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# DIVERSITY OF TREE SPECIES POTENTIAL FOR MEDICINAL PURPOSES IN INDONESIA

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**ABSTRACT:** Few people are aware that Indonesia has a large number and diversity of tree species with documented medicinal benefits other than timber. This information is very useful for conservation and sustainable use, especially in terms of bioprospecting. We conducted a desk study using several databases (including POWO, BGCI, MPNS, and IUCN) and some primer resources (including data from ethnobotanical studies) to set an initial database and inventory of the tree species potential for medicinal purposes in Indonesia. This study aims to reveal information regarding the diversity of tree species in Indonesia with medicinal uses to support the planning of conservation and sustainable use. It has been discovered that Indonesia has 1737 tree species with medicinal records, divided into 128 families and 608 genera. Only 138 species of all are introduced. Most species belong to families of the Fabaceae (163 species), Euphorbiaceae (117 species), and Moraceae (79 species), whilst the three most genera are Ficus (61 species), Diospyros and Macaranga with each 30 species, respectively. More than 60% of species have been evaluated by the IUCN Redlist, but only 7% are included in the threatened list, with one species being extinct in the wild/EW, 38 species being critically endangered/CR, 38 species being endangered/EN, and 38 species being vulnerable/VU (68 species). Moreover, only 50% of tree species have been conserved in ex situ areas. In conclusion, there is diversity of potential tree species for medicinal purposes in Indonesia that have not been explored to their full potential, particularly for advancement toward bioprospecting and the broader health of people. Given that the threat of species extinction continues, it is necessary to conduct conservation for sustainable use.

**Keywords**: tree, medicinal plant, health, conservation, Indonesia

## Introduction

Trees are the major component of the forest. Only relatively few studies on the diversity of tree species in Indonesia. Some of them have been published (Marjokorpi & Ruokolainen 2003, Kessler et al. 2005). The importance of tree species in the forest can be explained by their role in interacting with living creatures including flora and fauna. Medicinal plants are among the most valuable non-timber forest products because they considerably improve access to inexpensive healthcare and livelihood stability (Astutik et al. 2019).

Indonesia has known for its rich flora with 30,000-40,000 species identified (Ministry of National Development Planning 2016), but few people are aware that Indonesia has a large number and diversity of tree species with documented medicinal benefits other than timber. Many tree species, especially the famous tree species with medicinal use, also have high commercial value and therefore (Hidayat et al. 2021, Susilowati et al. 2022) their extinction due to over-harvesting, deforestation, land conversion and climate changes will entail not only ecological impacts but also have socio–economic implications (Budiharta et al. 2011).

To be able to conserve, the most important step is to make a list of medicinal plants. In this study, inventory refers to a listing of all the species in a defined area. To compile all available data on plants, including their taxonomy, ethnobotanical uses, and economic value, a global plant database has been created. Some global databases i.e., POWO (Plants of the World Online), BGCI (Botanic Gardens Conservation International), MPNS (Medicinal Plants Name Service), and IUCN (International Union for Conservation of Nature) Redlist can directly be accessed online (Cahyaningsih et al. 2021).

It has been successful in conducting an inventory of medicinal plants in some systems of traditional medicine such as Ayurveda (Astutuik et al. 2019). Besides the diversity of tree species, the importance of setting up a database and inventory of tree species could also be related to the existence of some species with conservation concerns indicated by the status of the IUCN Red List and the use of such plant diversity for local people (Fiqa et al. 2019). However, no complete list has been published of tree species with medicinal use in Indonesia; thus the diversity of tree species with medicinal uses in Indonesia is not yet understood. The present study was conducted to reveal diversity of tree species with medicinal records in Indonesia by setting the initial database and doing an inventory of the species using several available databases. This study will support the planning of conservation and sustainable use of the species.

## Methods

For this study, we applied the tree definition used by Global Tree Assessment (GTA) which is "a woody plant usually with a single stem growing to a height of at least two metres, or if multi-stemmed, then at least one vertical stem five centimetres in diameter at breast height" (BGCI, 2021). We modified the method used by the previous study to collect all the required data (Wati et al., 2023). We collated data and information from several databases which are global and national, namely Plants of the World (POWO, 2023), the global tree species database from Botanic Gardens Conservation International (BGCI) (Global Tree Search online database, 2023), IUCN Redlist data (IUCN, 2023), Medicinal Plants Name Service (MPNS, 2023), and national botanical gardens data in Indonesia (Makoyana, 2023). For national medicinal records, information from Cahyaningsih et al.'s study (unpublished) was also used in addition to this study's findings.

Plant species checklist in Indonesia consisting of species distributed in Sumatera, Kalimantan, Jawa, Lesser Sunda Islands (LSI), Sulawesi, Maluku Islands, and Papua were obtained from POWO and crosschecked against the global tree list from Global Tree Search online database (2023) to select the tree species in Indonesia. The resulting list was then completed with IUCN

Redlist status from IUCN (2023), medicinal records are obtained from MPNS (2023) and Cahyaningsih et al. (unpublished), and ex situ status for each species information was collected from national botanical garden data in Indonesia (Makoyana 2023). When a tree species is found exclusively in Indonesia and not in other countries, it is referred to as an endemic species. Moreover, the Taxonomic Name Resolution Service's online tool at https://tnrs.biendata.org (Boyle et al. 2013) was used for all species names to detect their taxonomic changes compared to the WCSV provided in the tool. An Excel spreadsheet was performed to evaluate all of the necessary data for classifying and determining the diversity of medicinal trees in Indonesia.

## Results

The result of the inventory from the online database shows a total of 8175 tree species were found in Indonesia, of which 7934 species are native and 4905 species are endemic. These species belong to 960 genera and 154 families.

### Tree Species in Indonesia with Medicinal Use

According to the database, we found 1737 tree species with medicinal use records within 608 genera and 128 families. 92% out of them or about 1599 of medicinal tree species in Indonesia are native and 14% (253) are endemic. The taxonomic status of them is accepted names (1729), synonyms of other species (6), and no opinion (2).

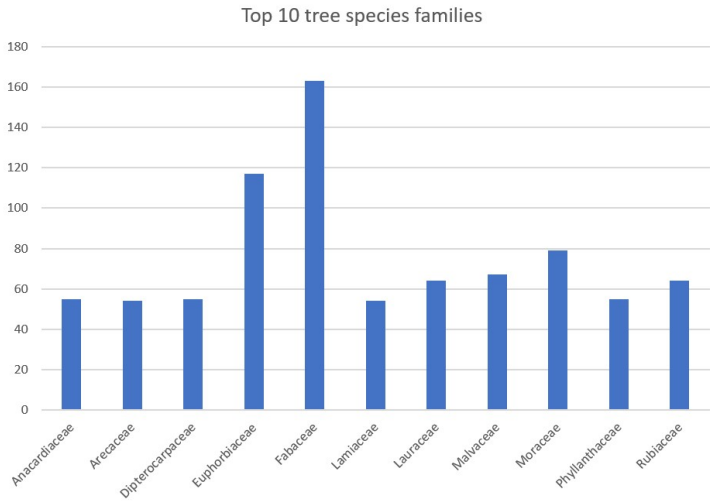


**Figure 1.** Top 10 species families

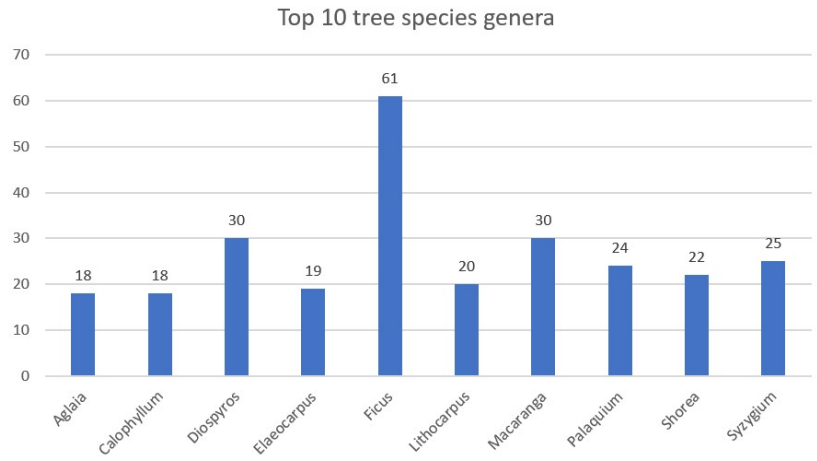


**Figure 2.** Top 10 species genera

The top 3 the tree species with medicinal records family were Fabaceae (163), Euphorbiaceae (117), and Moraceae (79), while the remaining can be seen in Figure 1. As for the genera, we found that ficus is the biggest species in number (Figure 2).

**Table 1.** Distribution of Tree Species in Indonesia with Medicinal Use

| Species | Kalimantan * | Jawa | LSI | Maluku | Papua * | Sulawesi | Sumatera |
|---|---|---|---|---|---|---|---|
| I | 49 | 108 | 57 | 12 | 48 | 32 | 30 |
| N | 922 | 719 | 474 | 404 | 469 | 485 | 926 |
| Endemic | 124 | 67 | 32 | 25 | 99 | 27 | 103 |

*might include neighbouring countries' species,
(I): introduced species, (N): native species

The highest introduced species was found in Java (108), followed by Lesser Sunda Island (57) and Kalimantan (49). While the highest native species were found in Sumatera (926), followed by Kalimantan (922) and Jawa (719). It was also found that 477 medicinal tree species in Indonesia were endemic.

**Table 2.** The Number of Medicinal Tree Species Listed in IUCN Redlist Status

| IUCN Redlist Status | Number |
|---|---|
| Extinct in the Wild | 1 |
| Critically Endangered | 19 |
| Endangered | 38 |
| Vulnerable | 68 |

The conservation status of tree medicinal species in our list recorded according to the IUCN Redlist has been assessed, and 126 out of them are included in IUCN Redlist species, which are vulnerable, endangered, critically endangered, and extinct in the wild (Table 2). From this species, we found surprisingly that an invasive species globally, *Brugmansia suaveolens* listed as Extinct in the wild by IUCN. We also found that 981 medicinal tree species have been conserved ex situ in Indonesia's botanic garden (Makoyana 2023).

## DISCUSSION

The data on tree species' potential for medicinal diversity purposes is expected to increase the awareness of many stakeholders, such as government, scientists, private business owners, local communities, non-government institutions, and farmers, regarding sustainable management of tree medicinal plants' biodiversity. Meanwhile, indigenous people and traditional local communities often have a profound understanding of their environmental ecology. This knowledge is an important foundation for the conservation and sustainable use of biodiversity (Schafer & Schulke 2008).

Many of the medicinal plants are tree habitus; some of them are harvested naturally and have been used for hundreds of years from generation to generation. It has been discovered that Indonesia has 1737 tree species with medicinal records or 21.25% of total tree species, divided into 128 families and 608 genera. Only 138 species of all are introduced. As one of the significant bioresource centers of the world, Asia accounts for over 38,660 species of medicinal plants (Astutik 2019); this means that 4.49% of medicinal plants, especially those with a tree habit, are found in Indonesia. If the number of Indonesian medicinal plants is estimated at 4,735 species (Table 2), it means that 36.68% are medicinal plants with a tree habit (1737:4735). These results are not much different from the previous study which used 48 ethnic samples throughout Indonesia (Permanasari 2001). The composition of medicinal plants in the form of trees is 39.02% or 224 species of 574 medicinal plants inventoried. In line with this result, another study found that medicinal plant species included in the tree habitus have a higher number of species and percentage than other habitus, which is 40.58%. This signals the importance of paying attention to trees with medicinal properties, especially those generally harvested as timber (Zuhud & Hikmat 2009).

Kalimantan is known as an island that has a wealth of plants, including timber and medicinal plants, followed by the islands of Sumatra and Java. This is also related to the many tribal cultures on these islands that use natural remedies, especially medicinal plants. Even though the forests in Java are relatively not as large as the forests in Kalimantan and Sumatra, the Javanese people's closeness to medicinal plants has been going on for a long time and the use of medicinal plants has been carried out from generation to generation until now. This is proven by a large number of herbal medicine packages, 'Jamu' made from medicinal plants. Meanwhile, although the Papua, Maluku and Sulawesi bioregions are known for their richness in forest plant species, including the potential for medicinal plants in them, the data obtained was not as much as expected. This is possible due to limited accessibility to remote areas and communication difficulties with indigenous peoples, which are obstacles experienced by researchers in uncovering the potential of

medicinal plants. Meanwhile, the Lesser Sunda region is a transitional area in the middle of the Indonesian archipelago, which has a relatively stable wealth of plant species. The recapitulation results from the Lesser Sunda Islands recorded 279 species of medicinal plants (consisting of 181 wild species and 98 domesticated plants) belonging to 225 genera and 83 families (Hidayat et al. 2020).

Most species belong to families of Fabaceae, Euphorbiaceae, and Moraceae. Fabaceae is of great ethnobotanical importance in indigenous and urban communities throughout the world (Morales & Ladio 2012). Fabaceae is one of the largest families of ethnopharmacological and has great importance in the use of medicinal plants, such as for the treatment and/or healing of various bodily systems (Macêdo et al. 2018). The Fabaceae family can adapt in the tropics to conditions of low soil fertility and acid pH (Maswar 2004). Fabaceae is a family of plants that can help the fertility of the soil because of its symbiosis with Rhizobium, which can fix nitrogen (N). The Fabaceae plant group is often used in a variety of general treatments such as fever, cough, sore eyes, indigestion, and anti-cancer. The results of this recapitulation are not much different from the results of recapitulation in other studies which used 28 ethnic samplings, with the largest family for medicinal tree habitus being Fabaceae with 41 species, followed by Euphorbiaceae with 20 species (Hidayat 2022). Likewise, the recapitulation results for medicinal plants in Lesser Sunda Island (Macêdo et al. 2018), Fabaceae is the most habitus tree for medicinal plants. Aside from being a medicinal plant, the family Fabaceae is often grown as a source of vegetables and spice foods, such as tamarind (*Tamarindus indica* L.) and turi (*Sesbania grandiflora* L.), and some are used as fence plants in the garden (i.e. *Gliricidia aculate* (Kunth) and *Leucaena leucocephala* (Lam) de wit).

Euphorbiaceae or the spurge family is one of the largest and most genetically diverse plant families with nearly 322 genera and 8,910 species, ranging from large woody trees to simple weeds. The members of this family are mostly tolerant of various environmental conditions, notably in open and dry areas Polosakan & Alhamd (2012). Moreover, some of the members can be used as traditional medicine. These are usually applied to cure several diseases such as eczema, stroke, rheumatism, wound, toothache, swelling, itching, indigestion, gout, acne, cough, and malaria (Munawaroh et al. 2020). There are some with potential medicinal trees from the family Euphorbiaceae, for instance, trees in Bengkulu province, Sumatera island, namely candlenut (*Aleurites moluccanus* L.) wild), bone wood (*Euphorbia tirucalli* L.), *Jatropha curcas* L. and others (Kasrina & Zukmadini 2021). Furthermore, it explained that the use of these plants is for the treatment of tonsils, headaches, wound medicine, malaria, jaundice, magh, itching, colds, warts, heart disease and so forth. The literature study from Maulana et al. (2023) found that some plants from the Euphorbiaceae family have pharmacological activities, and the most dominant is antimicrobial, antioxidant, anti-inflammatory, analgesic, antipyretic, antithrombotic, anti – hypercholesterolemia, antihyperglycemic, antihistamine, diuretic, and antiseptic.

Regarding Moraceae, there are ten species of Moraceae have been used by the local communities as traditional medicine (Sahromi 2021). The species consisted of *Artocarpus elasticus* Reinw. Ex Blume, *A. altilis* (Parkinson) Fosberg, *Ficus adenosperma* Miq., *F. ampelos* Burm.f., *F.*

*fistulosa* Reinw. Ex Blume, *F. religiosa* L., *F. variegate* Blume, *Milicia excels* Welw., *Morus alba* L., and *Streblus asper* Lour.

The results of this study are also almost the same as the results from Polosakan and Alhamd (2012) where there are similarities in 7 families which are included in the top 10 most medicinal plant species, namely Fabaceae, Euphorbiaceae, Moraceae, Lauraceae, Malvaceae, Moraceae, and Rubiaceae. Likewise, the genus that has many species of the highest medicinal plants belongs to Ficus. Ficus is a plant that has various life forms and is abundant in tropical forests due to its ability to bear fruit throughout the year (Hasanah et al. 2017). This has made several Ficus species tried as an alternative to natural medicine. Ficus fruit is used as a traditional medicine because it contains laxatives, flavonoids, sugars, vitamins A and C, acids and enzymes (Nur'aini 2013).

One component of natural resources that is closely related to human life is plants. The problem, it is estimated that up to 30% of all species will be at serious risk of extinction by 2050 (Dunn 2017). It is estimated that the world could lose 25-50 plant taxa per year (Miranto et al. 2012, Dunn 2017). Until now, plants in Indonesia are facing an increasingly serious threat of extinction where 600 species are included in the endangered list, namely 116 species Critically Endangered (CR), 94 species Endangered (EN), 227 species Vulnerable (VU), and 163 Near Threatened (Widyatmoko, 2019). For medicinal plants with a tree habit, there were 19 species with CR status (16.38%), 38 species with EN status (40.42%) and 68 species with VU status (29.95%). This condition is very worrying for the existence of Indonesian plants because these plants will be increasingly threatened or become extinct if there is no meaningful protection and rescue, in the near or very near future. What is very worrying is the disappearance of several species of medicinal plants in their habitat, even on cultivated land. Some of the causes of the loss of this species can be due to human activities or natural disasters. Excessive human behavior tends to be the main factor causing the extinction of certain medicinal plant species. Forest damage due to changes in land use, uncontrolled harvesting, illegal logging, theft of forest products, various encroachments for settlements and plantations, are some examples of cases that occur in several forest areas rich in medicinal plants. Meanwhile, of the many species of medicinal plants, only 20-22% have been cultivated, while around 78% are obtained through direct extraction (exploitation) from the forest (Aminah et al. 2016). What has been described above is a phenomenon that must be corrected immediately for the survival of medicinal plants, especially tree habitus species. Therefore, we understand why Brugmansia is listed in IUCN Redlist although the plant is a potential weed; one of the strong justifications is the potential medicinal use to study (Hay 2014). Considering the large number of diversities of tree species potential for medicinal purposes in Indonesia, the study of plant distribution, genetic diversity, ethnobotanical studies, conservation and propagation, cultivation, and biochemical research to support pharmacological research that proves the biological activities of species that require further study is recommended.

## Conclusions

We can conclude that Indonesia has rich tree species as thousands of tree species distributed in Indonesia recorded has potential medicinal use. Some of them are native and even endemic

species. Due to the biodiversity declining happening in Indonesia which may result in these species extinction, it is compulsory to conserve those tree species for sustainable use in terms of bioprospecting to achieve human well-being today and in the future, not only for Indonesian but also for global people. These findings may be utilised as a basis for additional studies into secondary substances of the tree species and any other studies related to the potential medicinal use of each tree, which would be advantageous to researchers, herbal industries and users as well as regulators.

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