



Mental Model-Based Ethnochemistry Approach: Local Wisdom on the Utilization of "Penbrike" Leaves in the Context of Postpartum Health in the Indigenous People of the Byak Tribe of Yendidori Village, Papua

Albaiti Albaiti^{1*}, Lusia Narsia Amsad¹, Monika Gultom², Frans Demingus¹, Paulus Laratmase³, Tresya Yobi¹, Celine Dion Ayu Naema¹

¹Chemistry Education Study Program, Universitas Cenderawasih, Jayapura, Papua, Indonesia.

²English Language Education Study Program, Universitas Cenderawasih Jayapura, Papua, Indonesia.

³Biak Nursing Study Program, Politeknik Kesehatan Kementerian Kesehatan RI Jayapura, Papua, Indonesia.

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Corresponding Author*:

Albaiti

albaiti@fkip.uncen.ac.id

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Abstract: The local wisdom of the indigenous people of the Byak tribe of Kampung Yendidori in utilizing the leaves of red hibiscus (the local name of the leaves "Penbrike") as an herb for mothers after childbirth shows rich empirical knowledge and is relevant to modern chemical concepts. This research aims to integrate an ethnographic perspective based on a mental model in describing the cultural significance of this practice and explaining the content of active compounds in these plants through macroscopic, submicroscopic, and symbolic level approaches. This type of research is qualitative with an ethnographic approach based on mental models. The results obtained show the sacredness of the use of "Penbrike" leaves. The community believes that treatment is effective if it is carried out by the clan or the person appointed to inherit its use. The results of a literature review show that the main content in its leaves is alkaloids, tannins, flavonoids, steroids, saponins, phenols, proanthocyanidins. The active compounds in this plant function as powerful antioxidants that help reduce oxidative stress and postpartum inflammation, some accelerate hemostasis and wound recovery, and some provide vasoconstriction and protein binding effects and help stop bleeding. However, based on the results of other literature reviews, it was found that hibiscus leaves contain anti-fertility compounds, so further research is needed. These studies can serve as a basis for the development of ethnoscience-based chemistry learning models and further research on ethnopharmaceuticals.

Keywords: Byak Tribe Kampung Yendidori; Ethnochemistry; Mental models; Penbrike leaves; Postpartum maternal health

Introduction

Papua is a region that is very rich in cultural, ethnic and natural resource diversity. The indigenous Papuan people who are spread across various regions hold a lot of local knowledge and traditional wisdom that is an

integral part of their daily lives. However, scientific exploration and documentation of these various forms of local knowledge is still very limited, especially in the field of chemistry. One of the branches of science that is relevant to exploring and understanding local knowledge is ethnochemistry, which is the study of

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chemical concepts contained in the cultural practices, traditions, and local knowledge of indigenous peoples, which are inherited from generation to generation through empirical experience and are not always formally documented. Chemistry as part of the natural sciences has a strategic position in explaining natural phenomena, both through empirical and theoretical approaches. However, chemistry learning in Indonesia is often still abstract, non-contextual, and far from the real experience of students, especially those from areas with high local cultural richness such as Papua. Ethnochemical studies is one of the approaches that can bridge the gap between modern chemical concepts and local experiences.

The indigenous people of the Byak tribe of Kampung Yendidori in Biak Numfor Regency, Papua have a unique culture that is rich in traditional practices such as the use of medicinal plants. This local knowledge is tacit knowledge, which is knowledge that is possessed intuitively and inherited from generation to generation through the process of socialization without written documentation (Gultom et al., 2023). As a result, this valuable knowledge is at risk of extinction along with rapid socio-economic changes and the penetration of modernization and globalization. In this context, it is important to conduct in-depth exploratory research to document and scientifically understand how the indigenous people of the Byak tribe of Kampung Yendidori build local knowledge of chemistry through their traditions and daily lives. This research is designed to explore specifically how mental models are formed and used by society in an ethnochemical context.

The study of mental models allows researchers to understand how societies organize, arrange, and mentally represent chemical concepts to explain phenomena in their surroundings that are often unaware that their traditions or customs contain chemical content. A mental model is an idea that represents a person's thoughts, an internal representation constructed by a person, including a visual-pictorial component and a propositional component for understanding or to provide a rational explanation of a phenomenon (Greca & Moreira, 2002; Schnotz & Bannert, 2003). Scientists or cognitive experts state that mental models describe a person's conception of the world (Wang & Barrow, 2011). A person's mental representation can be symbolic, narrative, and analogous (Fazio et al., 2013; Schwedler & Kaldewey, 2020). The operational definition of ethnochemistry in this study is an interdisciplinary study that explores chemical concepts contained in indigenous peoples' cultural practices, such as the extraction of medicinal materials, which are represented in the form of local wisdom and hereditary traditions. Meanwhile, the

mental model is an individual or group's internal representation of the surrounding environment or scientific phenomenon based on cultural backgrounds, experiences, and social interactions; It can be symbolic, narrative, or analogous, influencing the way chemical concepts are understood and explained locally.

Several research results examining the use of medicinal plants and natural dyes by the Byak tribe have been conducted (Mahmud & Wahyudi, 2014; Simaremare et al., 2019). Medicinal plants are an inseparable part of the traditional medicine practices of the Indonesian people, especially the Byak tribe of Yendidori Village. Based on the results of preliminary studies, one of the plants that is widely used by the local people of Yendidori Village is the red hibiscus leaf (*Hibiscus rosa-sinensis* L.), which is known to have properties for postpartum recovery and is known by indigenous people as "Penbrike". Although this practice is based on oral traditions, its utilization can be scientifically studied through an ethnochemical approach based on mental models, by integrating chemical concepts and local cultural knowledge. Recent studies confirm that *Hibiscus rosa-sinensis* contains bioactive compounds that support its role as a medicinal plant (Dowara et al., 2024; Bala et al., 2022; Hagaggi et al., 2025). The traditional medicine practice of the Byak Tribe of Yendidori Village unknowingly contains chemical concepts that can be explained scientifically and has great potential to be raised in the context of chemistry learning. However, until now there has been no research that explicitly examines these chemical concepts through a mental model approach, which is the way individuals understand and represent scientific concepts based on their experiences and culture, specifically the traditional medicine traditions of the Byak tribe of Kampung Yendidori (Salillas et al., 2022; Ulum et al., 2020).

Recent studies on ethnochemistry based on mental models are still very limited. Previous research has generally separated ethnochemical studies from mental model studies (Siregar & Kurniawati, 2022; Albaiti et al., 2017). Several research results on ethnochemistry in chemistry learning have been reported, including the local wisdom of the Sasak and Javanese tribes, the Ngejot tradition, the local wisdom of Samawa, the local wisdom of Brebes Central Java, the local wisdom of Papua and Semarang Batik. The study of mental models is usually applied in the context of formal education or the process of teaching science as well as laboratory studies (Wahyudiati, 2022; Sanadheera et al., 2021). Meanwhile, the results of research on Papuan local wisdom are related to the use of plants for traditional medicine of the five Papuan tribes itch leaves ethnobotany noken ethnotechnology traditional games

of kampong Yahim Sentani, and ethnoconservation (Bongers et al., 2020; Wardah & Wiyarsi, 2020). Therefore, the integration of ethnochemistry and mental models in the context of the indigenous people of the Byak tribe of Kampung Yendidori, is a very relevant innovation.

Through this research, it is hoped that an in-depth picture will be obtained of the indigenous peoples' perspective on chemistry from their own local perspective. The results of the research are also expected to make a significant contribution to developing contextual and culturally sensitive chemistry learning methods in Papua, as well as being part of efforts to preserve the valuable local wisdom of indigenous peoples. The objectives of this research are to explore and reflect on the cultural meaning based on mental models and the process of inheriting knowledge in the traditional medicine practice of "Penbrike" leaves; Describe the benefits of the active compounds contained in the leaves of "Penbrike" using a three-level approach of chemical representation.

Method

This type of research is qualitative with an ethnographic approach based on mental models. This study uses two main theoretical approaches. First, a three-level framework of chemical representation (macroscopic, submicroscopic, symbolic) developed by Johstone (Wang et al., 2022) and developed in an educational context by Mekwong & Chamrat (2021). Second, an ethnographic approach based on mental models as part of a qualitative methodology used to understand cultural phenomena in depth. The data collection technique included in-depth interviews, with 8 key informants such as village medicine practitioners, mothers who had used herbs, village people, health center nurses, religious leaders, community leaders, and traditional leaders. Documentation is in the form of recording the process of making herbs and photos of red hibiscus leaves. Literature review, to identify the content of active chemical compounds through previous studies and cultural literature reviews on color symbolism. The data obtained was analyzed thematically through the stages of data reduction, data presentation, and conclusion drawn. Chemical representations are described in stages based on macroscopic, submicroscopic, and symbolic structures. Qualitative data from interviews and documentation were analyzed with an interpretive approach to explore the cultural meanings behind the use of these plants.

Results and Discussion

Ethnographic Approach Based on Mental Model of the Utilization of "Penbrike" Leaves in the Context of Postpartum Health

Yendidori Village is a village located in Yendidori District, Biak Numfor Regency, 20 km to the west and can be reached in approximately 20 minutes. Based on the story of the people in Yendidori village, there is a mother named SA who has expertise in using traditional plants that have been entrusted from generation to generation since their ancestors and can only be inherited to one of the descendants of certain clans and should not be told to anyone to know the benefits of leaves which are believed to have medicinal properties, especially for a mother who after giving birth experiences health conditions. The villagers of Yendidori are very heterogeneous. According to Mrs. TW, neighboring villages used to come from Yendidori village, but since the presence of the plywood company, the villagers began to settle outside the village and gradually formed new villages. The presence of the company has an impact on most migrant workers who come to live and live in Yendidori village.

Various issues related to the benefits of the hibiscus flower in curing various diseases experienced by humans have been researched by various experts, including indigenous peoples in various regions in Papua who have used it for generations since ancient times. One of them is in "Yendidori Village" in Yendidori District, Biak Numfor Regency about the benefits of red hibiscus leaves that can restore maternal health after childbirth. The information obtained in Yendidori village was both from AM informants (Nurses) at the Yendidori Health Center, LM (housewives), WA (Papua Bank Employees), ZM (Religious/Traditional Leaders), CR (Housewives), MM (Traditional Leaders), AA (Traditional Leaders, Community Leaders), and SA (practitioners of traditional medicine of red hibiscus leaves).

Through 6 informants, it was found that Mrs. SA (66 years old) from one of the certain "keret" or "clans" in Yendidori Village was entrusted to pass on the benefits of "Red Hibiscus Leaves" for the recovery of maternal health after childbirth. "The leaves in question are red hibiscus leaves (*Hibiscus rosa-sinensis* L.) which was always planted in the yard by their ancestors. However, the benefits of the flower leaves should not be told to others. One will see another benefit of hibiscus leaf flower which is its beautiful petals and attractive because it is colorful. But the benefits of the leaves for health people don't know it. The local wisdom of the Byak Indigenous People (read: Biak), especially the people in Yendidori village, is believed to be hereditary

by the clan or keret (in the term of the Byak tribe) that the use of *Hibiscus rosa sinensis L leaves*. or "Penbrike" in Byak language is believed to be beneficial for a postpartum mother.

The people of Yendidori village, which were revealed from the statements of the seven informants (AM, LM, WA, ZM, CR, MM, and AA) believed that the use of "Penbrike" leaves could only be effective if the leaf extract of "Penbrike" was concocted by a mother named SA who was passed down from generation to generation through her. This means that there are many families or descendants of the clan or keret, but only Mrs. SA is entrusted to continue the tradition of local wisdom in the use of "Penbrike" leaves. The utilization of the leaves of "Penbrike" should not be entrusted to others. In this information, there is a sacredness of the use of "Penbrike" leaves, meaning that outside the clan or the person appointed to inherit its use, it is not effective.

The results of the interview with SA's mother showed that a number of hibiscus flower leaves were picked. Not all types of hibiscus flowers have efficacy except for those whose flowers are red and grow in rocky areas. The leaves of "Penbrike" are taken and washed by hand until they are crushed then wrapped in a cloth mixed with one glass of aqua water, squeezed until they are green all that is visible and ready to be drunk by the mother who asks for it. This herb after being taken three to four times every day, has an impact on the disease process in the mother's stomach will be cleaned through the extract in such a way that a mother will experience "dragging" and over time will disappear on its own. At that time, the cleanliness or vertilization of the mother will facilitate fertilization in the following month.

SA's mother said that the impact of the cleanliness of the mother's stomach who has just given birth, the

mother's milk will be healthier for the baby and the mother's health is guaranteed. Mrs. SA's explanation that the mucus from hibiscus leaf extract smooths out all the dirt in the stomach of the newly born mother and the elimination process will be smooth on its own. The evidence of the impact of the potion made by Mrs. SA received recognition from everyone in Yendidori village and even the surrounding villages revealed by the seven informants. Mrs. SA's ability to remember the number of people who come for treatment is described globally, not only from the village of Yendidori, but the non-Papuan community has also benefited more from the leaves of "Penbrike". Information about Mrs. SA through midwives and nurses at regional public hospitals and health centers, that many gave recommendations to meet Mrs. SA in the use of "Penbrike" leaves and succeeded.



Figure 1. "Penbrike" (Red Hibiscus)

The findings obtained from the results of interviews with the eight respondents are as follows.

Table 1. Findings from the interview results

Aspects	Findings
How to acquire knowledge about the use of red hibiscus leaf herbs for postpartum maternal health and how to reduce it between generations in society	The use of hibiscus flower leaves known in the Biak language "Penbrike" should not be entrusted to others. The leaf extract "Penbrike" was concocted by a mother named SA who was passed down from generation to generation orally through her. There are many families or descendants of the clan or keret, but only Mrs. SA is entrusted to continue this tradition of local wisdom. There is a sacredness in the use of "Penbrike" leaves, meaning that outside the clan or the person appointed to inherit its use, it is not effective.
Key concepts that appear in the traditional medicine of red hibiscus leaves	The chemical concept that emerged in this traditional medicine is natural extraction by washing the leaves, mashing, and squeezing in a container using a cloth, filtered, then the water is put in an aqua bottle containing 1/4 liter of water until a green, slightly slimy liquid is obtained and given to the new mother.
Mental representation	Symbolic representation: hibiscus flower leaves that are believed to have healing properties are those whose flowers are red and grow in rocky areas. Narrative representation: knowledge is passed down from generation to generation through selected generations by showing how to make medicinal herbs. Analogous representation: red hibiscus leaf extract water is green and slimy so that it helps the cleansing process in the mother's stomach (cleansing dirty blood) after childbirth. The

Aspects	Findings
Cultural factors that play a role	mucus from hibiscus leaf extract smooths out all the dirt in the stomach of the newborn mother and the removal process will be smooth on its own. Supporting factors: medical knowledge is only allowed to certain clans that are selected through the story of how to make medicinal herbs from generation to generation. All villagers believe in the efficacy or efficacy of the medicine carried out by the clan. Inhibiting factor: the advancement of science and technology has an impact on the mindset of this clan generation that does not yet have an interest in continuing the traditional healing of the family from generation to generation.

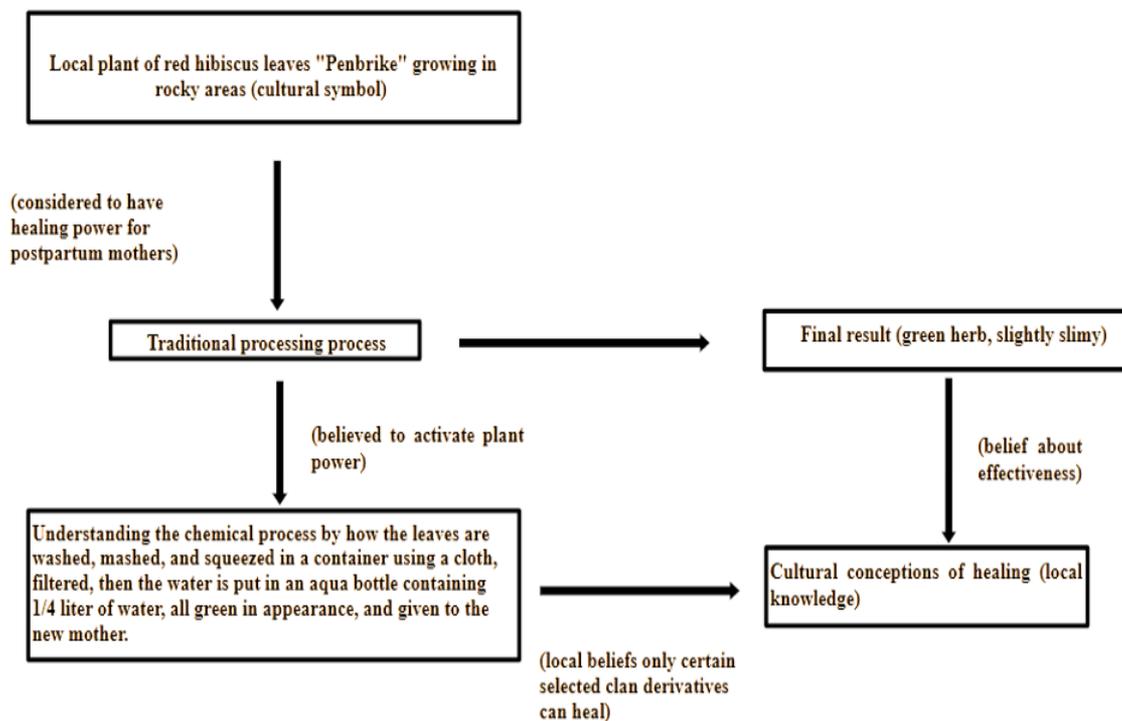


Figure 2. Mapping of the mental model of society

From the results of the interview, a mapping of the mental model of the people of Yendidori village about the traditional treatment of red hibiscus leaves was made presented in Figure 2.

Macroscopic, Submicroscopic, and Symbolic Approaches Explain the Chemical Benefits of "Penbrike" Leaf Extract (Red Hibiscus Leaves) that Support Postpartum Maternal Recovery

The macroscopic approach describes what can be seen, felt, and perceived by the senses. In the context, the local wisdom of the use of the traditional herb "Penbrike" leaves can be described as the activity of traditional medicine practitioners (Mrs. SA) squeezing the leaves of hibiscus flowers to produce a green liquid and the mother who consumes it feels lighter, breast milk is smooth, and the stomach feels clean is an explanation of the macroscopic level. Facts at the macroscopic level can be explained scientifically using submicroscopic and symbolic approaches. The explanation at the submicroscopic level has to do with

the benefits of the active compounds contained in the leaf extract "Penbrike" that support macroscopic facts. The results of the study by Luviani et al. (2021) and Simanjuntak et al. (2025) state that the leaves of red hibiscus (*Hibiscus rosa-sinensis L.*) (the leaves of "Penbrike") contain antioxidant and antibacterial compounds. Antioxidants are compounds that neutralize free radicals in our body and protect cells and tissues from the adverse effects of oxidative stress. The main contents in its leaves are alkaloids, tannins, flavonoids, steroids, saponins, phenols, proanthocyanidins. Flavonoids & phenolic compounds function as powerful antioxidants that help reduce oxidative stress and postpartum inflammation. Tannins and flavonoids have vasoconstrictor properties, accelerating hemostasis and wound recovery.

The tannins and flavonoids in the leaves provide vasoconstriction and protein binding effects, helping to stop bleeding (Labu et al., 2025; Akesson-Nilsson & Adbo, 2024). In-vitro in uterine guinea pigs showed leaf extract providing significant contractions, possibly

through oxytocin stimulation. It supports placental excretion and uterine recovery (Ahmadi et al., 2025; Binder et al., 2016). Saponins can damage the lipid membranes of microorganisms, making them effective against Gram-positive bacteria and some viruses (Hernandez et al., 2021; Yoshihara et al., 2023). Saponins can stimulate the production of antibodies and increase the phagocytic activity of macrophages as well as lymphocytes (as immunostimulants, boosting the immune system) (Cao et al., 2025; Trivadila et al., 2025). Furthermore, symbolic representations in chemistry are used to describe the molecular structure of the content of active compounds present in red hibiscus leaves (Vijayaram et al., 2024; Awad, 2025). Tannins and saponins have complex structures that are not represented by a single formula. The following is a picture of the formula for the structure of the compounds contained in the leaves of red hibiscus, the leaves of "Penbrike":

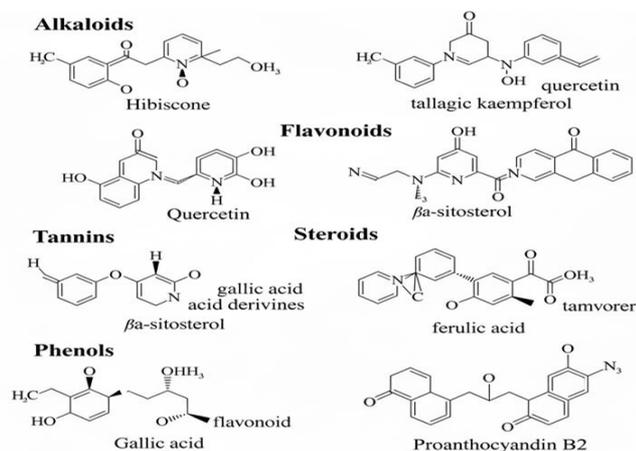


Figure 3. Picture of the structure of the compounds in the leaves of "Penbrike" (Red Hibiscus leaves)

People interpret red hibiscus leaves not only as a medicinal plant but also as a symbol of postpartum recovery. Color in cultural anthropology is often understood as a symbolic language that represents the values, emotions, and social structure of a society (Lavrenova, 2023; Tazegul & Ayanovna, 2020; Jonauskaitė et al., 2020), emphasized that cultural symbols serve to mediate between the empirical world and the system of social meaning. The color red is associated with blood and vitality (Jue & Ha, 2022; Wu et al., 2018). The color red in many cultural traditions is often associated with blood. The Biak ethnic group recognizes red as an icon of bravery (mambri-ness). In Asmat's view, blood symbolizes the source of life, vital energy, and a bond with ancestors. The knowledge of traditional medicine of red hibiscus leaves is passed down through oral and practice, with the important role of certain clans or keret from the female line (Riaz &

Chopra, 2018). On the other hand, based on the results of other literature reviews, hibiscus leaves contain anti-fertility compounds (Daniyal & Akram, 2015). Therefore, there is a need for a more in-depth study (pre-clinical and clinical trials) related to this traditional herb so that the right dosage is obtained and prevents other effects from the use of this traditional medicinal herb, such as anti-fertility. The use of medicinal plants is sometimes not optimal because it is only consumed fresh, has not been standardized, and has not been tested pre-clinically and clinically, so further technology and research are needed to maximize its utilization.

Conclusion

The practice of the Byak indigenous people of Yendidori Village in a chemical and cultural perspective to use red hibiscus leaf extract, also known as "Penbrike" leaves, has a strong scientific basis. The ethnographic approach allows for a thorough understanding of cultural values, while the macroscopic-submicroscopic-symbolic approach helps science bridge local knowledge. These studies can serve as a basis for the development of ethnoscience-based chemistry learning models and further research on ethnopharmaceuticals.

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Author Contributions

Conceptualization, writing—review and editing, A.; methodology, visualization, L.N.A.; validation, M.G.; formal analysis, F.D.; investigation, resources, P.L.; data curation, T.Y.; writing—original draft preparation, C.D.A.N. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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