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Unveiling Therapeutic Potential of *Cordia macleodii*: Ethnobotanical Insights and Modern Perspectives

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Abstract

Background: *Cordia macleodii* Hook. F. and Thomson, also referred to as "*Dahiman*," is a deciduous medicinal tree native to India. It has been used for a long time in traditional healing systems like *Ayurveda* and *Unani*. It is widely used by local communities to treat many health problems. Though it has great medicinal potential, it needs proper scientific study and clear documentation. **Aim:** This review looks at *C. macleodii*, its chemical compounds and modern medicinal applications, especially focusing on its growing importance in nanomedicine. **Methods:** The body of research on the taxonomy, pharmacognostic properties, and traditional applications of the plant in several Indian states was systematically reviewed. The effectiveness of its leaf, bark, and stem extracts in a range of biological tests was investigated experimentally. **Results:** Terpenoids, phenols, and flavonoids were among the important bioactive substances found by phytochemical screening. Its strong antioxidant activity (81.20% DPPH inhibition), remarkable wound-healing qualities, and significant antihypertensive and hepatoprotective benefits were all confirmed by scientific investigations. Additionally, improved antibacterial efficacy against multidrug-resistant organisms such as *Staphylococcus aureus* was shown by the green production of Silver Nanoparticles (AgNPs) employing stem extracts. **Conclusion:** *C. macleodii* is a therapeutic agent that may be used in a variety of ways and has a lot of potential for medication development. But because it is a vulnerable species, immediate conservation measures using seed-based propagation are required to guarantee its continued availability for pharmaceutical innovation.

Major Findings: The study verifies the effectiveness of *C. macleodii* as a strong antivenom against Naja lethality and proves its green manufacture of silver nanoparticles with high antibacterial power. Clinical evidence shows notable hepatoprotective and antihypertensive effects that are on par with those of common medications like silymarin in lowering serum biomarkers. After vegetative cutting attempts failed, seed-based propagation was determined to be the only successful restoration strategy for this endangered species.

Keywords: Biological Activity, *Cordia macleodii*, Ethnobotany, Pharmacology, Therapeutic

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1. Introduction

Cordia macleodii Hook. F and Thomson, commonly referred to as *Dahi Phalas* or *Dahiman*, is a deciduous medicinal tree native to the Indian subcontinent. It is characterised by white flowers and broadly ovate, green leaves with a cordate base and crenate-dentate margins. The plant holds significant medicinal value, as it has been shown to exhibit analgesic, anti-inflammatory, antimicrobial, wound healing,

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hepatoprotective, antioxidant, and acute toxicity-reducing properties.

Traditionally, the stem extract is used by local communities to reduce the harmful effects of alcohol consumption. The bark ethanolic extract is sometimes used as a remedy for snake bites as it is believed to have anti-venom properties. The paste of leaves is applied to wounds to help control bleeding. While powdered leaves are used as a remedy for mental health issues and high blood pressure. The other conditions, like liver swelling, jaundice, and obesity, are treated by powdered bark.

Several species of the *Cordia* genus, such as *C. dichotoma, C. latifolia, C. macleodii, C. myxa, C. rothii*, and *C. obliqua*, have a long history in traditional healing systems like *Ayurveda*, Siddha and *Unani*. These plants are commonly used to treat problems like wounds, boils, tumours, gout and ulcers, and also purify blood and reduce fever. The fruits of *C. macleodii* are traditionally utilised both as food additives and a remedy for stomach pain. The indigenous tribes of areas like Chhattisgarh, Madhya Pradesh, Odisha, and Chhota Nagpur have widely used this plant because of its healing properties. Phenols, terpenoids, saponins, volatile oils, flavonoids and glycosides are some of the beneficial natural compounds of this plant. Research on its plant properties suggests that its extract may help in establishing quality standards and verifying the authenticity of raw materials used in herbal medicines[1].

Table 1. Vernacular names in different languages

S. No.	Languages	Vernacular Name
1	**Sanskrit**	*Dadhimanth, Sitapatra*
2	**Hindi**	*Dahiman, Dahipalash, Dadhipalash, Dahipala Gadhapalash, Dhengan, Gonni, Kuhman, Bohad, Daiwas, Dahichir*
3	**Marathi**	*Bhoti, Dhaiwan, Daivas, Dhaim*
4	**Tamil**	*Palandekku*
5	**Telugu**	*Botuku, Peddabotuku, Iriki*
6	**Kannada**	*Bilichlle, Doddachelle*
7	**Oriya**	*Bhoto, Bohurolo, Baurlo, Sambarsinga, Shikari, Panki*
8	**Bengali**	*Sitapatra*

2. Vernacular Names

The common names of *C. macleodii* in different languages are listed in Table 1. The tree is widely known as "*Sitapatra*" (meaning Sita's letter) in Sanskrit and Bengali. This name comes from the leaves of this tree. Interestingly, when the upper surface of the leaves is scratched, it produces permanent black marks[2].

3. Taxonomy and Distribution of *Cordia macleodii*

Cordia macleodii belongs to the Kingdom Plantae and falls under the Phylum *Streptophyta*. It is classified within the Class *Equisetopsida* and the Subclass *Magnoliidae*. The plant is a member of the order Boraginales and the family *Boraginaceae*. It is categorised under the genus *Cordia*, with the specific species being *C. macleodii*[3]. The natural habitat of *C. macleodii* includes Uttarakhand and extends across various regions of North and Central India. This tree thrives predominantly in seasonally dry tropical environments. It is commonly found in the moist and dry deciduous forests of states such as Bihar, Chhattisgarh, Jharkhand, Gujarat, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, and West Bengal[4].

4. Morphological and Microscopic Characters

4.1 Morphology

Medium-sized deciduous tree, typically no taller than six meters (Figure 1A). Light brown is the colour of the bark. Light green, ovate to obtuse-ovate, and petiolate, the leaves are 8–12cm × 6– 9cm. Young leaves have a pubescent upper surface and a paler, thickly tomentose lower surface with Gray to yellowish hairs. In mature leaves, the leaf margin becomes finely serrated from subentire to somewhat undulate. With three to five major veins emerging from the base and pinnate venation, the leaf base is frequently cordate. The length of the petiole ranges from 4 to 7.5cm. When the upper leaf surface is scratched, the exudate turns black when exposed to air, creating a permanent black stain on the leaf surface (Figure 1B)[5].



Figure 1. **(A).** *Cordia macleodii* (young plant); **(B).** Leaf morphology of *C. macleodii* showing adaxial (upper) and abaxial (lower) surfaces.

4.2 Anatomy (T.S. of Bark)

The bark appears brownish with a thickness of 12-15mm, featuring a well-developed outer cork that forms about 1/3rd of the total bark thickness. The rest of the bark consists of a thin, undifferentiated cortex and a wide phloem, followed by a narrow cambium (Figure 2).

4.2.1 Cork

The cork is made up of 8-12 layers of radially arranged, rectangular-shaped cells with brownish colouring materials visible in 5-10 rows (Figure 2a).

4.2.2 Cortex

The cortex is narrow and indistinguishable from the inner phloem (Figure 2b).

4.2.3 Medullary Rays

Wide medullary rays extend from the narrow cortex to the cambium region. These rays consist mainly of rectangular, radially elongated cells, often bi- to multiseriate. Several cells contain prismatic crystals of calcium oxalate, and some sclerenchyma cells are present with brownish contents.

4.2.4 Crystals

Prismatic calcium oxalate crystals were observed embedded in the surrounding parenchyma cells, and brownish colouring material likely represents tannin deposits, which are commonly recorded as dense pigmented inclusions in the plant parenchyma (Figure 2c)[5].

4.2.5 Parenchyma

The middle bark is narrow, composed of thin-walled parenchyma, with a thin phelloderm (Figure 2e).

4.2.6 Inner Bark

The inner bark includes phloem, medullary rays, and tangential rows of sclerenchyma fibres. It has radial and tangential strips of compressed parenchyma cells associated with phloem tissues, sclerenchyma fibres, and secretory cells containing calcium oxalate crystals (Figure 2f).

4.2.7 Phloem

The phloem consists of fibre groups arranged in tangential rows, alternating with parenchyma and phloem tissue. The fibre is thick-walled and lignified, containing 30-80 cells per group, and sometimes up to 150 cells (Figure 2g). Secretory cells filled with brown contents and crystals are common.

4.2.8 Sclerenchyma Fibers

These fibre groups are lignified and turn reddish/pinkish upon application of phloroglucinol and HCl, indicating lignification (Figure 2d). Some parenchyma cells in the phloem region contain pitted walls and orange-red contents.

4.2.9 Cambium

A thin layer of cambium lies just inside the phloem, composed of thin-walled rectangular cells arranged in radial rows.

4.2.10 Starch Grains

A few simple and compound starch grains are present in the phloem parenchyma, which turn blue when treated with iodine, confirming the presence of starch.

5. Phytochemical Investigations

The phytochemical compounds found in plants play a crucial role in determining their medicinal properties. These bioactive constituents are directly associated with the therapeutic and pharmacological effects of the plants. A review of existing literature on *C. macleodii* highlights the presence of several phytochemical groups, including terpenoids, glycosides, tannins, flavonoids, steroids, phenols, alkaloids, resins, amino acids, and carbohydrates (Table 2). These compounds

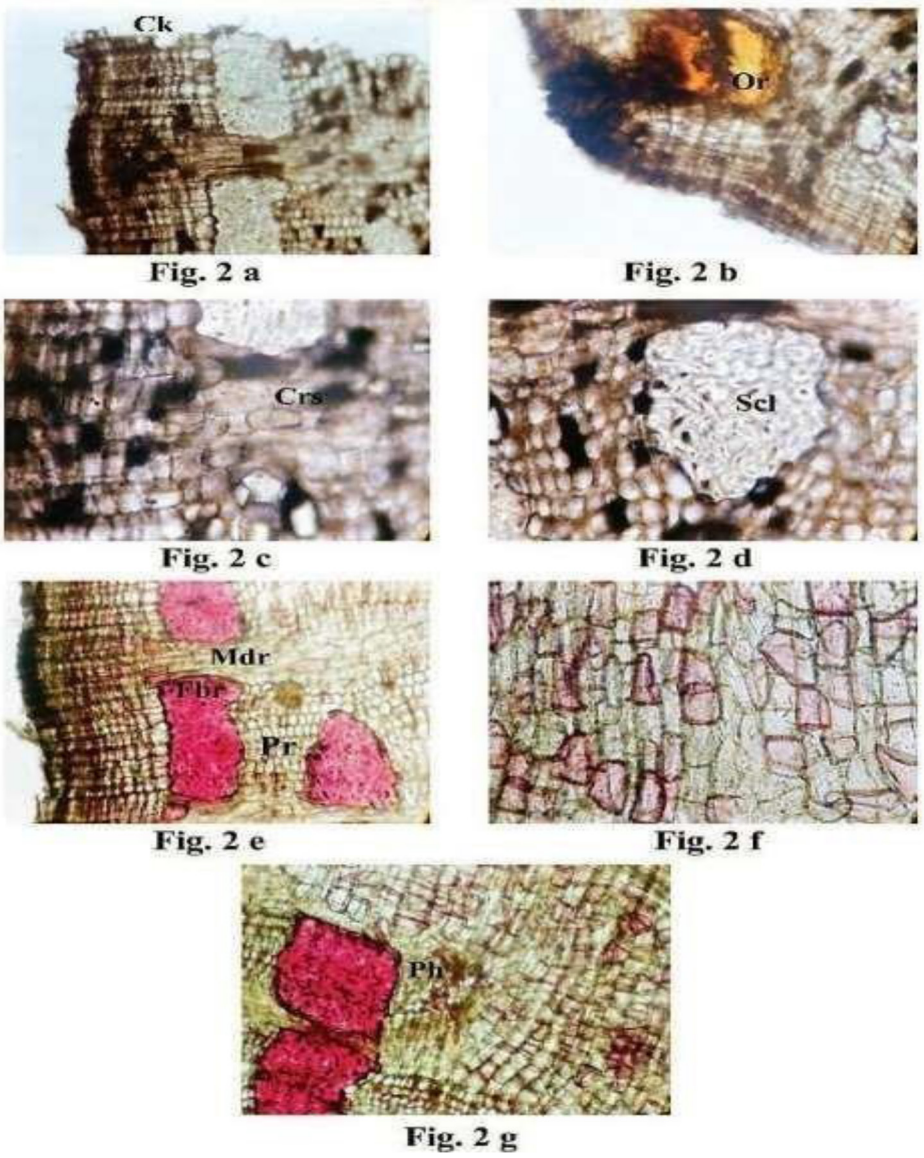


Figure 2. Transverse Section (TS) of bark of *Cordia macleodii* showing different anatomical features: **(A).** Cork cells (Ck); **(B).** Outer region of cork (Or); **(C).** Cortex with starch grains (Cr); **(D).** Sclereids (Scl); **(E).** Medullary rays (Mdr) and phloem fibres (Pf); **(F).** Phloem parenchyma; **(G).** Phloem tissue showing starch grains (ph)[6].

Table 2. List of identified phytochemical constituents and pharmacological activities from various parts of *C. macleodii*

Plant Part	Phytochemical	Identified Lead Compound	Pharmacological Activities	References
Leaf	Glycosides, alkaloids, flavonoids, tannins, fats, fixed oils, terpenoids, steroids, phenolic compounds, and resin.	Tiliroside, Ouabain	Antimicrobial, antibiofilm, antioxidant, antihypertensive, and wound healing. Tiliroside exhibits strong antibiofilm activity by downregulating *bssS* and *metE* genes in *Klebsiella pneumoniae*, a multidrug-resistant pathogen. Ouabain also shows antibacterial effect against *Enterococcus faecalis*	8-11
Bark	Saponins, Tannins, Alkaloids, Terpenoids, Phenolics	β-Sitosterol, Stigmasterol, Campesterol, Phlobaphene's	Antivenom, hepatoprotective, antibacterial, antioxidant, and wound healing. High amounts of phenols and tannins help the plant fight against free radicals. Phlobaphene provides a natural brown colour to the plant bark.	9, 10, 12
Stem	Flavonoids and phenolics	Biogenic Silver Nanoparticles (AgNPs) synthesised using stem extract	Enhanced antimicrobial and antibiofilm due to synergistic effects between phytochemicals and silver nanoparticles, effective against multidrug-resistant bacterial strains	12

have been identified in various parts of the plant, such as its wood, bark, leaves, and flowers[6,7].

6. Medicinal Properties

6.1 Nanoparticles Synthesis

Silver nanoparticles (AgNPs) synthesised using *C. macleodii* stem extracts, a reddish-brown colour change that confirms their formation through surface plasmon resonance. An important role is played by pH; acidic conditions produce larger particles, while smaller particles are formed by alkaline conditions, and well-distributed nanoparticles. The absorption peak around 420450nm is assured by Ultraviolet (UV)- Vis analysis with a strong peak at 425nm, indicating spherical particles. The images of Scanning Electron Microscope (SEM) also confirmed spherical Nano particles ranging from 5 to 50nm, and the functional groups were detected by Fourier Transform Infrared (FTIR) analysis, involved in their formation and stabilisation[13].

The biological produced silver nanoparticles are more effective with strong anti-bacterial effects in killing bacteria than the plant extract or silver nitrate alone, particularly against *S. aureus*. This indicates that *C. macleodii* extracts may be valuable for making silver nanoparticles with a strong potential in biomedical applications.

Surface Plasmon Resonance (SPR) is a special light absorption feature of metal nanoparticles. It is caused by light interacting with their electrons in UV-visible testing. The Ag-Mn Nano particles showed peaks between 400 and 450nm, confirming that the nano particles were successfully formed.

The water-based nanoparticles worked best at stopping bacteria, especially *Bacillus subtilis* and *Proteus vulgaris*. Due to thick walls, Gram-positive bacteria were easier to kill as they attract more Nano particles. These nanoparticles work well because silver is evenly spread inside them, which increases contact with bacteria while staying less harmful to human cells.

pH is a key factor in making silver nanoparticles, as shown by the research. Smaller evenly spread particles are consistently formed by alkaline conditions, ensuring reliable results and better control of nanoparticles for improved, anti-bacterial and biomedical applications.

6.2 Antioxidant

This remarkable plant has also demonstrated potent antioxidant activity, comparable to that of flavonoids[13]. The alcoholic extract of *C. macleodii* leaves showed significant antioxidant potential *in vitro*, demonstrating concentration-dependent free radical scavenging activity. At 800 µg/ml, the extract inhibited DPPH

Table 3. Values show the antioxidant potential of *C. macleodii* extract and ascorbic acid in various *in vitro* assays, with the extract demonstrating significant radical scavenging and iron chelation activity[15]

Parameters	*Cordia macleodii* Extracts (800 µg/ ml)	Ascorbic Acid (400µg / ml)
DPPH Radical Inhibition	81.20%	90.91%
Nitric Oxide Radical Inhibition	72.70%	94.97%
Iron Celation (Absorbance)	0.433%	0.330%

radicals by 81.20%, and nitric oxide radicals by 72.70%, compared to ascorbic acid's 90.91% and 94.97% inhibition, respectively (Table 3). The extract also exhibited dose-dependent reducing power and iron chelation abilities, with an absorbance of 0.433 (800 µg/ml), higher than ascorbic acid's 0.330 at 400 µg/ml[14,15].

Oxidative stress has become a significant global health threat, leading to severe conditions such as diabetes, heart disease, and other illnesses. The phytochemicals in *C. macleodii*, along with its antioxidant enzymes (SOD, CAT, and GPx), exhibit scavenging properties. These phytochemicals bind to metal-binding domains, supporting metal-binding proteins and thereby enhancing antioxidant activity4. Ferric Reducing Antioxidant Power (FRAP) measures the ability of antioxidants to convert ferric 2,4,6-tri-pyridyl-s-triazine (TPTZ) complex into an intensely blue coloured ferrous complex in an acidic medium. This assay is based on the principle that any compound with a lower redox potential than the Fe (III) / Fe (II) redox pair can theoretically reduce Fe (III) to Fe (II)[16].

6.3 Anti-microbial and Antifungal

The study checked that *C. macleodii* leaf and stem extracts have germ-fighting ability. The extracts worked well against gram-positive bacteria and fungi, but were less effective against gram-negative bacteria. The leaf water extract taken after 12 hours worked even better than ciprofloxacin. The good results were also observed by the same extract. Overall, samples collected after 12 hours worked better than those taken after 6h (Table 4).

In Table 4, various extracts of *C. macleodii* were prepared using different solvents and durations to evaluate their antimicrobial potential. The extracts were labelled based on solvent and extraction time. The water extracts were named as 1A (6 hours) and 1B (12 hours), methanol extracts as 2A (6 hours) and 2B (12 hours), ethyl acetate extracts as 3A (6 hours) and 3B (12 hours), and n-hexane extracts as 4A (6 hours) and 4B (12 hours)[16]. The difference in antimicrobial efficacy against *E. coli* across various studies may be due to the type of plant part used (leaf vs. bark) and the type of extraction solvent".

The water extracts of *C. macleodii* bark showed antibacterial activity against *E. coli*, *P. aeruginosa, Streptococcus pyogenes,* and *S. aureus*, with the strongest action taken against *E. coli* and *P. aeruginosa*. When compared with the standard drug, it shows strong antibacterial potential[16,17].

6.4 Antibacterial Activity

The methanolic extract of *C. macleodii* bark demonstrated significant antibacterial properties when tested using the agar plate method. It effectively inhibited the growth of two gram-negative bacteria (*P. aeruginosa* and *E. coli*) and two gram-positive bacteria (*S. aureus* and *S. pyogenes)*. Among these, *S. aureus* and *E. coli* exhibited the highest sensitivity to extract[18,19].

In antifungal testing, the bark methanolic extract, along with standard antifungal drugs (Nystatin and Griseofulvin), demonstrated activity against *A. niger* and *Candida albicans*. The extract was most effective against *C. albicans*, indicating its antifungal capability[19]. The antimicrobial activity results of *C. macleodii* show that it has a zone of inhibition against *Streptococcus* and *S. aureus*, indicating moderate sensitivity. However, the extract is ineffective against gram-negative bacteria like *Klebsiella pneumoniae* and *E. coli*, as there was no inhibition observed in the methanolic leaf extract. Additionally, the extract displayed poor sensitivity to yeast and moulds, with a minimal inhibition zone of 1 mm[20,21].

Antibacterial activity results showed that biosynthesised silver nanoparticles (AgNPs) had a greater zone of inhibition against all tested bacterial pathogens compared to $AgNO_3$ alone and the plant extract. The highest antibacterial effect of AgNPs

Table 4. Table showing the inhibition zone (in mm) of different extracts with different time durations

Extract Source	Code	Solvent	Duration	*B. subtilis*	*A. niger*	*E. coli*	Key Observation
Leaf	1A	Water	6h	22mm	0mm	0mm	Moderate Antibacterial
Leaf	1B	Water	12h	38mm	0mm	0mm	Best Antibacterial
Leaf	2A	Methanol	6h	6mm	16mm	0mm	Moderate Antifungal
Leaf	2B	Methanol	12h	8mm	0mm	0mm	Low Activity
Leaf	3A	Ethyl acetate	6h	7mm	0mm	0mm	Low Activity
Leaf	3B	Ethyl acetate	12h	9mm	5mm	0mm	Low Activity
Leaf	4A	n-hexane	6h	7mm	0mm	0mm	Low Activity
Leaf	4B	n-hexane	12h	7mm	0mm	0mm	Low Activity
Stem	1A	water	6h	4mm	6mm	0mm	Poor Antifungal
Stem	1B	Water	12h	16mm	7mm	0mm	Moderate antibacterial
Stem	2A	Methanol	6h	6mm	3mm	0mm	Low activity
Stem	2B	Methanol	12h	13mm	7mm	0mm	Moderate Activity
Stem	3A	Ethyl acetate	6h	3mm	2mm	0mm	Poor Activity
Stem	3B	Ethyl acetate	12h	7mm	3mm	8mm	Activity Against *E. coli*
Stem	4A	n-hexane	6h	6mm	6mm	2mm	Poor Activity
Stem	4B	n-hexane	12h	9mm	9mm	5mm	Best Stem Activity
Standard	Ciprofloxacin	-	-	25mm	-	24mm	High Antibacterial
Standard	Fluconazole	-	-	-	25mm	-	High Antifungal

was observed against *S. aureus* (15.1mm), *Citrobacter* sp. (14.0mm) and *Klebsiella* sp. (11.9mm). Silver nanoparticles synthesised using *Tinospora cordifolia* also demonstrated effectiveness against several human pathogenic bacteria, including *S. aureus, P. aeruginosa, Bacillus pumilus, S. pyogenes, Serratia marcescens,* and *E. coli.* This shows the ability of AgNPs synthesised from plant sources for antimicrobial applications[22].

The strong anti-antibiotic material is shown by Ag-Mn Nano particles against both gram negative and gram-positive bacteria. They were because they release metal ions that stick to and enter the bacterial cell membrane and damage. Then the water-based nanoparticles show the strongest antibacterial activity as compared to other nanoparticles made using different solvents. The largest inhibition zone is shown by *Bacillus subtilis* (≥15mm), followed by *Proteus vulgaris* (≥12mm) at concentrations ranging from 25–100 µg/mL. In contrast, bimetallic ethanolic AgMnNPs showed the minimum effectiveness, with all tested microorganisms displaying resistance[23].

6.5 Anti-hypertensive

As per the World Health Organisation (WHO), hypertension is defined as when systolic blood pressure is above 140 mmHg and diastolic pressure is above 90 mmHg. Research tested the blood pressure-lowering

effect of *C. macleodii* leaf powder on 20 patients divided into two groups. One group received the leaf powder while the other was given *Sarpagandha* powder. The research shows that both systolic and diastolic blood pressure were reduced due to *C. macleodii* wound with support from scientific and statistical analysis[24].

6.6 Anti-inflammatory

The study on *C. macleodii* leaf extract reveals significant anti-inflammatory and analgesic properties. Acute toxicity tests showed no mortality up to 2000 mg/kg, though animals displayed depression, indicating the LD50 value of the extract is greater than 2000 mg/kg. This finding suggests that the extract possesses a high safety margin and low acute toxicity.

Phytochemical analysis showed the presence of sterols, flavonoids, and saponins, which are known to inhibit prostaglandin synthesis and reduce inflammation using the carrageenan-induced paw oedema model. The extract exhibited maximum anti-inflammatory (2-3 hours), likely due to inhibition of prostaglandin release. These results show the therapeutic ability of *C. macleodii* for the further ability of its bioactive compounds[25,26].

Inflammation is the body's natural response to injury or infection. It involves immune cells, blood vessels and fluids that collect at the affected area to protect and heal. It improves strength in dead space bones. It has only small effects on new blood vessels, growth and tissue formation. It suggests that only applying it to the skin may not be enough, but taking it early or in another form might work better[27].

6.7 Wound Healing

The leaves of *C. macleodii* (commonly known as *Panki*) help in healing wounds in both early and long-lasting stages. An ointment is made from these leaves, which have been used successfully with patients recovering from cuts and wounds. The plant also seems to have antibiotic properties that protect against pus formation, and it's how it supports earlier research findings[28,29].

A controlled study by Sharma and team tested the wound healing effects of *C. macleodii* leaf ghrita. Two groups were formed with 10 patients in each. One group received the herbal *ghrita* and the other povidone-iodine. The *ghrita*-treated group showed a much greater reduction in size, indicating wound healing ability[29].

6.8 Analgesic Activity and Acute Toxicity

The pain-relieving effect of *C. macleodii* leaf extracts was tested in mice using a hot plate test at various time intervals. The results showed that the extracts reduced pain noticeably compared to the standard drug, Pentazocine. The safety of the alcoholic bark extracts was also checked by giving female mice an oral dose of 2g/KG and observing them for 24 hours. Findings indicated that oral administration of the extract at this dose did not induce any toxic effects[29].

6.9 Antivenom Potential

The ethanolic extract of *C. macleodii* bark was found to significantly reduce the lethal effects of *Naja* venom, including hemorrhagic lesions, necrotic damage, and oedema in rats. Additionally, the extract counteracted the cardiotoxic and neurotoxic effects of the venom in isolated frog heart and rectus abdominis muscle experiments. At doses of 400 and 800 mg/kg, the extract demonstrated notable protective effects against venom-induced lethality and tissue damage. This protective action is likely attributed to the precipitation of active venom components by the extract[30].

6.10 Hepatoprotective

The hepatoprotective effects of both aqueous and ethanolic extracts derived from the bark of *C. macleodii* were assessed using ethanol- and CCl4-induced hepatotoxicity models in male Wistar rats. In both models, the extracts reduced serum levels. Pyruvate Transaminase (SGPT) in liver extracts lowered liver enzymes (GOT and ALP) and helped maintain liver health, indicating that it can protect the liver.

The liver-protecting effect of *C. macleodii* leaf extract was tested in rats with CCL4-induced liver damage. The liver markers increased by CCL4 are GOT, GPT, ALP and bilirubin. Giving the extract at 100-400 mg/kg lowered these markers, which shows similar effects[30].

6.11 Antidepressant

The antidepressant effects of *C. macleodii* were tested in rats at two doses, that is, 100 mg/ kg and 500 mg/ kg. This extract helped rats stay active longer in the forced swimming and tail suspension test, like the standard drug fluoxetine. The open field test, which measures movement, exploration and anxiety, confirmed the antidepressant effects. This shows

that the extract has strong antidepressant effects at both doses[30].

7. Threat Status and Conservation

Cordia macleodii, an endangered plant native to India, is declining due to major human activities. Its natural habitat has been reduced due to deforestation for farming, urban development and overharvesting for its wood and medicinal uses. According to studies based on the International Union for Conservation of Nature's (IUCN) Red List Criteria (2000 – Version 3.1), the conservation status of *C. macleodii* differs by region. It is listed as "Critically Endangered" (CR) in areas like the Vindhyan region[30], Central India, and Chhattisgarh. In contrast, it is classified as "Endangered" (EN) in states such as West Bengal, Odisha, Chhattisgarh, Maharashtra, and Rajasthan[31-35]. Efforts have been made to protect *C. macleodii*. were done at Arogya Dham herbal Garden in Chitrakoot and a forest nursery in Rewa, guided by Dr PC Dubey. Cuttings planted in bags survived for 1 to 2 months but eventually died because they didn't grow roots. Seeds were also used to grow *C. macleodii* collected from Forest staff and local tribes. Many seeds grow into seedlings. Exact numbers were not recorded. These seedlings were shared with the forest department, research centers and universities to support conservation of plants in botanical gardens. Growing *C. macleodii* from a cutting didn't survive. Long is an important finding. It shows that using seed is a more reliable and effective way to protect and grow this plant on a large scale.

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Author Contribution

Arun Kumar, Saurabh Guleri provided support and guidance, conceptualized, methodology, data curation, formal analysis and drafted the manuscript; Sumaiya, Sudhanshu, Vaishali Dobriyal, Naveen Gaurav, edited and provided critical review of the manuscript. All authors have read and agreed to the published version of the manuscript.