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Phytochemical and pharmacological screening of *Delonix regia*: A brief review

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Abstract

Delonix regia is an ornamental tree from the Fabaceae family. The '*Delonix*' genus includes various species like *Delonix regia* Rafin, *Delonix elata* etc. It is known to have anti-diarrheal, anti-inflammatory, antioxidant, hepatoprotective and antibacterial properties. It has been used in folk medicine throughout history to treat conditions such as constipation, pain, arthritis, hemiplegia, leukorrhea and rheumatism. Poinciana flowers are used as pills in herbal medicine and in the treatment of gynecological diseases. *Delonix elata* is believed to have antioxidant, and anti-inflammatory properties. This article provides an overview of Poinciana's botanical description, distribution and cultivation, ecological importance, ornamental value, botanical description, medicinal value and other uses as well as its polysaccharides content and pharmacological activities. Also, it provides a full description of *Delonix regia*, emphasizing its significance and problems, as well as recommendations for future research to maximize its benefits while limiting its shortcomings.

Keywords: *Delonix regia*, *Royal poinciana*, medicinal plant, phytochemistry, ornamental plant

Introduction

India is a country full of life; many researchers, environmentalists, and nature lovers from all over the world are in awe of and fascinated by its biodiversity due to the astounding variety of flora and fauna [1]. The numerous studies emphasize India's unique position as a biodiversity hotspot. Researchers have catalogued an astonishing number of species in diverse ecosystems, from the Western Ghats' endemic flora to the varied wildlife found in the Himalayan region. Research on Indian flora reveals a multitude of plant species, many of which are used in traditional medicine, agriculture, and various industries. The Western Ghats and north-eastern India are particularly rich in endemic plant species. Ayurveda, a traditional Indian system, is gaining great importance in the international market due to the side effects of allopathic systems of medicine and their high cost.

Delonix regia (Bojer, ex-Hook) Raffin (*Poinciana regia*, *Royal poinciana*, Gul mohar, Flame tree, or Flamboyant; Fabaceae, Caesalpinioideae) is a large ornamental tree with fern-like bipinnately compound leaves and attractive red peacock flowers [2]. It is native to Madagascar and East Africa. Its generic name, '*Delonix*', is derived from the Greek words delos (visible) and onyx (claw), referring to the prominently clawed petals. The specific name, '*regia*' is derived from the Latin word '*regis*'. The best-known species is Poinciana (*D. regia*). This deciduous tree has spread to tropical and subtropical regions worldwide, both as an ornamental tree and for its potential ecological benefits.

This review explores the botanical description, distribution, phytoconstituents medicinal uses, the ecological benefits of *Delonix regia*, the polysaccharides in it, and the challenges associated with them.

Scientific Classification [3]

Kingdom: Plantae

Phylum: Magnoliophyta

Class: Magnoliopsida

Subclass: Rosidae

Order: Fabales

Family: Fabaceae

Sub family: Caesalpinodeae

Genus: *Delonix*

Species : *Delonix regia* (Bojer ex Hook.) Raf.

Different species of *Delonix regia* ^[4]

D. decaryi (Flamboyant Tree)

D. decaryi (Flamboyant Tree)

D. elata (White Gul Mohur)

D. floribunda (Poinciana)

D. leucantha (Poinciana)

D. pumila (Poinciana)

D. regia (Flamboyant)

D. regia Kampong Yellow (Flamboyant Tree)

D. regia Smathers Gold (*Royal poinciana*)

Distribution and Habitat

It thrives in well-drained soils and prefers full sun, making it ideal for urban areas in countries with a suitable climate. This tree is often found in drought-prone areas and may shed its leaves to save water.

Ornamental value

All Phoenix trees are valuable because of their ornamental beauty ^[5]. Its broad stripes, thick leaves, and striking, eye-catching flowers make it a popular choice for landscaping and urban beauty. The tree has a striking visual impact during the blossoming season, which adds to its aesthetic appeal. The tree is often planted in parks, streets, and residential areas. During the flowering season, the beauty of the tree increases, and a magnificent view emerges.

Botanical Description

- 1. Stem:** Stem is woody, erect or ascending, arched, straight or outward. Stems or young branches are glabrous or sparsely glabrous. The body is large, broad, supported, and angled towards the base ^[6].
- 2. Leaves:** Each leaflet is further divided into 10 to 20 pairs of secondary pages, approximately 12 mm long ^[7]. Leaves are alternate, entire, oval-shaped, 8 to 20 inches long, and 1/2 inch across. It is mostly seen between April and August.
- 3. Flowers:** The flowers are hairless, five-lobed, and have a thick calyx ^[8]. The sepals are light red with yellow edges and green inside. Each flower has four clawed spatula petals. The fifth petal is longer and narrower than the others and is striped with white and yellow. The flowers are 2-3 cm wide, 5-6.5 cm long, and round. The number of stamens varies between nine and ten. Stamens are unisexual, unique, and completely free. Filaments are pink or red, hairy, and villous.
- 4. Fruits:** Fruits are brown from legumes and are commonly known as pods ^[9]. The fruits are flat, woody pods containing numerous seeds. The pods are about 30–50 cm long, green when young, dark brown, and hard when mature.
- 5. Bark:** The bark is smooth, grey-brown, slightly fissured, and covered with dots (lenticels). The bark is used as an antiperiodic and antipyretic agent. The flowers can be used to eliminate parasites, kill insects, treat gynecological diseases or colds, and reduce fever, pain, and diarrhoea ^[10-13].
- 6. Seeds:** The pod contain 10-12 hard glossy brownish seeds about 2 cm long ^[14].

Propagation and Cultivation

Despite its potential applications, this species develops slowly when reproduced from seeds because of dormancy ^[15]. Given

the importance of this species, continued propagation and conservation efforts are required. Identifying the best soil media for species proliferation is critical for successful conservation initiatives. *Delonix regia* propagates mostly through seeds, but it can also be propagated through cuttings. Seed germination can be difficult due to the stiff seed coat, which frequently needs scarification to promote water absorption. Mechanical scarification and soaking seeds in hot water are traditional ways of increasing germination rates. Once germinated, seedlings require well-drained soil and direct sunlight to grow. Once established, the tree is very drought-tolerant; however, it does benefit from regular hydration throughout its early growth period.

Shade and shelter

Delonix regia's large canopy provides plenty of shade, making it an ideal tree for creating shaded areas in hot weather ^[16]. It is frequently planted in playgrounds, parks, and sidewalks to provide shade from the sun. The shade also helps to lower temperatures in metropolitan areas, making them more comfortable.

Maintenance

The tree requires constant care, especially in urban areas. Its enormous pods can produce litter, and the broad root system can harm pavements and underground services. Pruning is frequently required to control its growth and retain its shape ^[10].

Pest and Disease Control

Poinciana is susceptible to many pests and diseases, including root rot, leaf spot, and leaf beetle. Effective management strategies include regular monitoring, the use of various preventive measures, and appropriate leadership ^[10]. Conservation efforts are important for protecting the natural habitats of animals. Ex-situ conservation, such as botanical gardens and seed banks, plays an important role in preserving genetic diversity. Reducing the heat island effects of climate change in the city. The tree is also known for its ability to increase soil fertility through nitrogen fixation, a characteristic of legume plants. Additionally, vibrant flowers support local biodiversity by attracting many pollinators, including bees, birds, and bats.

Conservation Status

Delonix regia is threatened by habitat degradation and overharvesting ^[10]. Conservation activities are critical for preserving this species in its natural habitat. Ex-situ conservation, such as botanical gardens and seed banks, is critical for preserving genetic variety.

Ecological Significance

Delonix regia's dense canopy offers much-needed shade in hot climates, helping to reduce the urban heat island effect. The tree is also noted for its ability to improve soil fertility through nitrogen fixation, which is characteristic of the Fabaceae family. Furthermore, the vivid flowers attract diverse pollinators, such as bees, birds, and bats, promoting local biodiversity.

Phytoconstituents of *Delonix regia*

The *Delonix regia* tree produces a thick mucilage of water-soluble gum in yellowish or reddish-brown warty tears, and its seeds contain gum that can be used in the textile and food industries. Its flowers contain amino acids, proteins, cardiac

glycosides, alkaloids, flavonoids, tannins, phenolic compounds, saponins, steroids, carotenoids, and anthocyanins. In addition to this, it contains cyanidine 3-O-glucoside, cyanidine 3-O-rutinoside, pelargonidine 3-O-rutinoside, zeaxanthin, carotenoids, and natural dyes [17-20]. Furthermore, it includes flavonoids, which have wound healing properties [21]. The floral components are abundant in 1,2-benzene dicarboxylic acid. The seeds contain lectin, fatty acids, proteins, and a free amino acid [22]. It also contains polysaccharides (galactomannan), crude fibres, minerals such as potassium, magnesium, calcium, phosphates, sodium, iron, zinc, manganese, copper, and vitamins [23]. Fruits consist of activated carbon [24]. The leaves contain flavonoids, phenolic substances, triterpenoids, lupeol, phenolic acid, and β -sitosterol [25-26]. The root and stem include lupeols, eulupeol, β -sitosterol, sitmasterol, and p-methoxy benzaldehyde [27-28]. It also functions as a natural colour and an acid-base indicator.

Medicinal uses

Apart from ornamentation, many components of *Delonix regia* have been employed in traditional medicine. Its leaf extract is used for hypoglycemic, antioxidant, antibacterial, cardio protective, anti-inflammatory, diuretic, wound healing, anticancer, and antidiabetic properties [29-31]. Flowers are commonly employed as pro-vitamin A in the culinary, pharmaceutical, and cosmetic industries, as well as for dysmenorrhoea, febrile illness, and diarrhoea. antiulcer, anti-diarrheal, anthelmintic, hepatoprotective, cytotoxic, antioxidant, antibacterial, and in constipation, inflammatory conditions [32-33]. Seeds are used as antidiabetics and antioxidants. Seed gum is employed as a binder in sustained-release dosage forms [7,19]. Bark is used for its antioxidant, antimicrobial, antibacterial, wound healing, antimalarial, and antioxidant properties [34-35]. Aerial components are used as anti-periodic and febrifuges.

Other uses of *Delonix regia* [36-38]

I. Leaf extract

Traditional Medicine: The leaves' therapeutic qualities are employed in traditional medicine. Leaf extracts are applied topically to treat wounds, skin diseases, and fevers. Often, the crushed leaves are used in herbal teas or as a topical application.

Enhancement of Soil Fertility: *Delonix regia* leaves have a major impact on enhancing soil fertility. Through its root nodules, it can fix atmospheric nitrogen, raising the nitrogen content of the soil. As the leaves fall, they break down and enrich the soil with organic matter, enhancing its fertility and structure.

Animal Feed: *Delonix regia* leaves are used as animal feed in some areas. They offer cattle a nutrient-dense addition to their diets, especially in dry seasons when there is a shortage of other fodder.

II. Flowers

Traditional Medicine: The blooms of *Delonix regia* are used in traditional medicine to treat respiratory conditions, asthma attacks, and urinary tract infections. For these therapeutic purposes, the blossoms are frequently made into decoctions or infusions.

Ornamental Uses: The most famous application for *Delonix regia* flowers is for ornaments. The big, vivid orange or red blooms are highly prized in landscaping and are frequently utilised to enhance streetscapes, parks, and gardens.

Production of Dye: Natural dyes are also made from the flowers of the *Delonix regia* plant. An environmentally beneficial substitute for synthetic dyes in fabric colouring is the pigment that can be taken from the flowers.

III. Seeds

Traditional Medicine: The seeds are also used in traditional medicine for their antipyretic and anthelmintic effects. In some cultures, the seeds are ground into a powder and used to cure intestinal parasites. They are also used to treat fevers and intestinal issues.

Ornamental Uses: *Delonix regia* seeds are occasionally used in craft and jewellery manufacturing. Their distinctive form and silky texture make them ideal for making beads, bracelets, and other decorative products. This use emphasizes the aesthetic and economic importance of the seeds in artisanal goods.

IV. Bark

Traditional Medicine: *Delonix regia* bark is rich in tannins and has long been utilised for its therapeutic characteristics, including astringent and antidiarrheal effects. Bark extracts are used to treat diarrhoea, dysentery, and other digestive problems. The bark is often boiled to extract the active components, which can subsequently be ingested or applied topically.

Tanning and dyeing: The bark's high tannin concentration makes it ideal for tanning leather. The tannins help to preserve and reinforce the leather, increasing its durability. Furthermore, the bark can be utilised to create natural dyes for dyeing clothes and other materials, offering an environmentally beneficial alternative to synthetic chemicals.

IV. Root

Traditional Medicine: *Delonix regia* roots have been utilised in traditional medicine for their therapeutic characteristics, including analgesic and anti-inflammatory actions, notably in illnesses such as arthritis and rheumatism. The therapeutic ingredients are often extracted from the roots by boiling or infusing them.

Soil Stabilization: The vast root system anchors the soil and reduces the risk of erosion. This makes the tree ideal for planting in places prone to landslides and soil erosion.

Polysaccharides in *Delonix regia*

Polysaccharides are natural complex biomolecules (Carbohydrates) composed of a lengthy chain of monosaccharides connected by various glycosidic connections [39-40]. They can be acquired from natural sources such as microbes, plants, animals, and bacteria and play an important part in biological processes. They have demonstrated promising antioxidant, anticancer, immunological regulatory, antiviral, anticoagulant, and other biological actions [41]. Researchers have recently focused on the utilization of hydrocolloids or gum, as well as hydrophilic polymers, in the design of novel drugs. Polysaccharides derived from natural sources are preferred among hydrophilic polymers because they are harmless, biocompatible, and biodegradable. The flowers and seeds of *Delonix regia* are abundant in polysaccharides and pigments. Polysaccharides have significant roles in a variety of physiological functions, including immunology and cell growth regulation. They provide a diverse selection of medical applications, health items, materials, and functional foods. These green biomedical products have significant commercial potential. Plant

polysaccharides have demonstrated antioxidant action. The antioxidant capabilities of monosaccharides are determined by their structure, which includes content, linking pattern, and sequence, as well as molecular conformation and stereo configuration. Polysaccharides, often known as prebiotics, have health and industrial benefits. They enhance gut microbial growth and are widely used in functional meals. Impurities are the most significant issue with innovative natural polymers. Seed polysaccharides from tamarind, locust bean, and guar typically have a dull brown appearance because of their seed colour^[10]. The other seed sections colors may discolor the polysaccharides during the extraction procedure. However, the polysaccharides obtained from the cotyledon section of *Delonix regia* seeds are very thick, have a high practical yield, remain transparent even after boiling, and do not stain. It is easy to wash, free of contaminants, and non-toxic. As a result, it is acceptable for use in pharmaceuticals. Polysaccharide demand has increased globally as a result of increased food additive consumption.

Krishnaraj K. *et al.* (2012) isolated from the seeds of *Delonix regia* and developed a sustained-release antipsychotic tablet^[10]. They concluded that the isolated polysaccharide from the seeds of *D. regia* exhibited good physicochemical properties and did not show toxicity.

Aryantha NP *et al.* (2002)^[42] isolated polysaccharides from *Delonix regia* trees and prepared their extract in hot water^[42]. They concluded that the isolated polysaccharides are effective against the local strains of *Ganoderma tropicum* and *Ganoderma lucidum*, suggesting their medicinal value.

Elhassaneen YA *et al.* (2024) produced seed powder from *Delonix regia*^[43]. They next extracted polysaccharides, estimated carbohydrate content, and investigated their varied actions against carbon tetrachloride-induced biochemical and histological disorders in rat liver. They determined that *Delonix regia* seed powder (DRSP) is effective in the prevention and treatment of hepatotoxicity.

Pharmacological Activities

1. **Antioxidant activity:** The antioxidant activity of *Delonix regia* is investigated by extracting the leaves, flowers, and bark of *Delonix regia* Raffin in absolute methanol, absolute ethanol, absolute acetone, 80% methanol, 80% ethanol, 80% acetone, and deionized water. The plant's blooms contain polyphenols and flavonoids that may have antioxidant qualities.

Ebada D *et al.* (2023) isolated pigments and polysaccharides from *Delonix regia* flowers to study their antioxidant, anticancer, and antibacterial activity *in vitro*^[20]. They determined the existence of carbohydrates and anthocyanins, which are responsible for antioxidant, anticancer, and antibacterial properties.

2. **Antimicrobial activity:** A dichloromethane extract of *Delonix regia* leaves is used to separate scopoletin, a saponin with antifungal and antibacterial properties against *Candida albicans*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis*^[44]. Plant extracts were ineffective against the fungus *Apergillus niger* and *Trichophyton mentagrophytes*.

Xavier *et al.* (2012) studied *Delonix regia*'s antibacterial activity by preparing a methanolic extract^[45]. They concluded that a methanolic extract of *Delonix regia* root bark had substantial antibacterial activity.

3. **Anthelmintic effect:** Both aqueous and methanolic extracts of *Delonix regia* have significant anthelmintic

activity^[17]. The methanolic extract has the strongest anthelmintic action.

4. **Wound Healing Activity:** Ethanolic and aqueous extracts of *Delonix regia* flowers are tested for wound healing activities. Obeagu EI *et al.* investigated the wound-healing properties of *Delonix regia* in albino rats and concluded that the aqueous and ethanolic extracts exhibited rapid wound-healing activity^[46].

5. **Gastro protective effects:** An ethanolic extract of *Delonix regia* Rafin's flowers demonstrated gastro protective efficacy in an experimentally produced ulcer condition. Sachan N *et al.* (2015)^[47] evaluated the gastro protective capability of stem bark of *Delonix regia* in ethanol and cold restrict stress-induced ulcer in rats and experimental rats, and they concluded that ethanol extract of *Delonix regia* has gastro protective impact, which may be related to its antioxidant action^[47].

6. **Hepatoprotective activity:** A methanolic extract of *Delonix regia* aerial parts inhibited carbon tetrachloride-induced hypersensitivity in rats.

EI-Sayed *et al.* (2011)^[18] investigated the hepatoprotective and cytotropic effects of an ethanolic extract of *Delonix regia* flowers and discovered that the extract exhibits considerable hepatoprotective and cytotropic action in a dose-dependent manner^[18].

Future Research Directions

There is a need for extensive investigation into the ecological effects of *Delonix regia* in non-native habitats. Research on its possible invasiveness, involvement in carbon sequestration, and therapeutic characteristics could yield useful insights. Furthermore, breeding studies targeted at generating less invasive and more hardy types may improve its utility in urban environments.

Challenges and Considerations

While *Delonix regia* is appreciated for its beauty and function, it can present certain issues. The tree's large root system can harm pavements and underground utilities, necessitating frequent maintenance. Furthermore, in some areas, it has demonstrated invasive tendencies, potentially replacing native plants. To address these issues and preserve *Delonix*'s long-term viability, effective management solutions are required.

Conclusion

Delonix regia is a versatile tree with exceptional beauty and utility in diverse parts. This tree has tremendous significance, including decorative, ecological, and environmental benefits, as well as applications in traditional medicine and crafts. While it does bring certain obstacles, particularly in terms of upkeep and potential invasiveness, the benefits frequently outweigh the downsides. However, careful management and additional research are required to maximize its benefits and handle the issues it poses, ensuring that it remains a valued asset in tropical and subtropical locations around the world.

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