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Research Article

An Ethnopharmacological Study of Medicinal Plants in the Buffer Zone and Its Implication to the Conservation of Giam Siak Kecil-Bukit Batu Biosphere Reserve

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ABSTRACT

Local knowledge about natural resources is increasingly crucial in formulating conservation strategies and activities. This study collects data regarding medicinal plant use from Sepahat and Tamiang village residents. A total of 100 participants were included in the study, consisting of 50 participants from the Sepahat and another 50 from the Tamiang. Respondents were selected using the Snowball sampling technique, which involved identifying a key individual, such as local leaders, to initiate recruitment of other respondents. The study's findings indicate that the inhabitants of Sepahat village utilize 36 plant species belonging to 24 families, while Tamiang villagers use 11 plant species belonging to eight families. In Sepahat village, the botanical components used for medication comprise 25% rhizomes, 8% bark, 22% fruit, 3% shoots, 34% leaves, and 8% stems. In contrast, Tamiang comprises 23% rhizomes, 16% bark, 15% fruit, and 46% leaves. The utilization of stems and bark has the potential to pose a threat to sustainability. Among various uses, it has been observed that approximately 33% in Sepahat and 27% in Tamiang can lead to plant mortality. Conservation initiatives have been undertaken for 71% of Sepahat and 67% of the utilized plant species in Taminag. Traditional medicines have been used for generations to treat various health conditions, such as back pain, bleeding, controlling cholesterol, coughs, dengue fever, and diabetes. While current use might not threaten the biosphere reserve, villagers must embrace sustainable harvesting techniques, including selective harvesting, replanting, and establishing community nurseries dedicated to cultivating medicinal plants

Key words: biosphere reserve, ethnopharmacological, Giam Siak Kecil-Bukit Batu, local knowledge, medicinal plant

INTRODUCTION

Ethnopharmacology is the academic discipline studying the cultural significance of traditional medicine (Leonti & Casu, 2013). It involves investigating therapeutic plants and how different civilizations use them. Ethnopharmacology research has the potential to provide valuable insights into traditional practices and beliefs concerning health and healing. Various ethnic or cultural groups have utilized traditional medicines for centuries, and many of these remedies effectively treat multiple ailments. Ayurveda, Kampo, and Jamu are just a few of the ancient medical systems practiced for millennia in India, Japan, and Indonesia, respectively (Zaki *et al*., 2019).

The study of ethnopharmacology is crucial because it facilitates the development of new medications and therapies for a wide range of diseases. Ethnopharmacological studies can assist in identifying the active compounds in these remedies and provide a scientific foundation for their application in contemporary medicine for cost-effective, safe, and efficacious pharmaceuticals (Pirintsos *et al*., 2022).

An extensive array of medicinal plant species inhabits our natural environment. Throughout history, people all around the globe have relied on plants to help them stay healthy and disease-free (Zaki *et al*., 2019). These medicinal plants are easily accessible, hold substantial cultural significance in traditional medicines, and serve as the foundation of an accessible and affordable healthcare regime and a vital source of income for indigenous and rural populations (Suzuki *et al*., 2016).

Commonly, indigenous people have used medicinal herbs for millennia and have evolved sustainable practices for these plants (Marcelino *et al*., 2023). They understand plant medicinal properties and habitats, allowing them to harness these resources efficiently and sustainably.

While indigenous people have developed sustainable practices for the use of medicinal plants, there are instances of unsustainable harvesting practices that threaten the survival of these plants. The International Union for Conservation of Nature estimated that between 50,000 and 80,000 species of flowering plants are

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utilized for medicinal purposes across the globe. Globally, approximately 15,000 species of medicinal plants may be threatened with extinction. Experts estimate that at least one potentially important drug is lost every two years (Roberson 2008). In Indonesia, a total of 5,490 medicinal plant species were identified, of which 233 are a priority for conservation (Cahyaningsih *et al*., 2021)

Since many medicinal plants are harvested from the wild, concerns over the sustainability and conservation of these species are growing. Sepahat and Tamiang villages are the two settlements closest to the Giam Siak Kecil-Bukit Batu Biosphere Reserve (GSKBB-BR) (Simanjuntak *et al*., 2021). It is essential to look at how people in biosphere areas use forest resources, especially medicinal plant species, to ensure that conservation strategies are carried out effectively. Simanjuntak *et al*. (2021) also stated that the local communities around this biosphere reserve still utilize biodiversity, including medicinal plants, to meet their daily needs based on their traditional knowledge.

This study aimed to comprehensively inventory the plant species used in traditional medicine by the local community of Sepahat and Tamiang villages to identify further the most commonly used medicinal plants, their preparation and serving methods, and their therapeutic properties. Finally, the study aimed to determine whether these villages use medicinal plants sustainably and evaluate the potential implications of such utilization on the overall conservation of biosphere resources.

MATERIALS AND METHODS

Characteristics of the Study Site

The study was conducted from February to April 2020 in Sepahat and Temiang villages, two rural settlements in the Bandar Laksamana District, Bengkalis Regency of the Riau Province, Indonesia (Figure 1). Most of the inhabitants residing in these rural areas are of the Malay tribe (Titisari *et al*., 2016), while the Javanese, Batak, and Minangkabau ethnic groups constitute a significant portion of the population (Suzuki *et al*., 2016). While the predominant religious affiliation of the local population is Islam, a minority of individuals adhere to Christianity, Protestantism, Buddhism, and Hinduism. The predominant economic activities in the region are centered around agriculture, specifically rubber cultivation, oil palm cultivation, rice production, and fisheries. The native Malays primarily engage in rubber cultivation and fishing, while the Batak and Javanese

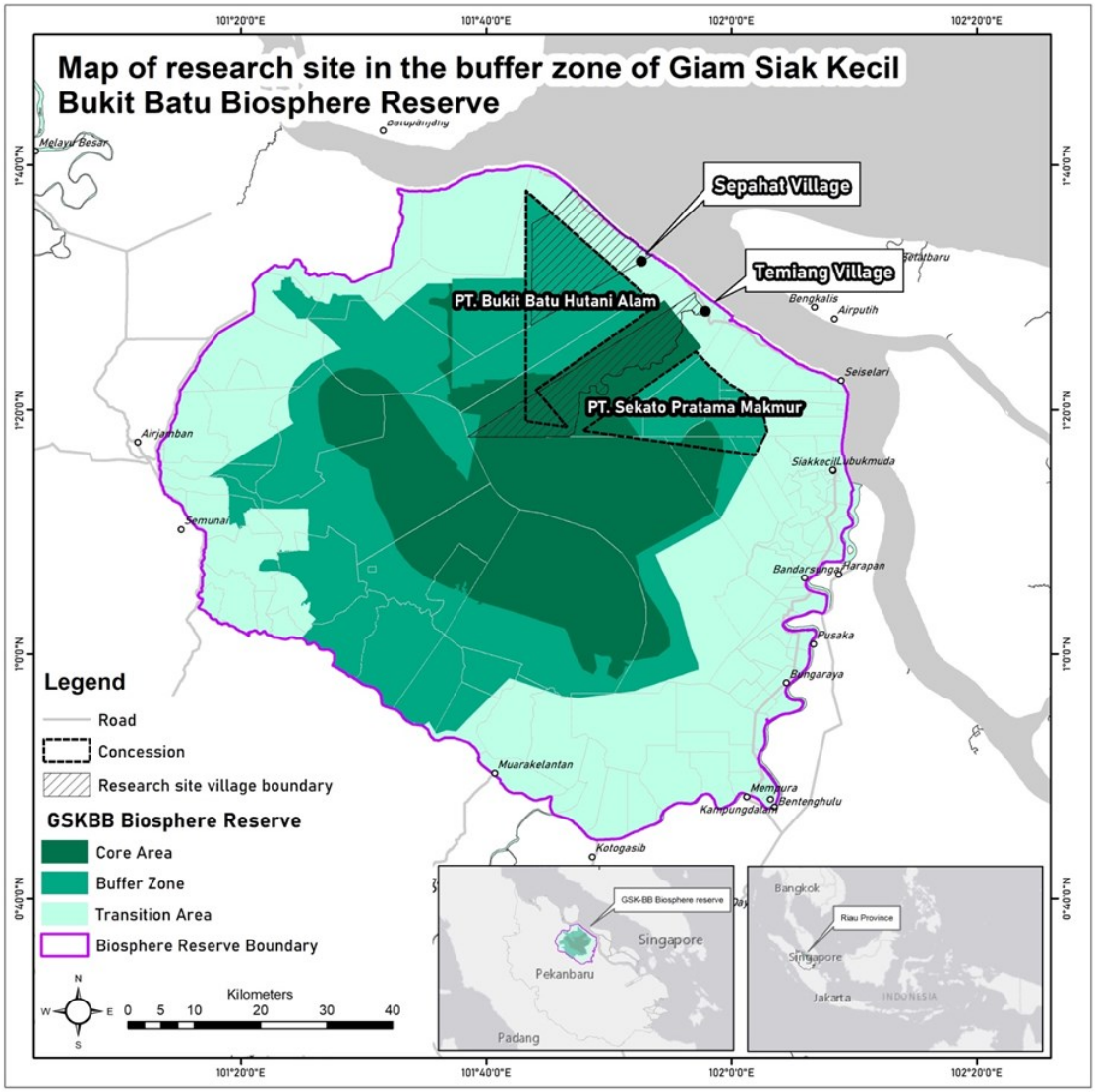

Figure 1. Map of research site in the GSKBB Biosphere Reserve buffer zone, Sumatra, Indonesia.

communities, who have migrated to the area more recently, are primarily involved in oil palm cultivation (Pramana, 2012; Afrizal, 2020; Gevisioner *et al*., 2020; Simanjuntak *et al*., 2021).

The selection of the two villages was based on two main factors. First, the two villages are in the buffer zone of the Giam Siak Kecil-Bukit Batu Biosphere Reserve (Partomihardjo *et al*., 2011). Secondly, the villagers engage in various activities within the buffer and transition zones of the Giam Siak Kecil-Bukit Batu Biosphere Reserve. Many people continue to use biodiversity to meet their daily requirements through traditional means such as climbing "sialang" trees to obtain forest honey, fishing with "bubu" or "lukah," and many other activities related to their daily needs (Juliarti, 2013; Simanjuntak *et al*., 2021). The potential impact of medicinal plant utilization on the biosphere reserve is a matter of concern.

The Giam Siak Kecil-Bukit Batu Biosphere Reserve encompasses significant peat swamp forest ecosystems and several smaller lakes. The biosphere reserve exhibits substantial biological diversity, encompassing various ecosystems, habitats, and species. Notable examples include many plant species and a diverse range of large animals, freshwater fish, birds, reptiles, and amphibians (Partomihardjo *et al*., 2011).

According to Zulkarnaini *et al*. (2022) and Priatna (2023), the Giam Siak Kecil-Bukit Batu Biosphere Reserve encompasses a combined land area of roughly 705,000 hectares, encompassing terrestrial, coastal, and marine ecosystems. The biosphere reserve is partitioned into three distinct zones: the core, buffer, and transition zones. The central region encompasses a combined land area of 179,000 hectares, comprising two distinct wildlife reserves, namely Giam Siak Kecil and Bukit Batu. The buffer zone has 222,000 hectares, comprising industrial forest plantations and other production forests. In contrast, the transition region spans 304,000 hectares, encompassing estate-crop plantations, agricultural activities, community settlements, and plantation forests.

We conducted structured interviews with selected respondents. Respondents were selected using the Snowball sampling technique (Naderifar *et al*., 2017), which involved identifying key individuals, such as local leaders, to recruit other respondents. The target interviewees also included villagers with significant knowledge of medicinal plants. The direction of the previous respondents determines the subsequent respondents.

Before initiating the interview regarding the medicinal plant, pertinent information regarding the respondent was collected, encompassing the length of time they had stayed in the village, their age, level of education, proximity to the nearest forest, and employment. The data was used to capture the characteristics of villagers.

Each respondent was interviewed with guided questions using a written questionnaire. The duration of the interviews ranged from 45 minutes to one hour. During the interviews, we documented information about the medicinal plant's usage, the specific part of the plant that is employed, the technique of preparation, the route of administration, the plant's habitat, its growth form (such as tree, shrub, herb, epiphyte, vine, or grass), and its vernacular name. Plant parts used are important information because they relate to the species' survival and conservation. Plant species harvested destructively- either by removing the rooting parts (root, rhizome, or tuber), bark, or harvesting the entire plant- were recorded.

RESULTS AND DISCUSSION

Characteristic of Respondent

Our study involved a sample size of 100 participants, with an equal distribution of 50 respondents from the Sepahat and Temiang villages. These individuals were selected to participate in structured interviews as part of our research methodology. A considerable proportion of the village's population has resided there for a prolonged duration, as indicated by the average length of their residency. As explained in Figure 2, most of the local community has maintained residency for over three decades. The results of this survey strengthen the argument of Simanjuntak *et al*. (2021), who state that knowledge about medicinal plants and their use in the Sepahat and Temiang village communities has been transferred down from their parents for generations.

The study sample consisted of individuals from a wide range of age groups, ranging from 18 to 70 years. Most participants were aged 30 years and above, as described in Figure 3. The study primarily focuses on the demographic of individuals within the productive age range, as they constitute the target of the study owing to actively looking for a living.

Most survey respondents had a senior high school or lower-level certificate as an educational achievement. Conversely, the percentage of people who had finished secondary level. To pursue a higher level of education,

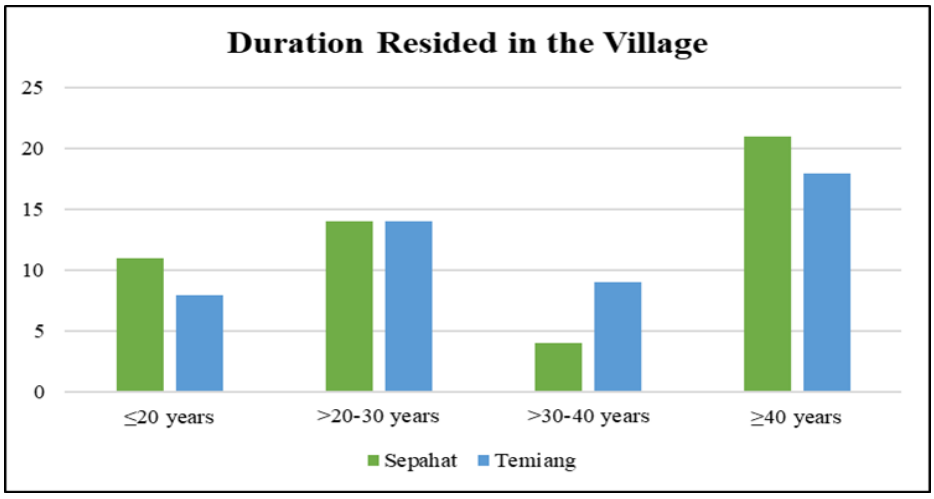

Figure 2. Duration of residence of the respondent in the villages of Sepahat and Temiang.

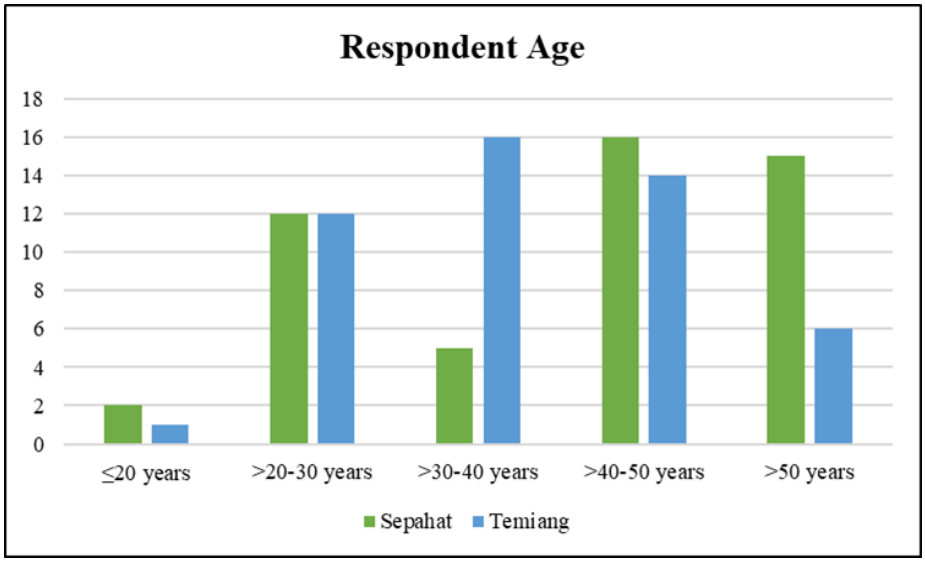

Figure 3. The age of respondents from Sepahat and Temiang villages.

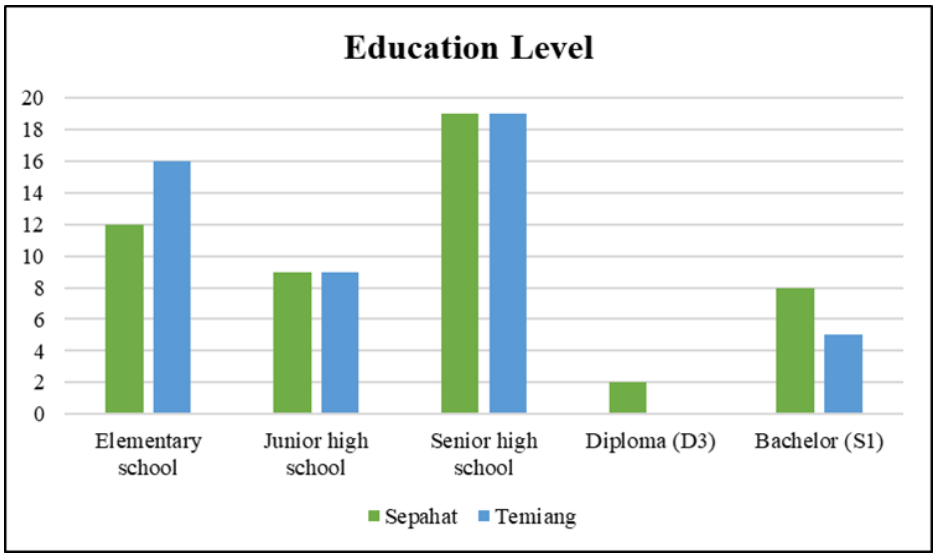

Figure 4. Education level of the respondents from Sepahat and Temiang villages

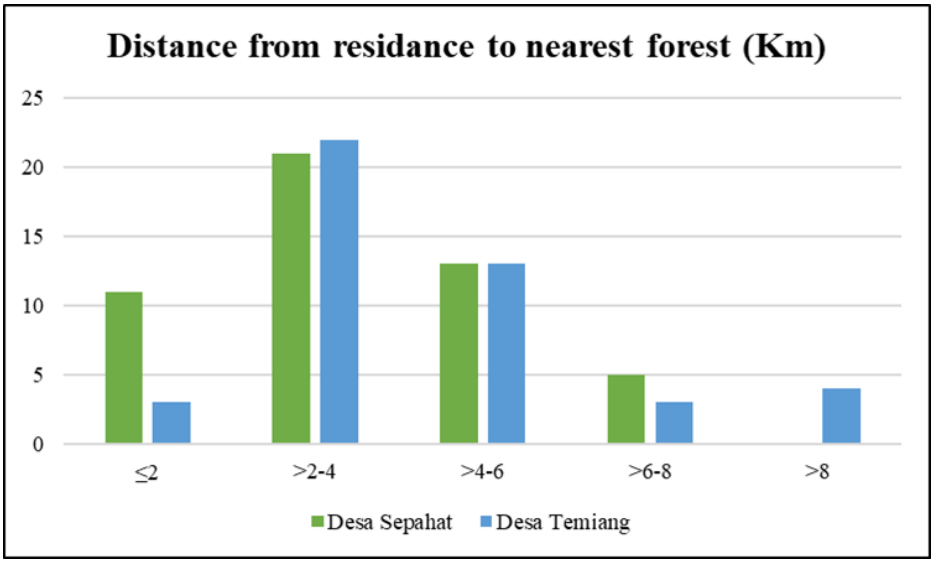

Figure 5. Distance from the respondent's place of residence to the nearest forested

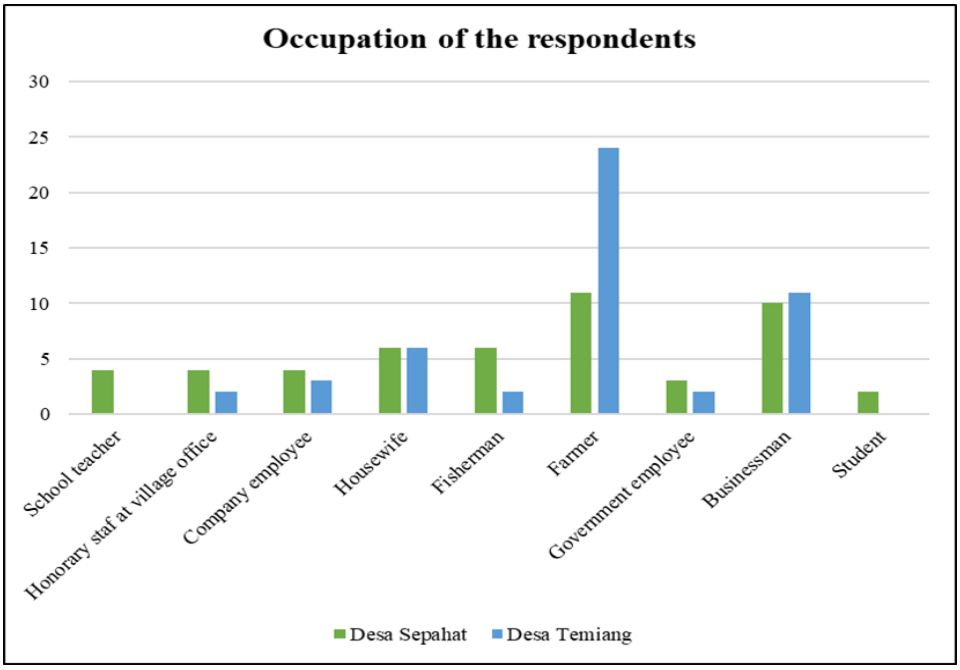

Figure 6. Occupation of respondents in Sepahat and Temiang villages.

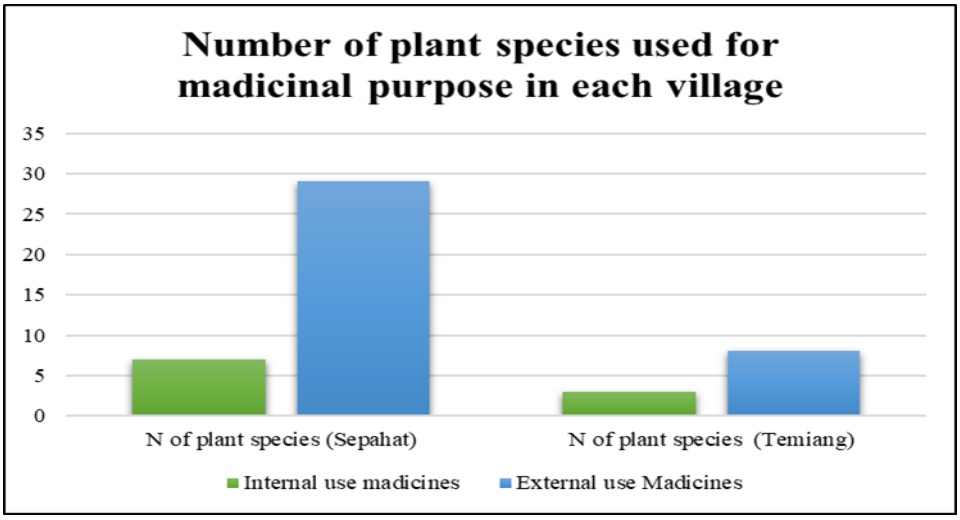

Figure 7. Plant species utilized for medicinal purposes in Sephat and Temiang villages.

an advanced degree at a university, such as a bachelor's and diploma degree, was relatively low, as shown in Figure 4. This phenomenon could perhaps be associated with the accessibility of educational resources. Typically, educational institutions in rural regions are limited in providing educational services, extending only to the students or younger people need to go to the bigger cities. The presence of responders with bachelor's degrees in these two villages serves as evidence of the local community's commendable commitment to education. Based on data from Priatna (2023), 114 school facilities from kindergarten level to senior high school are in the districts surrounding the GSKBB Biosphere Reserve, but not a single higher education facility yet, such as an academy or university.

Most respondents reside within fewer than 5 kilometers of the forest (Figure 5). Only some individuals inhabit areas remote from the forest. The activities of villagers could affect the forest. It is important to note that the impact of human activity on forests can be significant. According to Rinaldo *et al.* (2017), the typology of communities in the buffer zone of the GSKBB Biosphere Reserve is poor farming communities that still need expansion of agricultural land to improve their economy. As a result, the conversion of forests to agricultural and plantation areas in this buffer area has become uncontrolled. Hence, conservation initiatives within the biosphere reserve should prioritize local villagers' involvement, particularly those living close to the reserve. The respondents engage in various occupations, with farming being the most prevalent (Figure 6).

Medicinal Plant Species

A total of 40 different species belonging to 29 different families of medicinal plants have been recorded in the two villages. Sepahat villagers have a more extensive record of employing diverse medicinal remedies to treat an extensive array of afflictions than Temiang villagers.

Out of 40 medicinal plant species, Sepahat respondents provided information on 36 medicinal plant species belonging to 24 families, whereas the Temiang provided information on 11 plant species across eight

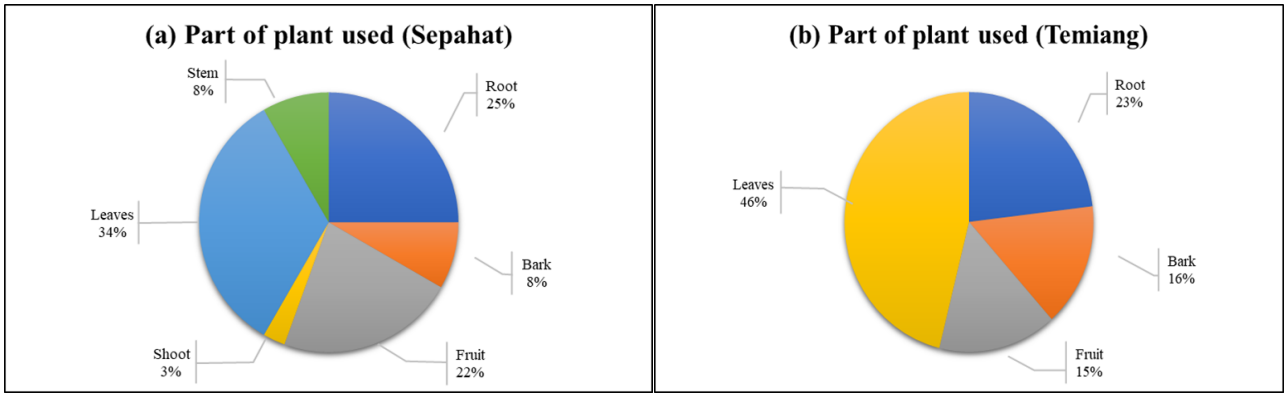

Figure 8. Utilized plant parts for medicine in the Sepahat (a) and Temiang (b) villages.

families. Titisari *et al.* (2016) and Priatna (2023) note that although Malays are the majority ethnic group of the population of Sepahat and Temiang villages, Sepahat village has most of its area as a production forest, while Temiang village has most of its area as a conservation area so that the usage of Non-Timber Forest Product more open for the community of Sepahat village. The Zingiberaceae family is widely prevalent in the Sepahat and Temiang villages. This finding is supported by the study of Simanjuntuk *et al*. (2021), which states that plants that are often used as medicine, mostly from the Zingiberaceae family, which is the turmeric plant (*Curcuma domestica*) is the most commonly used species. Therefore, the conservation initiatives should focus on plants whose extraction could lead to plant extinction. The difference in several plant species utilized for medicinal purposes in Sephat and Temiang villages is shown in Figure 7. The plant parts utilized by the community in Sepahat and Teminag villages for medicines include the root, bark, fruit, shoot, foliage, and stems (Figure 8).

Just like the findings of Simanjuntak *et al*. (2021), the use of plant parts for traditional medicines in the two villages (Sepahat and Temiang) is dominated by the leaves and roots. Simanjuntak *et al.* (2021) argue that the high frequency of use of leaf parts as medicine is because the leaves are available in large quantities and are easier to the BSKBB obtain and process before consumption. For plant species that are harvested destructively, which involves removing roots, rhizomes, tubers, bark, or the entire plant, additional information needs to be collected about their conservation status.

Until now, village residents have made no significant effort to preserve plant species used as traditional medicinal plants because they think these plants are still easy to find around residential yards. Therefore, using medicinal plant species does not threaten the sustainability of the GSKBB biosphere reserve. However, for the sustainable use of these plant species, it can be encouraged that the "Family Medicinal Plants" (TOGA= Tanaman Obat Keluarga) program has become a culture in the two villages. According to Sari & Andjasmara (2023), Family Medicinal Plants (TOGA) are planted with positive pharmacological effects on the human body and are usually grown on "a home or communal scale". These medicinal plants can then be used as traditional medicine, easily made. Apart from that, to grow community support for efforts to preserve Biosphere Reserve, the potential of medicinal plants in Sepahat and Temiang villages can also be developed as an alternative income for the community in these two villages (Priatna, 2023). Furthermore, the study findings of Priatna *et al*. (2022) show that the community surrounding the forest in Gunung Gede Pangrang National Park, Indonesia, will be aware of biodiversity conservation when it impacting their livelihoods. Meanwhile, the density of plants with hook roots is decreasing in forest areas due to the conversion of forests into plantations due to forest fires (Simanjuntak *et al*., 2021).

Within the villages of Sepahat and Temiang, 40 medicinal plants have been identified. These plants can effectively treat 28 and eight diseases in Sepahat and Temiang, respectively. These medicinal plants have been used to treat various health conditions, including aches and sprains, back pain, bleeding, increasing appetite, shortness of breath, controlling cholesterol, coughing, dengue fever, diabetes, diarrhea, and increasing energy. Hold and increase body immunity, increase breast milk after giving birth, fever, heart defects, hemorrhoids, high blood pressure, increase stamina after giving birth, hepatitis, weight loss, cure malaria, massage medicine, mosquito repellent, epistaxis, acne, stomach ache, lower blood pressure, gout, as well as treating leucorrhea (white discharge). Simanjuntak *et al*. (2021) stated that knowledge about medicinal plants and their use in the Sepahat and Temiang village communities has been transferred down from their parents for generations. The medicinal plant species recorded occur in Sepahat and Temiang villages, complete with the types of diseases that can be cured and their conservation attempt described in Table 1 and Table 2.

Additional in-depth research was conducted to ensure that the forty medicinal plant species genuinely possess pharmacological activity effective in curing disease. This comprehensive investigation was conducted using literature reviews (Table 3) The results indicate that each enumerated medicinal plant possesses genuine pharmacological activity.

*Phoebe hunanensis (*Lauraceae), *Uncaria* sp. (Rubiaceae), and *Zingiber americanus* (Zingiberaceae) were the only three species lacking references to their pharmacological activity. However, it is known that *Uncaria* sp. is commonly used by the island of Sumatra community to treat dysentery or diarrhea (Nursanti *et al*., 2018). Meanwhile, according to Silalahi (2018), Zingiber americanus is used as an ingredient in producing herbal medicines in Indonesia.

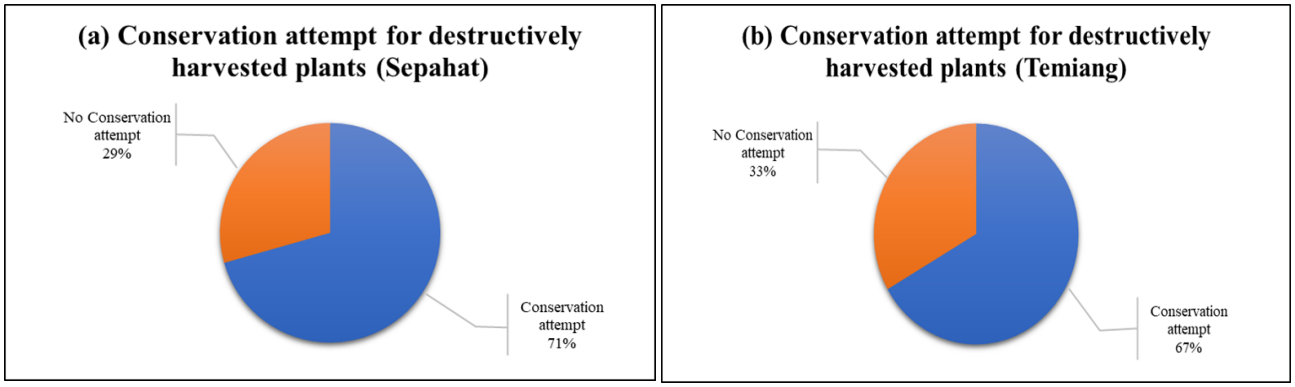

Figure 9. Conservation efforts of the villagers in Sepahat (a) and Temiang (b) villages.

Table 1. The diversity of medicinal plants found in Sepahat village and their conservation attempt.

Family	Botanical name	Vernacular name	Treated disease	Plant part use	Preparation and serving methods	Conservation attempt
Zingiberaceae	*Curcuma domestica* Val.	Kunyit	Enhance endurance and the immune system	Rhizome	Turmeric is washed clean, grated, or pounded to extract the water, then boiled in water. Drink it.	Plant in the yard
Zingiberaceae	*Kaempferia galanga* Linnaeus, 1753	Kencur	Enhance endurance and the immune system	Rhizome	The kencur is washed clean, then grated or pounded to extract the water, and then boiled in water. Drink it.	Plant in the yard
Zingiberaceae	*Alpinia galanga* (L.) Willd.	Lengkuas	Influenza/ cold enhances endurance and the immune system	Rhizome	Galanga is washed clean, grated or pounded, and cooked in water until boiling. Once the water is warm, drink it. Alternatively, slice it into small pieces, then dry it in the sun; after drying it, brew it in hot water for up to 3 minutes. Turmeric and palm sugar may be added. Drink it.	Plant in the yard
Zingiberaceae	*Zingiber officinale* Roscoe	Jahe	Influenza/ cold Enhances endurance and the immune system	Rhizome	Ginger is washed clean, grated or pounded, and cooked in water until boiling. Once the water is warm, drink it. Turmeric and palm sugar may be added. Drink it.	Plant in the yard
Zingiberaceae	*Zingiber officinale* Roscoe	Jahe merah	Influenza/ cold enhances endurance and the immune system	Rhizome	Ginger is washed clean, grated or pounded, and cooked in water until boiling. Once the water is warm, drink it. Turmeric and palm sugar may be added. Drink it.	Plant in the yard
Solanaceae	*Physalis minima* L.	Ceplukan	Diabetes, hypertension	Fruit	Wash the fruit clean, dry it, and boil it in two glasses of water until it is reduced to one glass. Drink it.	Plant in the yard
Myrtaceae	*Syzygium polyanthum* (Wight) Walpers	Salam	Breathlessness	Leaves	Bay leaves are dried, pounded until smooth, and mixed into oil or ointment. Smear it.	Plant in the yard

Annonaceae	*Annona muricata* L.	Sirsak	Influenza/ cold enhances endurance and the immune system	Leaves	Soursop leaves that are not too young are picked, washed, and then boiled in water. Drink it.	Plant in the yard
Zingiberaceae	*Zingiber americanus* Bl.	Lempuyang pahit	Increases appetite	Rhizome	Mempoyang is washed clean, grated, pounded, and squeezed out of the water. Drink it.	Plant in the yard
Mackinlayaceae	*Centella asiatica* (L.) Urban	Pegagan	Heart and increases stamina after birth.	Leaves and Root	The leaves or roots are washed clean and then boiled or can be chewed directly to extract the water. Drink it or chew.	Plant in the yard
Zingiberaceae	*Curcuma xanthorrhiza* Roxb.	Temu lawak	Stomach remedies	Rhizome	Wash it clean, grate or pound it, then squeeze the water. Drink it.	Plant in the yard
Thymelaeaceae	*Phaleria macrocarpa* (Scheff.) Boerl.	Mahkota dewa	Enhance endurance and the immune system	Fruit	The fruit is sliced and dried in the sun; the slices are dipped in hot/boiling water for 3 minutes. Drink it.	Plant in the yard
Zingiberaceae	*Boesenbergia rotunda* (L.) Mansf.	Temu kunci	Increases stamina after birth.	Rhizome	Wash it clean and then boil it to get the water. After boiling, leave it for 3 minutes. Drink it.	Plant in the yard
Rubiaceae	*Morinda citrifolia* L.	Mengkudu	Hypertension	Fruit	Washed thoroughly, blended or pounded, then filtered to separate the water from the ore. Drink it.	Plant in the yard
Poaceae	*Cymbopogon citratus* Stapf	Serai dapur	Losing weight	Stem	Cleanly wash the lemongrass, cut or slice 3 lemongrass stalks into 4, crush or pound them, and boil them in water. Drink it.	No attempt
Menispermaceae	*Tinospora cordifolia* Hook.f. & Thomson, 1855	Brotowali	Malaria	Stem	The stems are washed clean, cut into small pieces, then boiled and filtered to extract the water. Drink it.	Plant in the yard
Curcubitaceae	*Benincasa hispida* Cogn., 1881	Beligo/ Kundur	Fever	Fruit	The fruit is cleaned, and the skin is removed, sliced, and blended. Drink it.	Plant in the yard
Piperaceae	*Piper battle* L.	Sirih	Cough, vaginal discharge	Leaves	The fresh (not too young) leaves are picked, washed, and then chewed. If it is not strong, boil it and drink it.	No attempt,
Acoraceae	*Acorus calamus* L.	Jeringau	Facilitates breast milk after birth and dengue fever	Leaves	The leaves are washed, sliced, dried, and ground into flour and then brewed with hot water. Drink it.	Plant in the yard
Myrtaceae	*Psidium guajava* Linnaeus, 1753	Jambu biji	Diarrhea	Leaves	Washed until clean, ground to extract the water or starch, then filtered. Drink it.	Plant in the yard
Acanthaceae	*Graptophyllum pictum* Griff., 1854	Daun ungu	Hemorrhoids	Leaves	Washed clean, then dried. Once it dries, brew with hot water for several minutes. Alternatively, mash it to extract the starch. Drink or smear it.	Plant in the yard

Clusiaceae	*Garcinia mangostana* Linnaeus, 1753	Manggis	Hypertension	Bark	Wash the mangosteen skin clean, slice it, and dry it; after drying it, brew it with hot water and let it sit for 3 minutes. Drink it.	Plant in the yard
Zingiberaceae	*Zingiber cassumunar* Roxb.	Bonglai /Bangle	Nosebleed	Leaves	The leaves are washed clean, sliced, dried, and pounded to make flour, then fried/roasted, then brewed with warm water. Drink it.	Plant in the yard
Sapotaceae	*Manilkara zapota* P.Royen, 1953	Sawo manila	Diarrhea	Fruit	The sapodilla fruit is grated or pounded and squeezed out of the water. Drink it.	Plant in the yard
Piperaceae	*Piper ornatum* N.E.Br.	Sirih merah	Fever, malaria, diabetes	Leaves	The leaves are washed, boiled until boiling, and waited until warm. Drink it.	Plant in the yard
Bromeliaceae	*Ananas comosus* Merr., 1917	Nanas	Cholesterol	Fruit	Peel the pineapple, wash it clean, and then blend it. Drink it.	Plant in the yard
Malvaceae	*Ceiba pentandra* L. Gaertn.	Kapuk randu	Fever	Stem	The cottonwood stems are washed clean and then boiled in water; add a small towel to compress the patient once warm. Compressed.	Plant in the yard
Liliaceae	*Aloe vera* Burm.f., 1768	Lidah buaya	Pimple	Jelly	Wash it clean, remove the skin to get the jelly, and then pound it to get the starch. Smear it.	Plant in the yard
Arecaceae	*Cocos nucifera* L.	Kelapa hijau	Massage/ sprain medication	Fruit	The fruit is split, and the water is filtered to be stored. Smear it.	Plant in the yard
Rubiaceae	*Uncaria* sp.	Akar kait-kait	Jaundice disease	Stem	Washed clean, sliced into small pieces, boiled in water, let sit, and filtered. Drink it.	Plant in the yard
Melastomataceae	*Melastoma malabathricum* L.	Senduduk	Stops bleeding in wounds	Leaves	Leaves are chewed or crushed. Smear it.	No attempt
Solanaceae	*Solanum torvum* Swartz	Takokak	back pain	Leaves dan Fruit	Washed clean, then dried. Once it dries, brew with hot water for several minutes. Alternatively, mash it to extract the starch. The fruit is washed clean and then consumed. Drink or eat it.	Plant in the yard
Rosaceae	*Prunus subg. Cerasus* A.Gray, 1856	Ceri	Diabetes	Leaves	Cherry leaves are washed clean and then boiled. Drink.	Plant in the yard
Musaceae	*Musa balbisiana* Colla, 1820	Pisang batu	Diabetes	Shoot	Forest banana shoots are washed clean, chopped into small pieces, boiled, and mixed with coconut sugar and bay leaves. Drink it.	No attempt
Lauraceae	*Phoebe hunanensis* Hand.-Mazz.	Medang	Mosquito repellent	Bark	Medang bark dried and then burned to repel mosquitoes and gnats. Burn it.	No attempt
Hypericaceae	*Cratoxylum arborescens* (Vahl) Blume	Gerong-gang	Aches and sprains	Bark	Peel the bark, wash it clean, slice it into small pieces, then roast it; after it cools, mix it with approximately 1 kg of cooking oil, then let it sit. Smear it.	No attempt

Table 2. The diversity of medicinal plants found in Temiang village and their conservation attempt.

Family	Botanical name	Vernacular name	Treated disease	Plant part use	Preparation and serving methods	Conservation attempt
Zingiberaceae	*Curcuma domestica* Val.	Kunyit	Stomachache	Rhizome	Turmeric is washed, grated, or mashed; add water and then boil. Drink it. Sugar or honey may be added. Alternatively, grate turmeric and squeeze out the juice, then drink the juice without adding water.	Plant in the yard
Zingiberaceae	*Zingiber officinale* Roscoe	Jahe merah	Influenza/ cold, enhance endurance and the immune system	Rhizome	Clean the ginger, grate or pound it, then add water and boil it. When it is warm, drink it. Palm sugar and turmeric may be added.	Plant in the yard
Zingiberaceae	*Curcuma xanthorrhiza* Roxb.	Temu lawak	Boosting appetite	Rhizome	Temu lawak is peeled, washed, and cut thinly, then added water and boiled. Drink when it is warm. Honey and lemongrass may be added.	No Attempt
Iridaceae	*Belamcanda chinensis* (L.) DC.	Brojo lintang	Fever	Leaves and Flowers	Brojo lintang leaves and flowers are cleaned, mashed till smooth, and applied topically to the body to treat fever.	No Attempt
Piperaceae	*Piper betle* L.	Sirih	Cough	Leaves	Betel leaves that are not too young are picked, washed, and then chewed. Alternatively, the water can be boiled and drunk for a more tolerable flavor.	Plant in the yard
Myrtaceae	*Psidium guajava* Linnaeus, 1753	Jambu biji	Stomach ache	Leaves	Young guava leaves are selected, washed, and crushed. Squeeze until the water comes out. Little boiled water may be added. Drink the juice.	Plant in the yard
Lamiaceae	*Orthosiphon aristatus* (Blume) Miq.	Kumis kucing	Diabetes	Leaves	Several kumis kucing leaves are cleaned, boiled, and the water is drunk.	Plant in the yard
Annonaceae	*Annona muricata* L.	Sirsak	Colesterol and uric acid	Leaves	Select a few old soursop leaves, thoroughly wash them, and boil them in two or three glasses of water. Cook until just half of the water remains. When it is still warm, drink it.	Plant in the yard
Melastomataceae	*Melastoma malabathricum* L.	Sendudu k	Bleeding	Leaves	Wash several kenduduk leaves, chew them, and apply them to the wound.	Plant in the yard
Rutaceae	*Citrus aurantifolia* Swingle, 1913	Jeruk nipis	Cough	Fruit	Limes are washed, sliced, and squeezed to extract the juice before being mixed with sweet soy sauce and consumed. A teaspoon of warm water may be added.	Plant in the yard
Zingiberaceae	*Zingiber americanus* Bl.	Lempuya ng pahit	Boosting appetite	Fruit	The lempuyang fruit is washed, sliced, and crushed until smooth, then squeezed	Plant in the yard

Table 3. Confirmation of the pharmacological content of medicinal plants from the literature.

Family	Botanical name	Vernacular name	Treated disease	Pharmacology activity	References
Acanthaceae	*Graptophyllum pictum* Griff., 1854	Daun ungu	Hemorrhoids	Anti-inflammatory, anti-plaque, anti-diabetic	Singh *et al*. (2015).
Acoraceae	*Acorus calamus* L.	Jeringau	Dengue fever	Antimicrobial, Antioxidant, Insecticidal	Balakumbahan *et al*. (2010).
Annonaceae	*Annona muricata* L.	Sirsak	Influenza/ cold	Cytotoxic, antileishmanial, wound healing, antimicrobial, anticarcinogenic, and genotoxic effect	Gajalakshmi *et al*. (2012).
Arecaceae	*Cocos nucifera* L.	Kelapa hijau	Massage/ sprain	Antihelminthic, anti-inflammatory, antinociceptive, antioxidant, antifungal, antimicrobial, and antitumor	Lima *et al*. (2015)
Bromeliaceae	*Ananas comosus* Merr., 1917	Nanas	Cholesterol	Antiproliferative, pro-apoptotic, anti-rheumatic, anti-inflammatory, antioxidant, antimicrobial, anti-diabetic, anticoagulant, anthelminthic, anti-hyperglycemic, anti-plasmodial, antipyretic and cardioprotective	Rahman *et al*. (2020)
Clusiaceae	*Garcinia mangostana* Linnaeus, 1753	Manggis	Hypertension	Antioxidant, antimicrobial, anti-inflammatory, antihyperglycemic, anti-diabetic, antifungal, antibacterial, anticancer, anti-tumorigenic, antiproliferative	Ansori *et al*. (2020)
Curcubitaceae	*Benincasa hispida* Cogn., 1881	Beligo/ Kundur	Fever	Antioxidant, anti-inflammatory, analgesic, antiasthmatic, diuretic, antidepressant, nephroprotective, anti-diabetic, hypolipidemic and antimicrobial	Al-Snafi (2013)
Hypericaceae	*Cratoxylum arborescens* (Vahl) Blume	Gerong-gang	Aches and sprains	Anti-ulcerogenic, antibacterial	Sidahmed (2013)
Iridaceae	*Belamcanda chinensis* (L.) DC.	Brojo lintang	Fever	Anti-inflammatory, anti-oxidative, antitumor, anti-alcohol injury, cardiovascular, and oestrogenic activities	Xin *et al*. (2015)
Lamiaceae	*Orthosiphon aristatus* (Blume) Miq.	Kumis kucing	Diabetes	Antioxidant, anticancer, antibacterial and anti-inflammatory	Vijayan *et al*. (2017)
Lauraceae	*Phoebe hunanensis* Hand.-Mazz.	Medang	Mosquito repellent	-	
Liliaceae	*Aloe vera* Burm.f., 1768	Lidah buaya	Pimple	Antimicrobial, anti-inflammatory, antioxidant, aphrodisiac, antihelminthic, antifungal, antiseptic and cosmetic values	Qadir (2009)
Mackinlayaceae	*Centella asiatica* (L.) Urban	Pegagan	Heart diseases	Antimicrobial, anti-inflammatory, anticancer, neuroprotective, antioxidant	Prakash (2017)
Malvaceae	*Ceiba pentandra* L. Gaertn.	Kapuk randu	Fever	Antioxidant, anti-inflammatory, and antiapoptotic	Abouelela *et al*. (2020)
Melastomataceae	*Melastoma malabathricum* L.	Senduduk	Wound bleeding	Antinociceptive, anti-inflammatory, wound healing, antidiarrheal, cytotoxic, and antioxidant	Joffry *et al*. (2012)
Menispermaceae	*Tinospora cordifolia* Hook.f. & Thomson, 1855	Brotowali	Malaria	Antidiabetic, antimicrobial, antioxidant, antitoxic	Reddy & Reddy (2015)
Musaceae	*Musa balbisiana* Colla, 1820	Pisang batu	Diabetes	Antidiabetic, antibacterial, anticancer, hepatoprotective	Swargiary *et al*. (2021)
Myrtaceae	*Psidium guajava* Linnaeus, 1753	Jambu biji	Diarrhea	Antioxidants, polyphenols, antiviral compounds, anti-inflammatory	Naseer *et al*. (2018)

Myrtaceae	*Syzygium polyanthum* (Wight) Walpers	Salam	Breathlessness	Anti-diabetic, antihypertensive, antimicrobial, antioxidant, anticancer, antitumor, antidiarrheal	Ismail *et al*. (2019)
Piperaceae	*Piper betle* L.	Sirih	Vaginal discharge	Antibacterial	Fatimah *et al*. (2021)
Piperaceae	*Piper ornatum* N.E.Br.	Sirih merah	Malaria	Antibacterial	Nasution (2022)
Poaceae	*Cymbopogon citratus* Stapf	Serai dapur	Controlling weight	Anti-amoebic, antibacterial, antidiarrheal, anti-filarial, anti-fungal and anti-inflammatory	Manvitha & Bidya (2014)
Rosaceae	*Prunus subg.* Cerasus A.Gray, 1856	Ceri	Diabetes	Anti-inflammatory	Raafat *et al*. (2020)
Rubiaceae	*Uncaria sp*.	Akar kait-kait	Jaundice	Antidiarrheal	(Nursanti *et al*., 2018).
Rubiaceae	*Morinda citrifolia* L.	Mengkudu	Hypertension	Antidiabetic, antibacterial, anticancer, antioxidant	Ahmad *et al*. (2016)
Rutaceae	*Citrus aurantifolia* Swingle, 1913	Jeruk nipis	Cough	Anticancer, antimicrobial, antioxidant, antiulcer, anti-inflammatory, hypolipidemic, antityphoid, and hepatoprotective	Jain *et al*. (2020)
Sapotaceae	*Manilkara zapota* P.Royen, 1953	Sawo manila	Diarrhea	Anti-diabetic, Antilipidemic, antioxidant, anthelmintic, cytotoxic, and CNS depressant	Barbalho *et al*. (2015)
Solanaceae	*Solanum torvum* Swartz	Takokak	Back pain	Antimicrobial, anti-ulcerogenic, antiviral, anti-platelet aggregation, antioxidant, analgesic, anti-inflammatory	Yousaf *et al*. (2013)
Solanaceae	*Physalis minima* L.	Ceplukan	Hypertension	Antioxidant, antimicrobial	Banothu *et al*. (2017)
Thymelaeaceae	*Phaleria macrocarpa* (Scheff.) Boerl	Mahkota dewa	Immune booster	Anticancer, anti-diabetic, anti-hyperlipidemic, anti-inflammatory, antibacterial, antifungal, antioxidant	Altaf *et al*. (2013)
Zingiberaceae	*Zingiber purpureum*	Bonglai	Nosebleed	Antibacterial	Tandirogang *et al*. (2022)
Zingiberaceae	*Zingiber officinale* Roscoe	Jahe merah	Influenza/ cold	Antimicrobial, antioxidant, ayurvedic, anti-inflammatory	Gupta & Sharma (2014)
Zingiberaceae	*Kaempferia galanga* Linnaeus, 1753	Kencur	Immune booster	Antimicrobial, antioxidant, amebicidal, analgesic, anti-inflammatory, anti-tuberculosis, anti-dengue, antinociceptive, anti-angiogenic, anticancer, hyperlipidemic, hypo pigmentary, osteolysis, larvicidal, insecticidal and mosquito repellent, nematocidal, sedative, sniffing, vaso-relaxant	Kumar (2020)
Zingiberaceae	*Curcuma domestica* Val.	Kunyit	Immune booster	Antibacterial, antioxidant, anti-artiri	Jantan *et al* (2012)
Zingiberaceae	*Alpinia galanga* (L.) Willd.	Lengkuas	Influenza/ cold	Antimicrobial, anti-inflammatory, antifungal, anti-hepatotoxic, antioxidant, immunomodulatory activity, anti-diabetic, antiulcer, antitumor, anti-allergic, anti-SARS-CoV-2 Activity	Khairullah *et al*. (2020)
Zingiberaceae	*Zingiber americanus* Bl.	Lempuyang pahit	Appetite booster		
Zingiberaceae	*Boesenbergia rotunda* (L.) Mansf.	Temu kunci	Immune booster	Aphrodisiac activity	Ongwisespaiboon & Jiraungkoorskul (2017)
Zingiberaceae	*Curcuma xanthorrhiza* Roxb.	Temu lawak	Stomach ache	Antioxidant, antimicrobial, anti-inflammatory, anticancer and antitumor, anti-diabetic, skin-care and hepatoprotective properties	Rahmat *et al*. (2021).

CONCLUSION

Community living in Sepahat and Temiang villages utilize 40 medicinal plant species from 29 families. The residents of Sepahat village use more plant species than the residents of Tamiang village. The most widely used plants are from the family of Zingeberaceae. The plant parts used are roots, bark, fruit, shoots, leaves, and stems. These traditional medicines have been used for generations to treat various health conditions, such as back pain, bleeding, controlling cholesterol, coughs, dengue fever, and diabetes. Most villagers in Sepahat and Temiang villages make little effort to preserve the plants since they are abundantly available. Thus, the community's use of medicinal plants in Sepahat and Temiang villages does not threaten the integrity of the biodiversity of the biosphere reserve.

While current use might not pose a threat, it highlights the need for careful management to prevent future overexploitation and ensure long-term sustainability. Promoting the adoption of sustainable harvesting techniques among villagers is essential to ensure resource availability for future generations. This sustainable harvesting could involve employing selective harvesting techniques, replanting harvested areas, and establishing community nurseries dedicated to cultivating medicinal plants.

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