# A Comprehensive Review on the Therapeutic Potential of Calliandra haematocephala Hassk (Red Powder Puff)

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***Abstract*— Calliandra haematocephala Hassk, commonly known as Red Powder Puff, is a tropical ornamental plant belonging to the family Fabaceae that has recently gained scientific attention for its medicinal potential. Although primarily cultivated for its aesthetic value, various parts of the plant—including leaves, flowers, bark, and roots—are rich in bioactive phytochemicals such as flavonoids, phenolic compounds, tannins, saponins, alkaloids, glycosides, terpenoids, and steroids. These constituents are responsible for a wide range of pharmacological activities. The present review compiles and critically analyzes available literature on the botanical characteristics, phytochemical profile, traditional uses, and therapeutic properties of Calliandra haematocephala. Reported pharmacological activities include antioxidant, antibacterial, antifungal, antidiabetic, gastroprotective, immunoadjuvant, anti-inflammatory, and analgesic effects, supported by in-vitro and in-vivo studies. Key compounds such as quercetin, betulinic acid, lupeol, and β-sitosterol play a significant role in these biological activities. Despite promising findings, scientific data on this plant remain limited and fragmented. This review highlights the therapeutic relevance of Calliandra haematocephala and emphasizes the need for further pharmacological, toxicological, and clinical investigations to validate its efficacy and support its potential development as a natural therapeutic agent.**

***Key words*— Calliandra haematocephala, Ornamental plant, Phytochemistry, Therapeutic aspects**

## I. INTRODUCTION

Medicinal plants are natural sources of therapeutic agents and have been used since ancient times for the prevention and treatment of various diseases. They play an important role in traditional and modern systems of medicine due to their effectiveness, affordability, and comparatively fewer side effects. Medicinal plants contain a wide range of bioactive compounds, commonly known as phytochemicals, such as flavonoids, phenolic compounds, alkaloids, tannins, and saponins, which are responsible for their diverse pharmacological activities.

In recent years, there has been increasing scientific interest in plant-based medicines because of the limitations associated with synthetic drugs, including drug resistance and adverse effects. This has encouraged researchers to explore not only traditionally used medicinal plants but also ornamental plants for their hidden therapeutic potential. Calliandra haematocephala Hassk, commonly known as Red Powder Puff, is a tropical flowering plant belonging to the family Fabaceae and is widely cultivated for its attractive red inflorescences.

Although Calliandra haematocephala is mainly grown as an ornamental plant, various studies have reported that different parts of the plant, such as leaves, flowers, and bark, contain important phytochemical constituents. These compounds are known to exhibit several biological activities, including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and analgesic effects. Traditional uses of the plant in folk medicine further support its medicinal relevance.

However, the scientific information available on the therapeutic potential of Calliandra haematocephala is limited and scattered. Therefore, a comprehensive review is necessary to compile and analyze existing data related to its botanical characteristics, phytochemical profile, and pharmacological activities.


Figure1: leaves of Calliandra haematocephala.

Figure2: flower

Figure3: plant of Calliandra haematocephala.

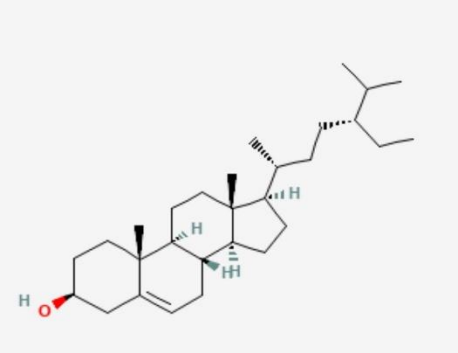
Figure4: budding

## II. PHYTOCHEMISTRY

Calliandra haematocephala contains a diverse array of bioactive compounds across its various parts, contributing to its medicinal potential. Its chemical profile includes phenolics, flavonoids, polysaccharides, alkaloids, glycosides, triterpenes, saponins, steroids, tannins, terpenoids, carbohydrates, and proteins. Compounds like betulinic acid are noted for anticancer, anti-HIV, and anti-rotaviral effects, while phenolics, flavonoids, and saponins act as antioxidants and support liver protection by scavenging free radicals.

The leaves are rich in imino acids such as pipecolic acid and its derivatives, along with other bioactive compounds including p-hydroxybenzoic acid, betulinic acid, caffeic acid, protocatechuic acid, astilbin, neo-isoastilbin, and lupeol. Flavonoids and phenolic compounds, including quercetin, gallic acid, caffeic acid, and sinapic acid, have been identified from aerial parts, with volatile constituents making up over 90% of total plant volatiles.

Several acylated quercetin derivatives and other flavonoid glycosides have been isolated from the leaves and stems, alongside procyanidin-type condensed tannins that vary in galloylation depending on the plant part. These tannins exhibit strong antioxidant activity, often surpassing synthetic antioxidants, with the leaf showing the highest effect. Bark extracts contain catechin-3-O-rhamnoside with antibacterial properties, and hexane fractions reveal lupeol, sterols, and β-sitosterol. Overall, the plant offers a rich source of natural antioxidants, antibacterial agents, and bioactive compounds with potential therapeutic.

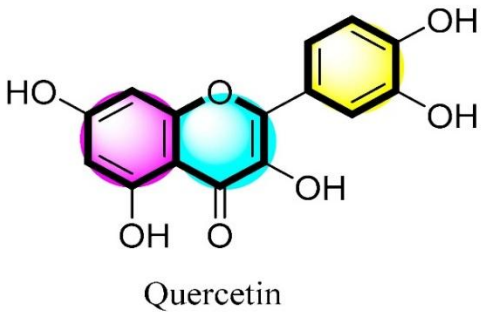


- Beta-sitosterol.

Scientific classification:-
Binomial Name - Calliandra haematocephala
Common Name - Red powder puff
Kingdom - Plantae
Order - Fabales
Family - Febaceae
Species - haematocephala

Antifungal activity :-
The red powder puff, scientifically known as Calliandra haematocephala, has been studied for its potential medicinal properties, including antifungal activity. Research suggests that extracts derived from different parts of this plant, such as leaves, flowers, or bark, contain bioactive compounds like flavonoids, tannins, saponins, and phenolic substances. These compounds are believed to interfere with the growth and reproduction of certain fungal species, thereby exhibiting antifungal effects.

Laboratory studies have demonstrated that extracts from the red powder puff can inhibit the growth of fungi responsible for skin infections and other fungal diseases. The exact mechanism is thought to involve disruption of the fungal cell membrane, inhibition of essential enzymes, or interference with fungal metabolism. However, the antifungal activity may vary depending on the method of extraction, the part of the plant used, and the concentration of the extract.




Quercetin

- Quercetin

While preliminary findings are promising, further studies are needed to determine the efficacy, safety, and potential therapeutic applications of red powder puff extracts as antifungal agents, particularly in clinical settings.

## III. ANTIDIABETIC ACTIVITY

1.Inhibition of Carbohydrate-Digesting Enzymes :
One of the well-studied antidiabetic actions of Calliandra haematocephalais its ability to inhibit digestive enzymes that break down carbohydrates, which can help reduce postprandial (after-meal) blood glucose spikes — a key therapeutic target in diabetes management.

Alpha-amylase and alpha-glucosidase inhibition: An ethanol leaf extract of C. haematocephala showed significant inhibitory activity against both α-amylase and α-glucosidase enzymes in vitro.The extract inhibited α-amylase by ~61% ($IC_{50} \approx 82.18$ µg/mL).It inhibited α-glucosidase by ~71% ($IC_{50} \approx 31.07$ µg/mL). For comparison, the standard antidiabetic drug acarbose inhibited these enzymes more strongly but with similar mechanistic profiles.
→ These findings suggest that C. haematocephala compounds can slow carbohydrate digestion and glucose absorption, helping moderate blood sugar levels after meals.

2. Phytochemicals Underlying Activity :
The antidiabetic potential of C. haematocephala is likely linked to its rich array of bioactive compounds, including:
Flavonoids
Phenolics
Alkaloids
Glycosides.
These phytochemicals are known to contribute to enzyme inhibition and antioxidant activity, which can protect pancreatic β-cells and support glucose metabolism.

3. Antioxidant Effects (Indirect Antidiabetic Support) :
While not a direct measure of blood glucose, C. haematocephala has antioxidant properties due to its flavonoid and phenolic constituents. Antioxidant activity is relevant because oxidative stress plays a role in diabetes progression and complications. Antioxidants may help preserve pancreatic function and improve insulin sensitivity. This supports

Calliandra haematocephala's overall potential in diabetes management, although direct in vivo blood glucose studies are limited.

## IV. ANTIBACTERIAL ACTIVITY

Research utilizing ethanolic extracts from the leaves, flowers, and bark has shown moderate to high inhibitory effects against both Gram-positive and Gram-negative bacteria. Specifically, the plant has exhibited notable zones of inhibition against Pseudomonas aeruginosa (12 mm), Salmonella typhi (12 mm), Bacillus subtilis (10 mm), and Staphylococcus aureus (9 mm). These antimicrobial properties are primarily attributed to its rich phytochemical profile, which includes flavonoids, tannins, alkaloids, and phenolic compounds such as gallic acid, caffeic acid, and catechin-3-O-rhamnoiside. Recent advancements have also explored the green synthesis of silver nanoparticles using C. haematocephala extracts, which further enhances its bactericidal efficiency, particularly against foodborne and multi-drug-resistant strains like Escherichia coli.

## V. IMMUNOADJUVANT ACTIVITY

Calliandra haematocephala (red powder puff) contains various bioactive compounds such as saponins, flavonoids, phenolics, glycosides, etc., which are associated with pharmacological effects including immunomodulatory activity.

Some studies have evaluated the plant's butanolic or alcoholic extracts and found evidence suggesting these extracts can enhance immune responses, acting like an immunoadjuvant — meaning they help boost the body's immune reaction to antigens when used alongside them. Saponins, one class of compounds present in the plant, are known from many plant-based studies to enhance antibody responses, cytokine (immune molecule) release, and cellular immunity by stimulating immune cells and signaling pathways. In traditional and phytopharmacological studies, red powder puff has also been shown to have immunomodulatory, anti-inflammatory, antimicrobial, and antioxidant effects, which overall support its role in health and immune support.

## VI. GASTROPROTECTIVE ACTIVITY

1.Plant and Phytochemicals :

Calliandra haematocephala is an ornamental shrub with traditional medicinal uses. Its leaves/flowers contain flavonoids, phenolics, saponins, alkaloids, glycosides, steroids and tannins compounds commonly linked to antioxidant and protective effects on tissues.

2. Evidence of Gastroprotective

A. Butanoli extract and gastric lesion:
A phytochemical screening and pharmacological evaluation of a butanolic extract of C. haematocephala showed gastroprotective activity.
In acidified ethanol-induced gastric lesion models, the extract reduced severity of acute gastric lesions and inhibited development of hemorrhagic and necrotic tissue injury, indicating a cytoprotective effect. This supports traditional use as a stomach protector.

B. Biochemical Basis (General Mechanisms):
The plant's secondary metabolites (flavonoids, tannins, phenolics) are known to exert antioxidant and free-radical scavenging effects, enhance mucosal defense, and potentially reduce gastric acid-mediated damage.

3. Related Anti-Inflammatory / Protective Activities
Extracts of C. haematocephala demonstrated anti-inflammatory, immunomodulatory and antioxidant actions, which frequently contribute to protection of gastric mucosa by decreasing inflammation and oxidative stress in the digestive tract.
In ulcerative colitis models, methanolic and hexane extracts exhibited amelioration of colonic damage, likely through modulation of cytokines, oxidative markers and inflammation pathways mechanisms that often overlap with gastroprotective activity.

Traditional Uses of Red Powder Puff
Medicinal Uses :-

- Blood purifier & tonic: Decoction of the flowers is traditionally used as a blood purifier and general tonic because of its antioxidant properties.
- Hemorrhoids: The roots are used in some regions (e.g., Nigeria) for relief from hemorrhoids.
- Inflammation & wounds: Crushed flowers or leaf preparations are applied to treat inflammation, skin ulcers, and wounds in traditional practice.

- Gastrointestinal issues: Leaf extracts have been used traditionally to help with diarrhea and digestive complaints.
- Anti-inflammatory: Traditional use includes reducing swelling and pain (e.g., associated with arthritis or skin irritation), linked to its bioactive compounds.

Non-Medicinal Traditional Uses :-

- Ornamental plant: Widely grown for its bright red “powder puff” flowers in gardens and landscaping around the world.
- Fodder/Forage: In some regions, parts of the plant are used as forage for livestock or as supplemental green manure.
- Agroforestry / Soil improvement: As a nitrogen-fixing legume, it is used in agroforestry systems to improve soil fertility.

## VII. CONCLUSION

This review gives an account of the knowledge on the morphology, phytochemistry and pharmacological aspects of Calliandra haematocephala (Hassk). Several alkaloids, glycosides, phenolic compounds, flavanoids and tannins have been reported to present in different parts of Calliandra haematocephala (Hassk). Every part of this plant and it's principle active constituents like quarcetin, betulinic acid has gained importance for its different pharmacological activities. The pharmacological studies so far have been performed in-vitro and in-vivo. The most important pharmacological properties of this plant include gastroprotective, antidiabetic, immunoadjuvant, anti-sickling, antifungal, etc. Traditionally, it’s different parts are used in folk medicines as anti-malarial and astringent. It is also used as a blood purifier. the data and studies presented in this review will help in new product planning and R & D.

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