempeh, coconut milk, and various spices (turmeric, candlenut, shallots, garlic, and chili). All ingredients are traditionally cooked using a clay stove (*hawu*), without the addition of synthetic additives such as preservatives or artificial coloring. The distinctive flavor and aroma arise from natural chemical reactions occurring during the heating process. The use of heated coconut milk can lead to partial hydrolysis of fats into fatty acids and glycerol, enhancing the flavor and texture of the soup (Su'i, Sumaryati, dan Yusron, 2017).

One of the key chemical reactions involved is the Maillard reaction. This reaction occurs through the interaction between aldehyde and ketone compounds, originating from the wood smoke produced by the *hawu* (clay stove), and glucose from the food, facilitated by heat, resulting in the development of brown color and a savory flavor (Kanya et al., 2023). The process of cooking *Angeun Gembrung* by the Kampung Naga community represents the application of green chemistry principles in everyday life. All ingredients are naturally sourced and free from synthetic additives such as monosodium glutamate (MSG), artificial colorants, or chemical preservatives. The cooking technique is simple, boiling the ingredients using a *hawu* (wood-fired clay stove), which reflects energy efficiency through the use of locally available and renewable resources.

B. Agricultural System in Kampung Naga

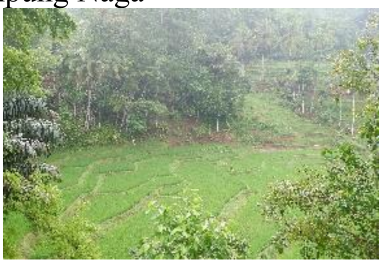

Figure 13. Kampung Naga Rice Fields

The agricultural practices of the Kampung Naga community represent a form of local wisdom that is closely integrated with cultural and environmental values. Farming is not limited to planting and harvesting rice, but also reflects a value system that emphasizes ecological balance and social cooperation. Land preparation is carried out collectively (*gotong royong*) by all residents approximately two months before the planting season, typically in July and January. The fields are thoroughly cleared to reduce pest populations such as rats, without the use of chemical pesticides. Seed selection is performed using a soaking method that lasts two days and two nights. Low-quality seeds float, while viable seeds sink and are selected for planting. This is a simple selection method based on seed density differences. After soaking, the seeds are dried for two nights to stabilize their moisture content, then sown in seedbeds for 15 days.The fertilizer used is a combination of inorganic fertilizers (such as Phonska and urea) and homemade organic fertilizers derived from sheep manure and household food waste.

The organic fertilizer is fermented using local microorganism solutions (MOL) produced independently by the community. During harvest season, agricultural waste such as rice straw is not burned. Instead, the straw is placed along the edges of the rice fields and allowed to decompose naturally through the activity of soil microorganisms. During the decomposition process, complex compounds such as cellulose are broken down into simpler compounds like glucose, which can be reused by plants. The decomposition products form humus, which improves soil structure and enhances its water retention capacity and nutrient content (Ratih et al., 2020).

The post-harvest process is also carried out naturally and efficiently. The harvested rice grains (*gabah*) are dried on woven bamboo trays using sunlight. This drying method helps prevent excess moisture that could lead to mold growth or crop spoilage (Panggabean et al., 2017).Without the use of chemical additives, properly dried and stored rice can last for up to three planting seasons. This reflects the food security of the Kampung Naga community, which is rooted in time-tested traditional practices.

Traditional agricultural practices in Kampung Naga demonstrate the application of ethnochemistry—an integration of chemical knowledge with culturally embedded local wisdom passed down through generations. The community intuitively utilizes biological reactions and natural processes, such as fermentation, decomposition, and density-based selection, in managing agriculture without relying on synthetic chemicals. All of these activities align with the principles of green chemistry, including waste prevention through non-burning straw management, the use of safe and renewable natural materials, energy efficiency through simple tools, and the use of microorganisms as biological catalysts in fertilizer fermentation. This demonstrates that local practices rooted in traditional wisdom can serve as sustainable models for education and the application of modern chemical science.

CONCLUSION AND RECOMMENDATIONS

The local wisdom of Kampung Naga encompasses ethnochemical practices that are relevant to chemical concepts. These practices align with the principles of green chemistry, particularly in waste reduction, the use of renewable materials, and energy efficiency. Although challenges remain, such as the open burning of plastic, which poses pollution risks the community's approach to maintaining harmony with nature offers a strong framework for developing chemistry education based on ethnoscience. By presenting this in the form of an e-book, its potential can be harnessed as a contextual learning resource that enhances chemical literacy, environmental awareness, and cultural preservation in education. An interactive e-book enables students to grasp chemical concepts through cultural experiences that are closely tied to their daily lives, thereby fostering scientific literacy, environmental consciousness, and appreciation for cultural heritage. Future studies may broaden the scope of the research by implementing ethnoscience-based teaching materials or e-books in other indigenous or local cultural communities, as well as across different educational levels.

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