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Exploring Ethnobotanical Insights and the Role of Artificial Intelligence in Plant Identification of Red Bead Tree (Adenanthera pavonina L.)

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Abstract:

Adenanthera pavonina L., commonly known as the red bead tree or red sandalwood, is a deciduous tree native to the tropical regions of Asia, but it is widely distributed in India, Africa, and the Pacific Islands [1]. This review examines its traditional uses in folk medicine across various cultures, focusing on applications for ailments such as diarrhea, inflammation, rheumatism, asthma [2, 3]. Drawing from ethnopharmacological studies, the plant's leaves, seeds, bark, and roots have been employed for their purported antidiarrheal, anti-inflammatory, antimicrobial, and antioxidant properties [4, 5]. While scientific validation is ongoing, preliminary research supports some of these uses, highlighting potential bioactive compounds like flavonoids, saponins, and alkaloids [6, 7]. This paper synthesizes historical and cultural contexts, emphasizing the need for further clinical studies to substantiate safety and efficacy.

Key Words: Red bead tree, Mimosaceae, Traditional medicinal value,

Introduction:

Adenanthera pavonina L. belongs to the Fabaceae family (subfamily Mimosoideae) and is recognized for its vibrant red seeds, often used in jewelry and as weights in traditional trade due to their uniform mass (approximately 0.25 g per seed) [8]. The tree grows up to 15-20 meters tall, with bipinnate leaves, small yellowish flowers, and curved pods containing 8-12 seeds [9]. It thrives in tropical climates and has been naturalized in many regions beyond its native Southeast Asia and India [1].

Traditional medicine systems, including Ayurveda, Siddha, and folk practices in Africa and the Pacific, have long utilized parts of this tree [2]. The seeds, bark, leaves, and roots are prepared as decoctions, powders, or pastes to treat a range of conditions [3, 10]. This review compiles these uses, supported by available scientific literature, to provide a comprehensive overview.

Traditional Uses in Different Cultures

India and Ayurvedic Medicine

In India, A. pavonina is known as "Raktachandan" or "Manjadi." Ayurvedic texts describe its cooling, astringent, and anti-inflammatory properties [2, 9].

• **Seeds**: Used to treat boils, inflammations, and eye ailments. A paste of ground seeds is applied topically for skin eruptions and rheumatism. Internally, seed decoctions are used to address diarrhea, dysentery, and hemorrhages [5, 10].

• **Bark and Leaves:** Decoctions for chronic rheumatism, gout, and asthma. Bark infusions serve as antiseptics for wounds [3, 7].

• **Roots:** Employed in treating pulmonary issues and as a tonic for general debility [1].

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Studies indicate that rural communities in Maharashtra and Kerala use seed extracts for antidiarrheal purposes, aligning with its astringent tannins [8].

Sri Lanka and Traditional Practices

In Sri Lankan folk medicine, the plant is called "Madatiya."

• **Leaves and Bark:** Used for inflammatory conditions and as an antidiarrheal agent. A study documented its use in treating cancer in traditional formulas combined with other herbs [1,7].

• **Seeds:** Applied in ointments for skin diseases and joint pain [5].

Ethnopharmacological surveys highlight its role in managing diabetes and hypertension [2].

Africa and Pacific Islands

In West Africa (e.g., Nigeria), it's known as "Oyo" or "red bead vine."

• **Seeds and Bark:** Treat stomachaches, diarrhea, and urinary infections. Seed oil is used for skin care [1, 6].

• **Leaves:** Decoctions for fever, convulsions, and as an antimalarial [4].

In the Pacific (e.g., Fiji), seeds are roasted and eaten, with medicinal uses for respiratory issues [8].

Other Regions

In Brazil and the Caribbean, where the tree is introduced, leaves and seeds treat wounds and inflammation, reflecting adapted traditional uses [1, 7].

Bioactive Compounds Supporting Traditional Uses

Phytochemical analyses reveal compounds that may explain traditional applications:

• **Flavonoids and Saponins:** Anti-inflammatory and antioxidant effects, supporting use in rheumatism and skin conditions [3, 4].

• **Alkaloids and Tannins:** Astringent properties for diarrhea and wound healing [9, 10].

• **Steroids and Terpenoids:** Potential antimicrobial activity [6].

For instance, seed extracts show trypsin inhibitory proteins with potential antidiabetic effects by modulating enzyme activity [5].

Scientific Validation and Potential Applications

While traditional uses are widespread, scientific studies provide preliminary support:

• **Antidiarrheal:** Aqueous seed extracts reduced castor oil-induced diarrhea in rats, validating folk remedies [7, 10].

• **Anti-inflammatory:** Methanolic leaf extracts inhibited paw edema in animal models [3].

• **Antimicrobial:** Bark extracts showed activity against bacteria like Staphylococcus aureus [10].

• **Antioxidant:** High phenolic content in leaves correlates with free radical scavenging [4].

However, human clinical trials are limited, and toxicity studies suggest safety at traditional doses, though raw seeds contain antinutrients requiring cooking [1, 6].

Conclusion

Adenanthera pavonina L. represents a valuable repository of traditional knowledge, with documented applications across cultures for gastrointestinal, inflammatory, and infectious disorders. Its rich phytochemical profile featuring flavonoids, tannins, and trypsin inhibitors

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underpins these uses and holds promise for drug discovery and functional foods. On the other hand, transitioning from ethnopharmacological knowledge to clinical practice demands robust human trials, standardized extracts, and comprehensive toxicity profiling. Listing sustainable cultivation is vital to preserve this resource among growing demand and ecological pressures. Future interdisciplinary efforts, including AI-driven bioactive screening, could unlock its full therapeutic and industrial potential.

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