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ENDANGERED ETHNO-MEDICINAL PLANT, *CORDIA MACLEODII* (GRIFF.) HOOK. F. AND THOMSON — A BRIEF REVIEW

Sandeep Kumar Mohanta, Bhaswatimayee Mahakur, Aryaputri Bedaprabha, Sanjay Kumar Madkami and Durga Prasad Barik *

Department of Botany and Biotechnology, Ravenshaw University, Cuttack - 753003, Odisha, India.

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Correspondence to Author:
Dr. Durga Prasad Barik

Associate Professor, Department of Botany and Biotechnology, Ravenshaw University, Cuttack - 753003, Odisha, India.

E-mail: dpbarik@ravenshawuniversity.ac.in

ABSTRACT: *Cordia macleodii* is an endangered ethnomedicinal plant found in dry deciduous forest areas of India. It is one of the 13 species belonging to the genus *Cordia* of the Boraginaceae family, commonly known as Dahipalas or Dahiman. The main identifying feature of this plant is that any injury to the adaxial surface of the leaf will result in persistent black markings. This plant species is at risk of extinction due to several causes, including early flowering, restricted fruit development, premature drying of fruits, and poor seed germination. *C. macleodii* has been highlighted for its therapeutic effects including antibacterial, antifungal, anti-inflammatory, antioxidant, wound healing, aphrodisiac and hepatoprotective abilities, and also used by different tribals of India for healing wounds, mouth sores, treating piles and diarrhoea. Leaf powder of *C. macleodii* is useful for treating hypertension and controlling blood urea, and the ethanolic bark extract is used against *Ophiophagus hannah* venom due to its antivenom properties. Various bioactive constituents, including saponins, tannins, glycosides, alkaloids, terpenoids, triterpenoids, flavonoids, lipids, fixed oils, resin and phenolic components are present in different plant parts of *C. macleodii*. Stem and leaf extracts of *C. macleodii* contain phytoconstituents like Stigmasterol, Cholest-5-EN-3OL (3β)-Carbonyl chlorinated, Campesterol and 3, 4-dihydroxy-5-methoxybenzoic acid.

INTRODUCTION: Medicinal plants have served as a significant part of the day-to-day healthcare practices of human beings since the ancient period. Despite their importance, the existence of several medicinal plants is in a threatened condition due to over-exploitation, destruction of habitats, agricultural encroachment, urbanization, over-mining activities and unmonitored trade [1].

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The Indian subcontinent is rich in medicinal plant diversity. Due to destructive harvesting methods and excessive harvesting of medicinal plants without much planning for future prospects, the genetic diversity of those plants is being threatened at a frightening rate.

The majority of plant species are conserved through *in-situ* conservation but many of those species either lack seeds or contain seeds having poor germination rates. Therefore, it is crucial to maintain and protect the natural assets of Indigenous medicinal plants [2, 3]. The genus *Cordia* belonging to the Boraginaceae family, comprises over 300 species of shrubs and trees which are

widespread across the tropical, subtropical and warm climates of tropical America, South Asia and Africa. In India, there are 13 species of the genus *Cordia* are found among which *C. macleodii* is an endangered one which is mainly found in the dry and deciduous forest areas [4, 5]. This species is under threatening conditions due to early falling of flowers, limited fruit formation, immature drying of fruits and low probability of seed germination [6].

Plant's Description: *Cordia macleodii* is a rare medicinal plant that can attain a height of about 9-12 m with a trunk diameter of about 50-60 cm. The plant's bark is light green to corky grey in colour; reddish colour inside and forms reddish brown colour exudates on an injury. Leaves are about 5-10 cm in length and exhibit a shape of broadly ovate, rough surface area and cordate base with crenate-serrate edges which are positioned in an alternate to sub-opposite manner. Trichomes are present on the petiole. White-coloured polygamous flowers are present in short terminal axillary corymbs. The corolla lobes are yellowish-white in colour, rectangular in form, and 0.6-0.8 cm long, while the calyx is heavily tomentose.

Exerted stamens having hairy filaments are found at the base. Glabrous ovary, bilobed and capitate stigma are seen in this species. 1.2-1.9 cm long, ovoid-shaped drupes are seated at a persistent calyx. The timing for flowers and fruits is from February through August [4, 8, 9]. Permanent black markings result from scratches on the adaxial surface of the leaf **Fig. 1** [10].

FIG. 1: *CORDIA MACLEODII* (GRIFF.) HOOK. F. AND THOMSON PLANT AND ITS LEAF SHOWING PERMANENT BLACK MARKS DUE TO SCRATCHES

Vernacular Names: Vernacular names of *Cordia macleodii* vary due to the language variation in India. It is generally known as Dahiman, Dahipalas, Dhengan, Gonni and Kuhman (in Hindi); Baurlo, Bhoto, Sambarsinga, Panki and Shikari (in Odia); Dhaman, Dhaiwan, Dhaim, Bhoti, Dhalm and Daiwas (in Marathi); Palandekku (in Tamil); Botuku, Peddabattava, Peddabotuku and Iriki (in Telugu); Bili challe, Doddacalle, Cellu, Hadang and Hirichalle (in Kannada) [4, 7, 11] and Dadhimanth, Sitapatra (in Sanskrit) [10, 12]. *C. macleodii* is popular in the name of Bhojraj among the Birhore tribe of Jharkhand [13] and as Kassamar among the Korku tribe of Maharashtra [14].

Taxonomic Position:

Kingdom: Plantae

Division: Tracheophyta

Class: Magnoliopsida

Subclass: Lamiidae

Superorder: Solananae

Order: Boraginales

Family: Boraginaceae

Subfamily: Cordioideae

Genus: *Cordia*

Species: *C. macleodii*

Geographical Distribution: *Cordia macleodii* is indigenous to India and is mainly found in Odisha, Chhattisgarh, Madhya Pradesh, Maharashtra, Chotanagpur, West Bengal and Rajasthan [4, 6]. In Odisha, *C. macleodii* is found in the Gandhamardan hills of Bargarh district, Mayurbhanj district, Ganjam district [8, 9, 15], and also in Nayagarh forest division [16]. In Chhattisgarh, *C. macleodii* is found in the Koriya district, Marwahi forest division, Pendra road and also in Bilaspur [4, 17]. In West Bengal, *C. macleodii* is found in the Amchura and Bhaluk Khulya forests of Bankura District [5]. It is also found in Thane, Mumbai, Pune, Raigad, Vidarbha and Marathwada of Maharashtra [18].

Pharmacological Activities: As a medicinal plant, *C. macleodii* has many medicinal properties. Different tribes in Odisha, Chhattisgarh and Madhya Pradesh utilise distinct plant parts of *C. macleodii* as aphrodisiacs, for jaundice treatment, to heal wounds, mouth sores and other illnesses. The results of pharmacological research on different extracts of *C. macleodii* plant parts show that the plant has hepatoprotective, anti-inflammatory, antibacterial, wound-healing, acute toxicity, antidepressant and antioxidant actions [8, 17, 19].

The root bark of *C. macleodii* is used by the Andh tribals of Katepurna Wildlife Sanctuary, Maharashtra for the treatment of piles [20]. The bark paste of *C. macleodii* is applied against diarrhoea by the tribal peoples of the Koraput district in Odisha [21]. Stem of *C. macleodii* is used to treat bone fractures by traditional healers of the Nizamabad district in Andhra Pradesh and the Nandurbar district of Maharashtra[10, 22].

The Birhor tribe of Jharkhand uses fresh leaves of *C. macleodii* to treat high fever and the powdery form of fruits for the treatment of dysentery [13]. In the Nandurbar district of Maharashtra, tribal peoples use the root powder of *C. macleodii* for treating Sprain by applying it as a paste along with the root powder of *Abelmoschus manihot* and *Grewia tiliaefolia* [23]. Daily use of leaf powder of *C. macleodii* is effective against hypertension and also controls blood urea [24].

Hepatoprotective Activity: Aqueous and ethanol bark extracts of *C. macleodii* have hepatoprotective properties as these extracts significantly reduce the Carbon tetrachloride (CCl_4) induced elevated levels of liver enzymes such as SGPT, SGOT, ALP and bilirubin [24]. Alcoholic extract of *C. macleodii* leaves also show hepatoprotective properties against CCl_4-induced hepatic cell injury and ethanol-induced hepatotoxicity. The ethanolic extract of *C. macleodii* bark is helpful in healing liver damage whereas the aqueous and ethanolic bark extracts have abilities for liver regeneration. The presence of flavonoids in extracts may possess hepatoprotective activity [7, 25, 26].

Analgesic Activity: Analgesic drugs are used as painkillers to get relief from pain. They act on the central nervous system and block the pain signals to the brain. The leaf extract of *C. macleodii* has significant analgesic properties as compared to Pentazocine. During the investigation of the dose-dependent analgesic effect of *C. macleodii* using the hot plate test in mice, it has been seen that the effect of 400mg/kg dose is quite effective as the effect of Pentazocine at the dose of 10mg/kg [4, 7, 27]. The seed paste of *C. macleodii*, along with lump sugar is used by the Korku tribals of Maharashtra for the treatment of mental illness. Inhalation of dry leaf powder helps in getting relief from headaches [14].

Anti-inflammatory Activity: Inflammation is a protective response of body tissue when it encounters harmful stimuli like pathogens, toxins, damaged cells, or irritants. To counter the inflammation that may be swelling, redness or pain; anti-inflammatory drugs are used [7]. As per a study on Wistar rats by using the carrageenan-induced rat paw edema method; it is found that *Cordia macleodii* leaf extract possesses significant anti-inflammatory properties. *C. macleodii* leaf extracts contain flavonoids that can interfere with the synthesis of prostaglandin; an important factor in the pain process during inflammation [7, 27].

Wound Healing Activity: *Cordia macleodii* leaves are used to heal wounds by the tribal peoples of

Odisha and Madhya Pradesh. It has been reported that the ghrita (cow's ghee) based formulation of *C. macleodii* leaves shows significant wound-healing properties but has lesser efficiency when compared to Povidone Iodine. Leaves of *C. macleodii* contain tannin which may help to upregulate the formation of new capillaries during the inflammation of the wound and speed up the healing process [28, 29]. Bark paste is used to heal wounds of buffaloes and cattle [19].

Anti-venom Activity: The alcoholic bark extract of *C. macleodii* shows anti-venom properties against *Naja* venom [30]. As per a study on Wistar rats, it was found that the bark extract of *C. macleodii* has significantly inhibited symptoms like- lethality, bleeding, narcotic lesions and edema induced due to the *Naja* venom. Phytochemicals like- cardiac glycosides and flavonoids are present in *C. macleodii* extract which have protective effects against snake venom. The coagulant property of *C. macleodii* bark extract is capable of neutralizing the venom of *Ophiophagus hannah* may be by precipitating the active venom components. Due to the coagulant properties of *C. macleodii* bark, traditional healthcare practitioners of Chhattisgarh use it to treat snake bites [31, 32].

Anti-bacterial, Anti-malarial and Anti-fungal Activities: Chloroform, ethyl acetate leaf extracts and petroleum bark extract of *Cordia macleodii* have antibacterial properties against some gram-negative bacteria like- *Escherichia coli, Pseudomonas aeruginosa* and some gram-positive bacteria such as *Staphylococcus aureus and Streptococcus pyogenes* [32, 33]. Besides *Escherichia coli, Pseudomonas aeruginosa* and *Staphylococcus aureus*; ethanolic leaf extract of *C. macleodii* also has anti-bacterial properties against *Klebsiella pneumoniae* and *Bacillus subtilis*. The methanolic bark extract of *C. macleodii* exhibits antibacterial properties against *Escherichia coli, Pseudomonas aeruginosa, Streptococcus pyogenes* and *Staphylococcus aureus* [32, 34]. The aqueous extract of *C. macleodii* shows better antibacterial potential in comparison to Ciprofloxacin against *Bacillus subtilis* [35]. Chloroform or ethyl acetate leaf extracts of *C. macleodii* possess anti-malarial efficiency against *Plasmodium falciparum*. Aqueous and methanolic extracts of *C. macleodii* stem and leaves have fungicidal properties against *Candida albicans.* The petroleum ether bark extract and the chloroform or ethyl acetate leaf extracts of *C. macleodii* show anti-fungal activity against *Candida albicans, Aspergillus niger* and *Aspergillus clavatus* [33, 34].

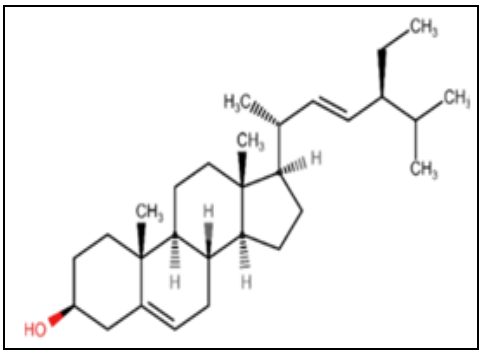
Antioxidant Activity: Methanolic and butanolic bark extracts of *Cordia macleodii* have antioxidant properties against free radicals like DPPH (2,2-diphenyl-1-picrylhydrazyl) and Nitric oxide (NO). These extracts also have a strong reducing power compared to the standard L-ascorbic acid. Both the methanol and butanol bark extracts contain phenols which play a crucial role in controlling the oxidation process. According to the findings, *C. macleodii* bark extracts can be utilised as an easily accessible natural antioxidant source [7, 26, 36]. The antioxidant activity of *C. macleodii* is significantly influenced by the phenolic content present in its leaves and bark [37]. The pharmacological activities of different plant parts of *C. macleodii* are summarized in **Table 1**.

TABLE 1: PHARMACOLOGICAL PROPERTIES OF DIFFERENT PLANT PARTS OF *CORDIA MACLEODII*

Plant parts	Medicinal properties	References
Leaf	Antioxidant and hepatoprotective properties	7, 26
	Used to treat high fever	13
	Used to treat hypertension and also to control blood urea	24
	Analgesic activities	4, 7, 27
	Inhalation of leaf powder is used to get relief from headache	14
	Anti-inflammatory activities	7, 27, 32
	Wound healing activities	28
	Used to treat edema	7, 31
	Anti-bacterial activities	33-34
	Anti-malarial properties against *Plasmodium falciparum*	24, 33
	Anti-fungal activities	32
Stem	Anti-bacterial properties	33-34
	Used to treat bone fractures by traditional healers.	11, 22
Bark	Bark paste is used to treat diarrhoea	21

	Used to treat wounds of cattle and buffaloes	19
	Ability to heal liver damage	7, 26
	Anti-venom properties against *Ophiophagus hannah* venom	7, 32
	Petroleum ether bark extract shows anti-fungal properties	31
	Bark extract is used as natural antioxidants	7, 37
Root	To treat Sprain	23
Root bark	Used by the Andh tribes of Maharashtra to treat piles	20
Fruit	Used for the treatment of dysentery	13
Seed	Used to treat mental illness by the Korku tribe of Maharashtra	14
	Used as a stimulant for sexual desire by the tribals of Odisha	9

Phytochemistry: *Cordia macleodii* plant parts are rich sources of different bioactive compounds which have important roles in treating diseases. The plant also contains several secondary metabolites like- Saponin, steroids, flavonoids, alkaloids, glycosides and terpenoids. *C. macleodii* bark contains active phytoconstituents like- Stigmasterol **Fig. 2**, Cholest-5-EN-3OL (3β)-Carbonyl chlorinated **Fig. 3** and Campesterol **Fig. 4** [4]. The aqueous bark extract of *C. macleodii* contains saponins, tannins, glycosides and alkaloids whereas the acetone, methanol, hexane and chloroform bark extracts mainly contain triterpenoids. The UV-visible spectrophotometry in a colloidal silver nitrate solution of stem extracts shows the presence of silver nanoparticles. The qualitative analysis of the leaf extract in methanol, petroleum ether and water reveals the presence of glycosides, alkaloids, flavonoids, tannins, lipids and fixed oils, terpenoids, steroids, phenolic components and resin. Phenolic and ethanolic leaf extract of *C. macleodii* also shows the presence of gallic acid (3, 4-dihydroxy-5-methoxybenzoic acid) **Fig. 5**. Chloroformic extract of leaf under UV-visible and FTIR spectra shows the presence of beta-carotene [7, 24, 38].



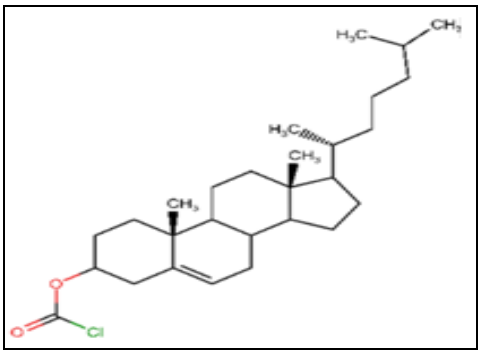
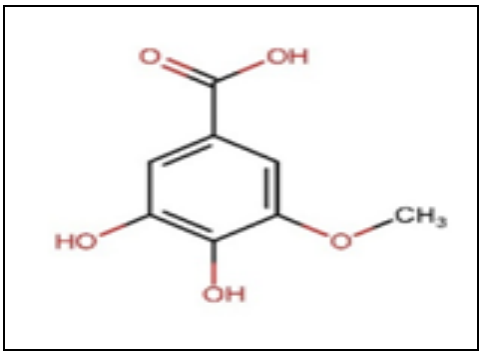


FIG. 2: STIGMASTEROL FIG. 3: CHOLEST-5-EN-3OL(3B)-CARBONYL CHLORINATED



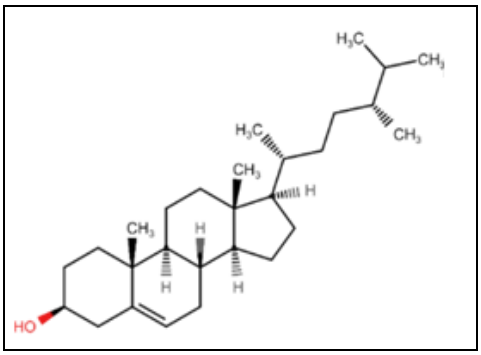


FIG. 4: CAMPESTEROL **FIG. 5: 3, 4-DIHYDROXY-5-METHOXYBENZOIC ACID**

CONCLUSION: Pharmacological studies on different plant parts of *Cordia macleodii* have revealed that it has hepatoprotective, anti-inflammatory, antibacterial, antifungal, anti-venom, wound-healing, antihypertensive and antioxidant properties. The phytochemical screening shows the presence of secondary metabolites like- Saponin, steroids, flavonoids, alkaloids, glycosides and terpenoids. Phytoconstituents such as Stigmasterol, Cholest-5-EN -3OL(3β)-Carbonyl chlorinated, Campesterol and 3, 4-dihydroxy-5-methoxybenzoic acid are present in bark and leaves of *C. macleodii*.

Although different plant parts of *C. macleodii* have a wide range of uses in traditional healthcare Practices, due to lack of scientific proof, this plant has not been too much used by modern-day pharmaceutical industries. As an endangered ethnomedicinal plant, more scientific investigation should be done on this plant for pharmacological benefits while considering its conservation.

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