

Illicium difengpi (Illiciaceae)

Subjects: Plant Sciences

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I. difengpi (Illiciaceae) is an endemic and indigenous medicinal species that has been used to treat rheumatoid arthritis and traumatic injury in China; *I. difengpi* (Illiciaceae) can endure various abiotic stresses, especially extreme drought, and thus has scientific value for exploring adaptive mechanisms of tolerance to extreme drought and in the ecological restoration of karst rocky desertification areas; and the beautiful tree shapes of *I. difengpi* (Illiciaceae) give it potential ornamental value.

Keywords: karst ; *I. difengpi* (Illiciaceae) ; medicinal plant

1. Introduction

Illicium difengpi K.I.B. et K.I.M., a species belonging to the Illiciaceae family, is an endemic shrub in southwestern China. The stem and root bark of *I. difengpi* (Illiciaceae) is widely used to treat rheumatoid arthritis and traumatic injury in traditional Chinese medicine ^[1]. *I. difengpi* (Illiciaceae) is listed in the Chinese Pharmacopoeia, an official publication of drug standards and regulations ^[1]. Mainly distributed in Guangxi province, *I. difengpi* (Illiciaceae) is a medicinal plant unique to karst rocky mountains that has considerable medicinal, scientific, ornamental, and ecological value, and its utilization potential needs further exploration and development ^[2]. In recent years, wild resources of *I. difengpi* (Illiciaceae) have sharply declined due to the narrow habitats, naturally low reproductive capacity, deforestation, and overexcavation, rendering this plant an endangered species.

2. Distribution of Wild Resources and Habitat Characteristics of *I. difengpi* (Illiciaceae)

Wild *I. difengpi* (Illiciaceae) populations are mainly distributed in the karst mountain areas of Guangxi, China, with the largest distribution area in southwestern Guangxi, i.e., Longzhou county, followed by those in central (i.e., Dou'an county) and northwestern (i.e., Tian'e county) Guangxi. Wild *I. difengpi* (Illiciaceae) plants often grow on top of karst hills and can also be found in sparse forests on rocky slopes. Geographically, the plants are mostly distributed at longitudes of 106°1'39.6"–108°46'20.6" and latitudes of 22°18'15.4"–25°2'33", with altitudes of 450–1200 m (most frequently, 500–800 m) ^[2].

In karst habitats, *I. difengpi* (Illiciaceae) plants are often under the combined stress of drought, high temperatures, and high salinity, which all create a harsh growing environment. The harsh karst habitat tends to further deteriorate over time. On the one hand, karst mountains with rocky desertification are more prone to drought, and drought exacerbates rocky desertification ^[3]; on the other hand, the frequency and extent of high temperatures under global warming are increasing, and high temperatures aggravate soil moisture loss, intensifying the effect of high temperatures on dry soil. High temperatures and drought usually occur simultaneously, leading to a vicious cycle ^[4]. Against the background of global climate change, the impact of karst habitat adversity on the growth and distribution of wild *I. difengpi* (Illiciaceae) resources is increasingly serious.

3. Morphological and Structural Characteristics of *I. difengpi* (Illiciaceae)

I. difengpi (Illiciaceae) is an evergreen shrub that is usually 2–3 m in height but can grow to 6–7 m ^[2]. The roots, leaves, flowers, fruit, and seeds of *I. difengpi* (Illiciaceae) show unique morphological characteristics (Table 1), and the whole plant exhibits an aromatic fragrance. The stripped bark of the *I. difengpi* (Illiciaceae) plant, which is used as medicine, takes the form of a roll or trough and measures 5–15 cm in length, 1–4 cm in diameter, and 0.2–0.3 cm in thickness. The outer surface of the bark is pale to dark brown and shows gray–white lichen spots in some cases, the coarse skin of which

is prone to peeling or falling off, leaving a brownish–red color in its place. The inner surface is brown or brownish red with obvious fine longitudinal wrinkles. The bark is brittle and shows a granular cross-section. The bark smells slightly aromatic and tastes slightly astringent.

Table 1. Morphological characteristics of *I. difengpi* (Illiciaceae) plants.

Part	Characteristics
Root	Cylindrical with dark reddish-brown outer skin and reddish-brown inner skin.
Branch	Young branches are brown, and old branches are gray.
Leaf	Alternating leaves mostly clustered at the tips of branches or nodes, with 3–5 leaves each; leathery or thick and leathery; oblanceolate, oblong, or obovate–elliptic in shape; acuminate with a short tip; a cuneate or broadly cuneate leaf base; shiny on both sides; holophyllus.
Flower	Red solitary flowers or 2–4 flowers in a cluster at the top of a branch or axillary flowers; 15–20 flower tepals, 21–23 stamens, and 13 carpels when flowering, which are arranged in a circle on the raised torus; a curved end, diamond-shaped stigma, and 2.5–3.5 mm long style.
Fruit	Aggregate, often with 9 to 11 mature carpels; 2.5 to 3 cm in diameter; lignified follicles and inwardly curved tips measuring 3 to 5 mm in length.
Seed	Ovoid in shape; yellow; shiny; 6–7 mm long.

4. Chemical Composition and Pharmacological Effects of *I. difengpi* (Illiciaceae)

The stem and root barks of *I. difengpi* (Illiciaceae) are mainly used as medicines to treat rheumatoid arthritis, lumbar muscle strain, and traumatic injury. Pharmacologically, the triterpenoids, neolignans, and amides showed anti-inflammatory and anticonvulsant activities [5][6][7]. Thus, *I. difengpi* (Illiciaceae) belongs to the subcategory of antirheumatic drugs that relieve rheumatism, and strengthen muscles and bones [8][7]. Yao [9] found that drinking the medicinal liquor of *I. difengpi* (Illiciaceae) bark is an effective treatment for rheumatoid arthritis. Liu et al. [10] showed that, in mice, the extract of *I. difengpi* (Illiciaceae) bark can slow the increase in abdominal capillary permeability caused by acetic acid, relieve ear swelling caused by croton oil, and increase the pain threshold of mice to light radiation heat. *I. difengpi* (Illiciaceae) has a certain toxicity, and some of the oils (safrole, linalool, and germacrene D) extracted from *I. difengpi* (Illiciaceae) are lethal to some agricultural pests [11] and should be treated with caution in clinical applications. Although some progress was achieved, the medicinally effective constituents in *I. difengpi* (Illiciaceae) have not yet been clarified.

5. Utilization Value of *I. difengpi* (Illiciaceae)

5.1. Medicinal Value

I. difengpi (Illiciaceae) is not only an endemic Chinese medicinal material in the Chinese Pharmacopoeia, but also a famous Zhuang medicine in Guangxi, China [1]. The species has been used in a large number of Chinese patented medicines for the treatment of rheumatic diseases, such as Fenghan Shuangliguai tablets, Fengshi Antai tablets, Zhuifeng Shujing Huoxue tablets, and Shujin pills. In addition, some endophytic fungi isolated from *I. difengpi* (Illiciaceae) can produce secondary metabolites with antibacterial activity (e.g., diterpenoids, phenols, and fatty acids) [12] and thus have great medicinal value.

5.2. Scientific Research Value

I. difengpi (Illiciaceae) is endemic to the karst area and a typical plant on the top of the karst mountains in Guangxi [13]. Individuals of this species can adapt to the extremely harsh living environment of the karst mountains, as supported by the fact that they can survive and grow on bare and semibare rock on the top of these mountains [2]. *I. difengpi* (Illiciaceae) can tolerate an extreme drought environment (during 30 consecutive days of drought stress with 10% soil water content), indicating that *I. difengpi* (Illiciaceae) has strong drought tolerance [14][15]. Drought is one of the greatest stresses threatening plant survival and development [16]. As a karst-specific medicinal plant, *I. difengpi* (Illiciaceae) has strong drought tolerance and can provide ideal testing material to study the mechanism of plant responses to extreme drought [8].

In our previous studies, we observed a large number of oil cells, stone cells, and mucous cells in the root bark, stem bark, and mesophylls of the *I. difengpi* (Illiciaceae) plant [14]. Oil cells are endocrine structures that produce secondary metabolites such as terpenoids, phenols, and lipids (including essential oils). The walls of stone cells are profoundly

lignified and thickened, giving the plant well-developed mechanical tissue. Mucous cells contain sophisticated rough endoplasmic reticula, Golgi complexes, coarse mucinogen granules, and the mucous cells of *I. difengpi* (Illiciaceae) mainly secrete viscous tannins. Both oil cells and stone cells contribute to the adaptability of *I. difengpi* (Illiciaceae) to various biotic and abiotic stresses, but the roles of mucous cells in the adaptability of *I. difengpi* (Illiciaceae) to extreme drought stress are still poorly understood, and the underlying mechanism needs further investigation.

I. difengpi (Illiciaceae) plants from different habitats are genetically diverse. During the process of germplasm collection, we found germplasm that blooms and bears fruit at the cotyledon stage. Generally, woody plants have a long growth and reproductive cycle, and bloom and bear fruit in the mature period. Few woody species begin to propagate at the young vegetative stage. The *I. difengpi* (Illiciaceae) germplasm described above, which blooms in the cotyledon stage, is an extremely rare short-life-cycle germplasm resource among woody plants that can provide model material for improving the growth period of woody plants. In terms of the genetic diversity of *I. difengpi* (Illiciaceae), Tang et al. [17] established a simple internal sequence repeat polymerase chain reaction system with high stability and good reproducibility that is suitable for analyzing genetic differences in this species, providing a technical basis for further genetic studies.

5.3. Ornamental Value

The leaves of *I. difengpi* (Illiciaceae) are red when young, and become dark green when mature. Alternating leaves exhibit interspecific differences in leaf shape, e.g., oblong, obovate–elliptic, and oblanceolate. The flowers of *I. difengpi* (Illiciaceae) are solitary, axillary, or perched on the tops of branches in clusters of 2–4 flowers, with 13 carpels arranged in a circle on the raised receptacle when blooming. The young fruits of *I. difengpi* (Illiciaceae), which are 2.5–3 cm in diameter, are red and clustered with 3–5 mm long inwardly curved tips. The leaves, flowers, and fruits have distinctive characteristics, and the tree has a beautiful shape, which gives it potential ornamental value.

5.4. Ecological Value

I. difengpi (Illiciaceae) can be utilized to restore rocky desertification areas and promote ecological stability in karst areas, as supported by the fact that the habitat of the karst stone mountains is harsh, and wild *I. difengpi* (Illiciaceae) is mostly distributed on the tops of karst limestone mountains at an altitude of 500–800 m due to its strong ability to adapt to drought and various abiotic stresses [2]. Intensive cultivation is currently an effective strategy to solve the shortage of wild *I. difengpi* (Illiciaceae) resources. We overcame technical challenges during artificial propagation (including seed propagation, cutting propagation, and rapid propagation through tissue culture) and the cultivation of *I. difengpi* (Illiciaceae) [18]. We are now conducting the simulative habitat cultivation of *I. difengpi* (Illiciaceae) in various karst mountainous areas, including Gongcheng county of Guilin city, Napo county of Baise city, and Fengshan county of Hechi city, which contributes to the restoration of the local karst ecology, the protection of endemic and endangered medicinal plants in the karst areas of Guangxi, and the boosting of local economic development [19].

Moreover, the extracts of *I. difengpi* (Illiciaceae) show an antagonistic effect on two major agricultural pests, *Sitophilus oryzae* and *Tribolium confusum* [11], and thus certainly have applied potentialities in agroecology. In short, *I. difengpi* (Illiciaceae) has considerable medicinal, scientific, ornamental, and ecological value, and its utilization potential needs further exploration and development.

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