

## Ethnobotanical and ecological study of medicinal plants of mangroves in Siak District, Riau Province, Indonesia

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**Abstract.** *The mangrove forest in Kayu Ara Permai Village, Sungai Apit, Siak Regency, Riau Province, Indonesia, is a mangrove forest managed by the local community as the "Historic River" Mangrove Ecotourism Area. Mangrove forests have become a tourist attraction for many local and national tourists. The purpose of this study was to identify plants that have potential as medicinal plants in mangrove ecotourism areas of "Sungai Bersejarah" Kayu Ara Permai Village, Sungai Apit, Siak Regency, Riau Province. This study used a survey method in mangrove forests to conduct an inventory of the medicinal plants scattered throughout the area. Observations were made using a combination of the path and plot methods. The investigation was carried out by cross-checking the traditional use of medicinal plants by the surrounding community with the scientific literature. The results showed 7 species of medicinal plants from 5 different families, namely *Avicennia alba*, *Rhizophora apiculata*, *Bruguiera parviflora*, *Bruguiera gymnorrhiza*, *Xylocarpus granatum*, *Sonneratia alba*, and *Acrostichum aureum*. Mangrove density levels were in the sparse category (<1,000 trees/ha) and had low diversity levels, with two dominant species, *Rhizophora apiculata* and *Xylocarpus granatum*.*

**Keywords:** *Ethnobotanical; mangrove; medicinal plants; diversity*

### INTRODUCTION

Mangroves are a group of vegetation that grow in coastal areas of the tidal zone[1],[2]. This vegetation consists of a variety of plant species that can live in extreme environments such as tides, high salinity, and muddy soils[3]. Mangroves play an important role in maintaining coastal ecosystem balance. The main functions of mangroves include protecting the coast from abrasion and storms, providing breeding grounds for various species of fish and invertebrates, maintaining water quality by absorbing excess nutrients and pollutants[4], and serving as a source of medicinal plants[5]–[7].

The Riau Province is known as an area rich in biodiversity, including mangrove species. The mangrove area in Riau Province is 213,459.21 hectares[8], making Riau the third-largest province for mangrove distribution in Indonesia. Mangroves in Riau Province are found in all habitats along the coastline[9], estuaries[10], and rivers[11]. Based on the administration, Riau Province mangroves are scattered across seven coastal districts and cities, one of which is Siak Regency, with an area of 296.96 hectares[12].

Mangroves in the Siak District have been utilized by local communities as firewood, charcoal, nipah, fishing locations, shrimp, crabs, and shellfish[13], and as medicinal plants[14]. Some common mangrove species found in Siak District include *Rhizophora apiculata*, *Avicennia alba*, *Sonneratia ovata*, *Rhizophora mucronate*, *Xylocarpus granatum*, and *Bruguiera*[15]. This species diversity provides a great opportunity to understand the potential of mangrove plants as a source for traditional medicine. Each mangrove species has different chemical characteristics, and understanding these properties can be the basis for the development of medicines, especially traditional medicines. A total of 27 mangrove species have been used in traditional medicines[16].

Traditional communities in mangrove ecosystems have long used mangrove plants for traditional medicinal purposes. Mangroves are the richest source of phytochemicals, important chemical compounds found in mangroves are carbohydrates, alcohols, amino acids, various types of fats, fatty acids, lipids, phenolic compounds, steroids, glycosides, and triterpenes[17]. Mangrove vegetation is a rich source of steroids, saponins, flavonoids, alkaloids and tannins[16]. These products are primary metabolic compounds that are essential for the maintenance of life processes, as well as secondary metabolic substances that have toxicological, pharmacological, and ecological importance. Mangrove plants have been shown to have anticancer, antitumor, anti-inflammatory, antiviral, antifungal, antimicrobial, and antidiabetic properties [18].

Currently, the younger generation is less motivated to explore their predecessors' knowledge and has gradually begun to be abandoned owing to various causal factors. This situation causes the traditional heritage of the place of origin to disappear gradually [19]. Technological developments and changes in the lifestyles of young people are factors that cause the loss of traditional knowledge about mangroves for medicinal purposes[20]. Therefore, efforts must be made to document traditional medicinal knowledge while protecting medicinal plants for the purposes of knowledge, conservation, and community welfare. One way to document this is through ethnobotanical studies of medicinal plants.

Ethnobotany can be understood as the relationship between botany (plants) relevant to people (communities) and society in various parts of the world[21]. Ethnobotanical research has a dual purpose: preserving this knowledge not only benefits humans and the environment but also protects the plant species used[22]. Ethnobotany is a science that studies the relationship between local communities and their natural environments, including knowledge of natural plant resources[23]. Therefore, ethnobotany can reveal the traditional knowledge systems of a community or ethnic group regarding biodiversity, conservation, and culture.

The potential of mangroves as medicinal raw materials has been widely studied and researched, but the dissemination of information related to their potential and efficacy as medicinal plants has not yet been optimized; thus, so there are still many aspects remain unknown. This study aimed to identify plants with potential as traditional medicinal ingredients in the mangrove area of Kayu Ara Permai Village, Sungai Apit, Siak Regency, Riau Province. The results of this study are expected to enrich the research on medicinal plants in mangrove ecosystems that are still limited by the diversity of mangrove plants in the Riau Province.

## METHODS

### Study area

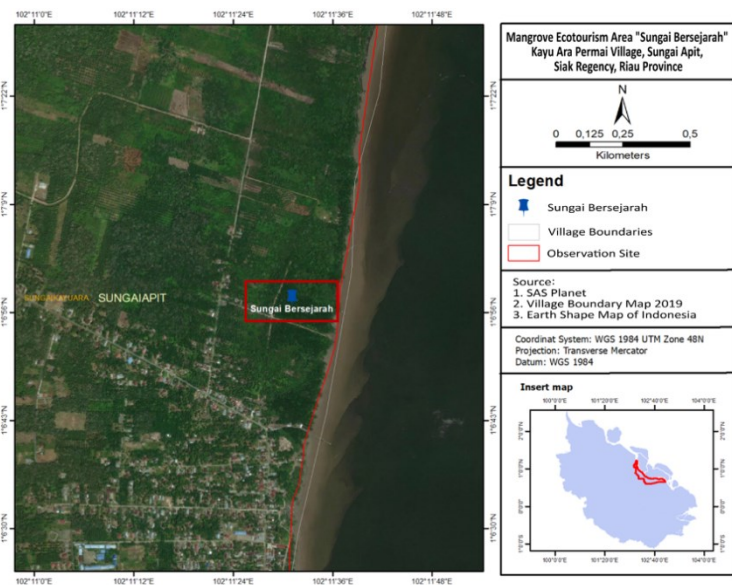
This study was conducted in the mangrove forest of Kayu Ara Permai Village, Sungai Apit, Siak Regency, Riau Province, Indonesia. The research site was located at latitude 1° 07' 02.2 "N and longitude 102° 11' 34.2 "E, as shown in Figure 1.

Mangrove biodiversity is stable and well-maintained in this forest. The forest is managed not only with government support but also with the participation of local communities. The local community manages this area as a mangrove ecotourism area "Sungai Bersejarah" and since 2017 this area has been designated as a protected education area by students and environmental activists. Therefore, this location is suitable for studying vegetation, including medicinal plants, growing in mangrove forests.

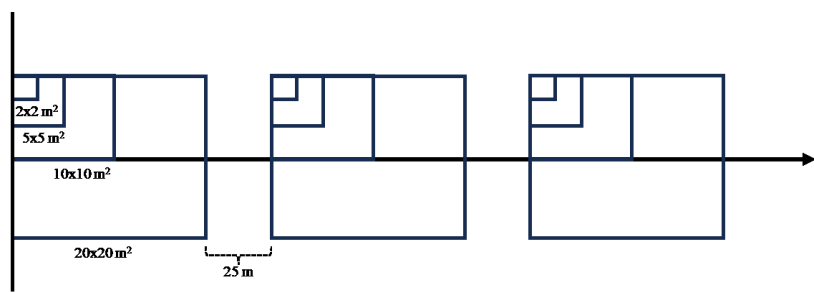
### Data collection

Before collecting field data, a survey was conducted to identify the proposed site. Once the location was identified, the route and observation points were determined. Mangrove species and density data were obtained from plots measuring 20 × 20 m<sup>2</sup> (tree level), 10 × 10 m<sup>2</sup> (pole level), 5 × 5 m<sup>2</sup> (sapling level), and 2 × 2 m<sup>2</sup> (seedling level) using a combination of path and plot methods[24]. Three test plots were placed in each transect. The distance between the plots was 25 m and the plots were arranged systematically. Transects from the coast perpendicular to the mainland cut through the mangrove community of the foremost formation (offshore) to the rearmost formation bordering the mainland[25]. In each predetermined observation plot, we determined the mangrove species present, counted the number of individuals of each species, and measured the trunk diameter of each mangrove tree at chest height (± 1.3 m). Simultaneously, measurements were recorded on a tally sheet.

Medicinal plants were identified by collecting information on medicinal plants used by the local community. To expand their knowledge, interviews were conducted with local people who had extensive knowledge of medicinal plants. Plant morphology (stem, leaves, and roots) was used to identify the plant species. Several references were used to verify information from informants regarding the effectiveness of plants as medicine, including Heyne's monumental book on Indonesian plants, which consists of four series (Series 1-4)[26]. Unidentified species were collected from the herbarium for further identification using the Indonesian mangrove recognition guide[27].



**Figure 1.** Map of the study area in the mangrove ecotourism area "Sungai Bersejarah" Kayu Ara Permai Village, Sungai Apit, Siak Regency, Riau Province, Indonesia



**Figure 2.** Diagram of transects and observation plots used at the study site

2.3. Data analyses

The structure and composition of medicinal plants in mangrove communities were analyzed using species, density, and dominance parameters. Species density ( $D_i$ ) is the number of stands of the  $i$ -th species in a unit area with the determination of species density, as follows [28]:

$$D_i = \frac{N_i}{A}$$

Description:

- $D_i$  = Density (individu/m<sup>2</sup>)
- $N_i$  = Total individuals
- A = Total sampling area (m<sup>2</sup>).

The classification of vegetation density refers to the Decree of the Minister of Environment Number 201 of 2004 concerning Standard Criteria and Guidelines for Determining Mangrove Damage, as follows[29]:

- Sparse (<1,000 trees/ha)
- Medium (1,000-1,500 trees/ha)
- Dense (>1,500 trees/ha).

**RESULTS AND DISCUSSION**

**Result**

Based on observations, there are various types of vegetation in the mangrove ecotourism area "Sungai Bersejarah" Kayu Ara Permai Village, Sungai Apit, Siak Regency, which have potential as traditional medicines (Table 1). All plant species used as medicines by residents of mangrove forests have a scientific

basis. There are 11 mangrove species in the observation spot, including *Avicennia alba*, *Rhizophora apiculata*, *Bruguiera parviflora*, *Bruguiera gymnorrhiza*, *Bruguiera sexangular*, *Scyphiphora hydrophyllacea*, *Xylocarpus granatum*, *Sonneratia alba*, *Lumnitzera littorea*, *Excoecaria agallocha*, and *Acrostichum aureum*. The number of tree-level strata was 32 trees/ha, sapling level was 73 trees/ha, and seedling level was 164 trees/ha (Table 2). The tree density decreased as the growth strata increased. Overall, the number of individual mangrove medicinal plants in the observation area was approximately 315, and was dominated by *Rhizophora apiculata* and *Xylocarpus granatum* (Table 3). Referring to the Decree of the Minister of Environment Number 201 of 2004 concerning Standard Criteria and Guidelines for Determining Mangrove Damage, the mangrove density level was in the sparse category (<1,000 trees/ha).

**Table 1.** Medicinal plants in the mangrove ecotourism area "Sungai Bersejarah" Kayu Ara Permai Village, Sungai Apit, Siak Regency, Riau Province, Indonesia

Scientific name	Local name	Famili	Phytochemical property	Part used	Medicinal use
<i>Avicennia alba</i>	Api-api	Avicenniaceae	Carotenoid	Sap	Prevent pregnancy
<i>Rhizophora apiculata</i>	Bakau Minyak	Rhizophoraceae	Tannin	Leaves	Wound medicine and neutralize poison
<i>Bruguiera parviflora</i>	Lenggadai	Rhizophoraceae	Polyphenol	Fruit	Treating herpes
<i>Bruguiera gymnorrhiza</i>	Tumu	Rhizophoraceae	Steroid, flavonoid	Flower	Treating Ear infection
<i>Xylocarpus granatum</i>	Nyirih	Meliaceae	Flavonoid, alkaloid, steroid	Fruit and Leaves	Treating itching, removes smallpox scars, and smoothes skin
<i>Sonneratia alba</i>	Perepat	Sonneratiaceae	Flavonoid, Tannin, Asam Fenolat, Saponin, Fenilpropanoid, Steroid	Fruit, Bark, and Root	Appetite enhancer, reduce muscle pain, relieve back pain, treating rheumatism, treating malaria, increase stamina, treating appendicitis and liver
<i>Acrostichum aureum</i>	Paku laut	Pteridaceae	Glucoside, saponin, steroid	Rhizome	stop bleeding, relieve pain

**Table 2.** Density of medicinal plants by growth stratum

Growth stratum	Mangrove density (tree/ha)
Seedling	164
Stake	73
Tree	32
Total	269

**Table 3.** Number of species, number of individuals, and dominant medicinal plant species by observation spot

Spot	Number of species	Number of individuals	Dominant species
1	4	52	<i>Rhizophora apiculata</i>
2	8	97	<i>Xylocarpus granatum</i>
3	9	166	<i>Xylocarpus granatum</i>

Among the 11 species of mangroves that have been identified, 7 medicinal plants are found in mangroves, including *Avicennia alba*, *Rhizophora apiculata*, *Bruguiera parviflora*, *Bruguiera gymnorrhiza*, *Xylocarpus granatum*, *Sonneratia alba*, and *Acrostichum aureum*. These medicinal plants belong to five families, namely *Avicenniaceae*, *Rhizophoraceae*, *Meliaceae*, *Sonneratiaceae*, and *Pteridaceae*. Various health-contributing phytochemicals, including glucosides, saponins, steroids, carotenoids, alkaloids, triterpenoids, flavonoids, tannins, steroids, and polyphenols have been identified in these plants. According to the local literature, parts of the plant used for medicinal purposes are rhizomes, roots, stalks, leaves, sap, flowers, fruits, and bark. This plant is used as an antioxidant to stop bleeding, relieve pain, prevent pregnancy, heal wounds, neutralize toxins, remove tongue fungus, treat skin itching, disguise smallpox scars, smoothen the skin, relieve muscle pain, restore stamina, and increase appetite. In addition, the plant is used to treat various ailments, including toothache, liver disease, diarrhea, herpes, ear infections, lumbago, rheumatism, malaria, and appendicitis.

## Discussion

Mangroves are a type of forest that grow and develop in tidal areas, especially in river estuaries and sheltered beaches. This forest is inundated at high tide but not flooded at low tide, and the plant community is salt tolerant [30]. Mangroves are communities dominated by various types of trees that can grow in saline water[31],[32].

Eleven plant species from 5 families have potential as medicine in Kayu Ara Permai Village, Mangrove Ecotourism Area "Sungai Bersejarah", Sungai Apit, Siak Regency. Medicinal plants are plant species with medicinal properties[33]. In general, these properties can be divided into three groups: (i) traditional medicinal plants used as raw materials for traditional medicine; (ii) modern medicinal plants that are medically proven and scientifically proven to contain bioactive compounds with medicinal properties; and (iii) potential medicinal plants that are believed to have medicinal properties but have not been scientifically proven.

In this study, the presence of medicinal plants was assessed by comparing information from the community in the study area with references representing basic pharmacology guidelines. Based on the results of the interviews, the surrounding community has been using mangrove plants to maintain health since ancient times. This was supported by information from valid guidelines and references. Plant parts used for medicinal purposes include the roots, stems, leaves, bark, flowers, and fruits. In terms of medicinal benefits, each plant part is used to treat various diseases, including toothache, liver disease, diarrhea, herpes, ear infections, smallpox, lumbago, rheumatism, malaria, and appendicitis. Some of them also help improve health by stimulating appetite, stopping bleeding, relieving pain, preventing pregnancy, acting as antioxidants, healing wounds, neutralizing toxins, removing tongue fungus, treating itchy skin, concealing pockmarks, smoothing the skin, and relieving muscle pain. According to pharmacological guidelines, this plant part contains carotenoids, tannins, polyphenols, steroids, flavonoids, alkaloids, phenolic acids, saponins, phenylpropanoids, and glucosides.

Plants containing active ingredients with therapeutic properties are classified as medicinal plants. Plants with healing properties can be found in both cultivated and uncultivated areas, including mangroves. Certain parts of the mangrove plant are capable of producing various types of phytochemicals. Phytochemical content varies greatly depending on the type of mangrove vegetation and provides a wide range of pharmacological effects[34],[35]. The pharmacological effects can be antibacterial[36], antioxidant[37], antivirus[38],[39], anticancer[40], antidiabetic[41], antihypertensive[42], neuroprotective[43], and others. This is thought to be due to the phytochemical biological components present in these natural ingredients, including carotenoids, tannins, polyphenols, steroids, flavonoid alkaloids, phenolic acids, saponins, phenylpropanoids, and glucosides, among others.

The mangrove forest in the "Sungai Bersejarah" ecotourism area located in Kayu Ara Permai Village, Sungai Apit, Siak Regency, is a low-density forest (<1,000 trees/ha), with *Rhizophora apiculata* and *Xylocarpus granatum* as the dominating species. Plant communities can be described differently depending on their purpose. Community descriptions can be made with reference to physiognomy and vegetation analysis. General physiognomic descriptions refer to the external appearance of vegetation. Geomorphological characteristics, including tree height, structure, and vegetation growth, are the main features of physiognomy[2]. A vegetation community is a collection of plants in the form of a unit plot containing a group of plants, including medicinal plants. A community is classified as having a high biodiversity if it consists of many species. However, if a community consists of few species and only a few dominant species, the community is classified as having low species diversity. Based on this classification, it can be seen that mangrove biodiversity in the "Sungai Bersejarah" ecotourism area in Kayu Ara Permai Village, Sungai Apit, and Siak Regency is low, with only two dominant tree species.

During life development, humans have a good understanding of the surrounding environment to sustain their lives. Useful organisms surrounding humans, such as plants, are important for human survival. Since ancient times, humans have relied on nature for their survival. Indonesia has a mangrove forest cover of  $\pm 3$  million hectares or  $\pm 20\%$  of the total mangrove forest area in the world and has high biodiversity[8]. One of the great potentials of mangrove forests is the provision of medicinal plants. The existence of mangroves as medicinal plants has a significant relevance to human health, especially in coastal communities. Mangroves not only provide diverse natural resources, but also contain active compounds with medicinal potential. These plants, with their diverse species such as Bakau Minyak (*Rhizophora apiculata*), Api-Api (*Avicennia alba*), Perepat (*Sonneratia alba*), and nyirih (*Xylocarpus granatum*), have long been utilized in traditional medicine by local communities in coastal areas, including in Riau. However, technological developments and changes in the lifestyles of young people have eroded traditional knowledge of mangroves for medicinal purposes. Therefore, the dissemination of information related to the potential and efficacy of mangroves as medicinal plants must continue to be socialized to the community, especially

the younger generation. Therefore, the potential of mangroves as a source of medicinal plants should continue to be explored. Understanding the existence of mangroves as medicinal plants also opens opportunities for further research into the development of modern plant-based medicines, which can contribute to the pharmaceutical industry while maintaining the sustainability of mangrove ecosystems and supporting the sustainable lives of coastal communities. Therefore, the preservation and further understanding of the role of mangroves as medicinal plants are essential to utilize this natural heritage wisely and sustainably.

## CONCLUSIONS

The "Sungai Bersejarah" mangrove ecotourism area of Kayu Ara Permai Village has seven types of medicinal plants that have extensive benefits for health. This mangrove ecosystem can be a natural pharmacy for humans, especially in the local communities around the ecosystem. Disseminating information and understanding mangroves as medicinal plants is an entry point for the development of modern herbal medicines. However, its utilization must be wise and prioritized for ecosystem sustainability.

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