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The Endangered Treasure of the Desert: Unveiling the Therapeutic Potential and Conservation Needs of Tecomellaundulata

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ABSTRACT

The endangered tree species Tecomellaundulata, which is indigenous to the desert regions of India and Pakistan, is thoroughly described in this review study. The plant, which goes by the popular names "Rohida" and "Desert Teak," is prized for its superior wood, beautiful flowers, and wide range of traditional medicinal use. The review summarizes recent studies on the phytochemical makeup of the plant, highlighting important bioactive substances as triterpenoids (oleanolic acid), naphthoquinones (lapachol), and other flavonoids. It draws attention to the plant's many pharmacological activities, including as its well-established antibacterial, anticancer, and hepatoprotective qualities, all of which support its traditional medicinal uses. The crucial ecological significance that T. undulata plays in maintaining desert ecosystems and offering wildlife habitat is also examined in the essay. It also discusses the conservation issues that have caused the species to be classified as "Endangered" by the IUCN, including overexploitation, inadequate natural regeneration, and the anticipated harmful effects of climate change. The analysis concludes by outlining the conservation tactics and future research avenues required to guarantee the long-term survival and sustainable use of this priceless ecological and therapeutic resource.

INTRODUCTION

Tecomellaundulata (Sm.) Seem., a little tree found in desert regions of India, Pakistan, and Arabia, is significant commercially and pharmaceutically. It belongs to the Bignoniaceae family. Known as "Desert teak" or "Marwar teak," it is the primary lumber source among the tree species found in Rajasthan, India's desert region. In both the traditional and traditional branches of indigenous medicine, T. undulata has a well-established reputation for having beneficial therapeutic qualities. Numerous medicinal properties of plants, including hepatoprotective, antibacterial, antimicrobial, antifungal, anti-termite, immunomodulatory, anticancer, cytotoxic, analgesic, anti-inflammatory, and anti-obesity properties, are well documented.Traditionally, seeds are used to proliferate it; however, because of airborne seed distribution to far locations, harsh weather conditions during seed dispersal, inappropriate seed harvest and storage, and short seed viability, natural plant regeneration is low. The tree grows very slowly, and there are no effective vegetative propagation techniques for its quick growth. In vitro methods have also been tried to propagate this tree, however they have a number of drawbacks, such as slow growth, low rooting rates, field establishing rates, and challenges with culture establishment.[1]

VERNACULAR NAME

Bombay: Lohera, Lohuri, Rakhtreora, Rugtrora, Roira; Bolan: Parpuk; Baluchistan: Rori; Hindi: Sanskrit: Chalachhada, Kushalmali, Kutashalmali; Sind: Khen, Lahero, Lohuri; Punjab: Lahura, Luar, Rohira, Roir; Pushtu: Raidawan, Rebdan, Rebdun; Rugtrora, Lasbala: Lahira; Marathi: Rakhtroda, Raktarohida, Marara: Rohira, Roira.

SYNONYMS:

Bignonia undulata Sm., Tecomaundulata G. Don.
Trade names include Marwar teak, Rohida tree, and desert teak.

CLASSIFICATION IN SCIENCE

Genus: Tecomella;
Species: T. Undulata;
Binomial Name: TecomellaUndulata;
Kingdom: Plantae;
Order: Lamiales;
Family: Bignoniaceae.[2]

PLANT DISCRIPTION

Tecomella is a big tree or shrub with greyish-green leaves and drooping branches. The tree grows to a height of roughly 2.5 to 5 meters. Simple leaves range in length from 5 to 12.5 cm.
and narrowly oblong, obtuse, whole, with undulating borders, measuring 1 to 3.2 cm in breadth. The flowers are big, lovely, orange, and smellless. Corymbose flowers are found in few-flowered racemes with short lateral branches that terminate, pedicles that are 6 to 13 mm long, calyxes that are 9.5 to 11 mm long, and campanulate. Flowers come in yellow, red, and orange hues and are exquisitely colored.The flower is regarded as Rajasthan's state flower. Lobes are obtuse, mucronate, roughly oval, and 3 mm long. The corolla is orange-yellow, campanulate, veined, and 3.8–6.3 cm long. Lobes are rounded to five subequals. Filaments are glabrous and stamens are exerted. Lobes are spherical, spathulate-oblong, and stigma are two lamellate. April and May are when the tree blossoms, and then it starts to produce fruit. The capsules are 20 by 1 cm, sharp, smooth, linear-oblong, and slightly curled. The valves are narrow. The seeds are 1 cm by 2.5 cm. Wings are nonexistent at the base of the seed and extremely narrow around the apex.[3]

DISTRIBUTION

India and Arabia are the origins of the economically and medicinally significant plant Tecomellaundulata (Sm.) Seem (Randhawa and Mukhopadhyay, 1986). The allocation of Only the drier regions of Arabia, southern Pakistan, and northwest India, up to an elevation of 1200 meters, are home to Tecomellaundulata (Tewari, 2007). It can be found in Pakistan's Baluchistan and Sindh areas. It is found in Maharashtra, Gujarat, Rajasthan, Punjab, and Haryana, India. The species is primarily found in Rajasthan's western regions. Its population is small and extremely uncommon in other states. Tecomellaundulata grows in the districts of Barmer, Jaisalmer, Jodhpur, Pali, Ajmer, Nagaur, Bikaner, Churu, and Sikar in Rajasthan.[4]

MEDICINAL USES

According to Ayurveda, the herb is also helpful for urinary discharges caused by ìkaphaî, ìpittaî, splenic enlargement, leucorrhea, and leucoderma. In Sind, the bark of the young branches is frequently used as a syphilis treatment (Murray). Bark has choleretic, cardiotonic, and mildly relaxing properties. The plant's extract has antibacterial, antifungal, analgesic, hepatoprotective, anticancer, and antitermite properties. Additionally, Tecomellaundulata is used to treat eczema, syphilis, diabetes, and typhoid fever.[5]

PHYTOCHEMISTRY

The traditional use of T. undulata in Ayurveda and Unani medicine for various ailments has driven extensive phytochemical research. The plant's bark, leaves, and heartwood have been found to contain a diverse array of bioactive compounds, including;

- **Naphthoquinones:**Lapachol, α-lapachone, β-lapachone, and tecomaquinone-I are key quinonoid compounds found in the heartwood and roots.[6] Lapachol, in particular, is known for its antifungal and antitermite properties.[7]
- **Triterpenoids:**The leaves have yielded the triterpenoidsbetulinic acid, ursolic acid, and oleanolic acid. These substances have been shown to have anti-HIV action, and some of their derivatives have been shown to be more effective than conventional medications.[8]
- **Flavonoids and Glycosides:** The plant contains several flavone derivatives and iridoidglucosides, such as undulatin and 6-O-veratryl catalposide.[9]
- **Phytosterols:**Stigmasterol and β-sitosterol have been identified in various parts of the plant. The bark also contains tecomin, a novel iridoidglucoside.[10]

CONSERVATION STATUS & ECOLOGICAL SIGNIFICANCE

In dry habitats, T. undulata is an essential element that is vital to preserving ecological balance:

1. Soil and Habitat Stabilizer: The tree's wide lateral roots serve as a natural windbreak and stabilize shifting sand dunes, making it a great soil binder. The fight against desertification depends on this function.[11]

2. Agroforestry and Fodder: This species is valuable for its ability to produce charcoal, fuelwood, and lumber. Particularly during dry seasons, its leaves and pods are valuable feed for animals such as sheep, goats, and camels.[12]

3. Biodiversity: The tree contributes to local biodiversity by acting as a nesting spot for birds and a vital habitat for desert species.[13]
Despite its importance, the species is facing a severe threat. It is categorized as "Endangered" by the IUCN [18]. The primary threats include:

- **Overexploitation:** Careless and unsustainable wild harvesting has resulted from the considerable demand for its premium timber for furniture and medicinal bark.[14]
- **Poor Regeneration:** Because of poor seed viability and unfavorable environmental conditions, natural regeneration proceeds slowly. Additionally, the tree grows slowly, and efficient vegetative propagation techniques for quick multiplication are still being developed .[15]
- **Climate Change:** Under several climate change scenarios, species distribution models project a considerable reduction in T. undulata's suitable habitats in the future .[16][17]
- **Abiotic and Biotic Stresses:** The species' survival is further impacted by a number of environmental stressors, such as drought, as well as diseases and pests.[18]

BIOACTIVITY IN MODERN SCIENCE

- **Hepatoprotective activity**
  In India, the medium-sized deciduous tree Tecomellaundulata (Bignoniaceae) is referred to as Rohitaka, Rohira, or Rakta-Rohida. Indigenous medical systems have utilized it to treat issues related to the liver, spleen, and abdomen (Kirtikar and Basu, 1984). Ferulic esters like octacosanylacetylferulate and octacosanylferulate are found in Tecomellaundulata bark. Moreover, it contains β-sitosterol, tectol, dehydrotectol, α-lapacone, tectoquinone, deoxylapachol, and lapachol. The bark also contains iridoidglucosides, including tecoside, tecomelloside, and undulatin (Verma et al., 1986). The bark has also been shown to contain two chromone glycosides, undulatoside-A and undulatoside-B (Gujral et al., 1979).[19]

- **Antimicrobial activity**
  Significant antibacterial activity and characteristics that support the plang's traditional use were demonstrated by the cnrde extracts of T. undulata, highlighting the need of ethno-pharmacological surveys in the selection of plants to check for bioactivity.[20]

- **Anti - Hyperglycemic activity**
  The T. undulata leaf extract treatments (250 mg/kg and 500 mg/kg) demonstrated hypoglycemia potential in varying progressive ways. This type of potential can be controlled synchronically or independently. action of having phytocompounds, such as 4,5-dihydroxy 3,6,8-trimethoxyflavones, betulinic acid, oleanolic acid, ursolic acid, triacontanol, cirsimaritin, cirilineol, pentariacontanol, and other phytocompounds as documented by earlier researches. The diabetic and treated animals showed significant and non-significant changes in body weight and organ weight, respectively. changes in the body and organ weight of diabetic and treated mice as a result of streptozotocin activity and phytocompounds' commensurate beneficial effects on hyperglycemia.[21]

- **Antimutagenic activity**
  TA100 (AZS) Tecomellaundulata 74.7 ± 1.6 µg/ml According to earlier studies, flavonoids have the capacity to prevent mutations brought on by a variety of mutagens and to forecast the correlation between herbal extracts' strong antimutagenic activity and antioxidant potential. It has been documented that a few more secondary metabolites limit the mutation brought on by various mutagens.[22]

- **Antioxidant activity**
  The plasma level of malondialdehyde (MDA) and reduced glutathione (GSH) of normal and experimental animal in each group is shown in Figures 4 & 5. Plasma MDA level in plasma was significantly increased in STZ diabetic rats compared to normal rats. Treatment of STZ diabetic rats with Tecomellaundulata resulted in marked decrease in plasma level of MDA.[23]

CONCLUSION & FUTURE PERSPECTIVE

Tecomellaundulata is a complex plant with significant ecological, medical, and economic importance. Numerous pharmacological effects, including its potent hepatoprotective and antibacterial qualities, are highlighted by the substantial body of research, which also validates its traditional applications. Nonetheless, due to its vulnerable status, urgent and coordinated conservation measures are required. Future studies ought to concentrate on:

- **Genetic Improvement:** Developing breeding programs for genetic improvement and high-yield varieties.
- **Sustainable Propagation:** Researching effective and scalable vegetative propagation techniques, such as micropropagation, for rapid multiplication.[24]
- **Clinical Trials:** Conducting rigorous clinical trials to validate its traditional and preclinically-proven therapeutic benefits, particularly for conditions like NASH.
- **Conservation Strategies:** Implementing comprehensive conservation plans, including *in-situ* and *ex-situ* measures, to protect its natural populations and genetic diversity in the face of climate change.

To sum up, Tecomellaundulata is a promising natural medicine source, but its future is unclear. Pharmacological research and strong conservation measures must be used in concert to guarantee the long-term survival of this priceless "Desert Teak."

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