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Review of the PhytoChemical Profile of Gymonosporiya Monta Beneth in Relation to its Medicinal Application

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Abstract: *Gymnosporia Montana is a medicinal plant long valued in traditional healing systems. This study aimed to investigate its phytochemical profile, pharmacological activities, and ethnobotanical relevance. Methods: Phytochemical composition was examined using NMR spectroscopy, GCMS, and HPLC. Pharmacological evaluation included cytotoxic, antimicrobial, antioxidant, and anti-inflammatory assays. Ethnobotanical information was gathered through community interviews and surveys. Results: The plant was found to contain key bioactive constituents such as flavonoids, alkaloids, and trapezoids. It demonstrated notable antimicrobial, antioxidant, and anti-inflammatory activity. Ethnobotanical importance: G. Montana is traditionally used to treat fever, digestive ailments, and to promote wound healing. Conclusion: The identified phytochemical and pharmacological properties support the plant's traditional uses. This study enhances scientific understanding of G. Montana and highlights its promise for future drug development and ethnopharmacological applications.*

Keywords: Ethnobotany, pharmacology, photochemistry, big data analytics, Gymnosporia montane, and traditional medicine

I. INTRODUCTION

Gymnosporia Montana is a highly branched, spiny shrub or small tree commonly found across the dry, arid regions of India. Its taxonomic classification is well established. The use of medicinal plants dates back to the earliest human civilizations, and they continue to play a vital role in global primary healthcare. Their effectiveness—despite complex structures and many yet-to-beidentified chemical constituents—has contributed to their widespread therapeutic application. The Celastraceae family, also known as the bittersweet family, comprises nearly 100 genera and about 1300 species, predominantly distributed in tropical regions. Many members of this family are traditionally recognized for their medicinal value. A variety of unique bioactive compounds have been isolated from this group. Certain species have been found to produce polyester sesquiterpene and pyridine-sesquiterpene alkaloids with insecticidal or antifeedant activities; more recently, sesquiterpene pyridine alkaloids have also been reported.

In modern healthcare, many diseases are complex and challenging to manage, often requiring multiple therapeutic targets, mechanisms, and medications. Plant-derived medicines, however, offer an advantage by naturally providing a mixture of bioactive compounds, thereby reducing the time and cost associated with developing multi-drug therapies[1]. A significant portion of today's pharmaceuticals can trace their origins to plants or plant-based remedies. Historically, the discovery of medicinal plants was largely driven by public experience, often through prolonged and risky trial-and-error use. Over time, progress in understanding plant-based medicine has depended on two closely linked factors. Most The World Health Organization (WHO) states that more than 80% of the global population relies on traditional medicines for their primary healthcare. Many plants contain chemical compounds with therapeutic potential because they produce specific physiological effects in humans. Among these bioactive substances, alkaloids, flavonoids, tannins, and phenolic compounds are particularly important. Using ethnopharmacological knowledge to guide

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phytochemical research is considered an effective approach for identifying new medicinal properties in higher plants. Understanding a plant's chemical constituents is valuable not only for developing medicinal agents but also for discovering new sources of useful materials such as tannins, oils, gums, and precursors for synthesizing complex chemical compounds. Additionally, knowledge of these chemical components can help determine the true value of traditional remedies.

It is a plant species native to tropical and subtropical regions and is known for its medicinal significance. Commonly called the "Indian spindle tree," it has been used for centuries in traditional healing systems, particularly in Unani and Ayurvedic practices.

Geographical Distribution:

Gymnosporia montana is widely found across three major regions—India (especially the Himalayan areas), Africa (notably in the southern and eastern parts), and Southeast Asia.

Traditional Uses:

The plant has been traditionally employed to manage various health conditions, including:

1. fever 2. digestive problems 3. Healing of wounds 4. Skin disorders 5. Issues with the respiratory system The Significance of Plant Chemistry Among the several bioactive substances found in Gymnosporia montana are:

1. Flavonoids 2. Alkaloids 3. Terpenoids 4. Glycosides Medical Possibilities Initial research has shown that the plant's

1. Antimicrobial action 2. Properties of antioxidants 3. Anti-inflammatory properties.

Kingdom : Plant Division : Spermatophyta.

Subdivision : Angiospermae

Class : Dicotyledonea

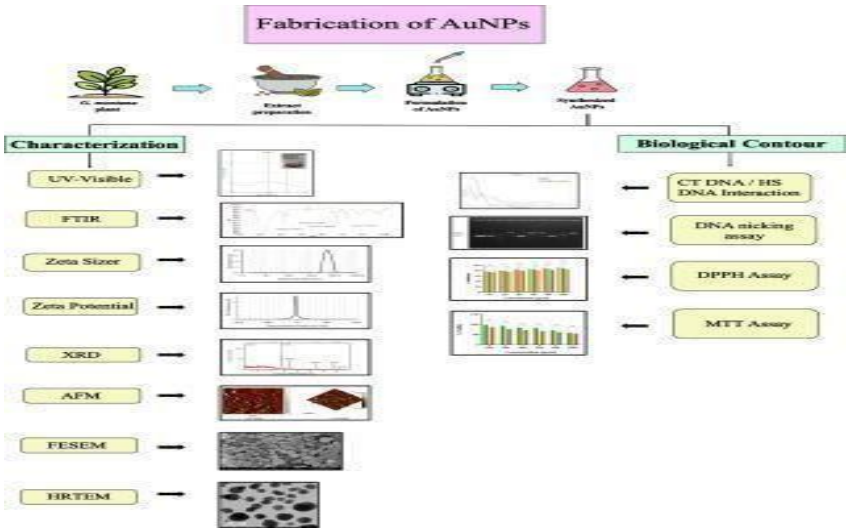
Subclass : Polypetalae Group : Disciflorae

Order:

Celastrales Family : Celastraceae Genus

Gymnosporia Plant's Name : Gynophore montana (Roth.) Benth

Class : Dicotyledonea



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Materials and Procedures Plant material collection and authentication:
In November 2008, the stem of Gymnosporia montana was collected from Vijapur, Gandhinagar, Gujarat, India, and authenticated by Dr. S. K. Patel, Head of the Botany Department at Government Science College, Gandhinagar. The voucher specimen, numbered KB/08/0011, was deposited at the K.B. Institute of Pharmaceutical Education and Research, Gandhinagar, Gujarat, India.

Preparation of various extracts:
The stem of G. montana was separated and dried under sunlight. After drying, it was stored in airtight containers and ground to a fine powder using a 60-mesh screen. For this study, the shadedried stem powder was sequentially extracted with water, 70% methanol, and petroleum ether (60–80°C). Each extraction was carried out for six to eight hours using a Soxhlet apparatus. The solvent was filtered and the extraction process was repeated three times using the same method. The combined extracts were concentrated and then dried in a water bath maintained at 60°C, and the extraction yield was recorded. Further analyses were performed using the dried extracts of both the stem and the leaves.

Regional G. montana Names :
Hyderabad: Vaichigachha
Bombay: Zekadi,
Hurmacha, and Malkangoni. Vikalo and Vikro are Gujarati
Hindi: Tondar Sajad, Kngani, Baikal. Marathi: Yekkadi, Vekal, Bharuli, Bharatti, and Vekar.
Punjab: Talkar, Mareila, Kingaro, Kharai, and Dajkar. Kattanji, in Tamil
Sanskrit: Himaka, Bahuphala, Dantakashta, Gopaghantha, and Grantham

Properties and uses :
The plant Shaligram Nighantu claims that it is used to treat blood problems, inflammation, and jaundice. Its application in kamla (jaundice) is mentioned by Nighantu Adarsh. Ripe fruit has been used as an anti-inflammatory and blood purifier in Vanaspati Srusti. Leaf juice is used as an eye drop to treat corneal opacity and in pandu (anemia). Bark is used to eradicate lice and other head infections. According to Aryabhishek, leaf juice can be used to treat eye conditions, including corneal opacity, irritation, and burning. Root pulp is used in Vanaspati Chandrodaya to treat rheumatic pain, and gum is used in combination with other medications in dry powdered

Properties:
1. Phytochemicals: glycosides, terpenoids, alkaloids, and flavonoids.
2. Antimicrobial: Prevents the growth of bacteria and fungi.
3. Free radicals are scavenged by antioxidants.
4. Anti-inflammatory: Decreases disarray.
5. Astringent: Tissues are constricted. 6. Analgesic: Reduces discomfort.

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Uses :

1.Neuroprotective: Guards against illnesses that affect the nervous system.
2.Reduces blood sugar levels; anti-diabetic.
3.cancer: Prevents the proliferation of cancer cells.
4..Cardiovascular: Lowers blood tension
5. Immunomodulatory: Boosts the immune system.

Additional Uses:

1. Dye plant: It produces a yellow dye from its leaves and stems 2.Timber: Wood is utilised in construction and furniture.
Insecticide: Extracts from plants keep insects away.
Fodder: Animals are fed leaves.

Components Used:

1. Leaves 2. Bark from stems 3. The Roots 4. Fruits *Getting ready: 1. Infusions 2. Infusions 3. Tinctures 4. Powders 5. Cream

G**. montana's medicinal use**:

are referenced in a number of Ayurvedic texts, including Nighantu Adarsh [12], Vanaspati Shastra [13,14], Aryabhishek [14], and Vasundhrani vanaspati [15]. Jaundice [2,12], inflammation and rheumatic pain [2,12,14], corneal opacity [12–14], ulcers, gastrointestinal diseases, diarrhea, toothaches, and vermifuge is one of its purported uses [2,16,17,4]. It is used to treat blood problems, inflammation, and jaundice, according to Thakar (Vanaspati shastra, 1998). According to Nighantu Adarsh, it is used to treat , or jaundice. The usage of ripe G. montana fruit as an anti-inflammatory and blood purifier has been noted in Vanaspati Srusti.G. montana bark is used to treat head infections and lice [4]. According to Aryabhishek, leaf juice can be used to treat eye conditions, especially corneal opacity, irritation, and burning feelings. The fruit of G. montana is tasty, digestible, and used to treat jaundice and enlarged spleen, according to Kirtikar and Basu. To avoid rheumatic pain from exposure to wet winds, it is advised to apply ground seeds with turmeric all over the body. In cases of rickets, external application of dry powdered leaves mixed with a small amount of olive oil has had promising results [13]. Indian Materia Medica [108] states that G. montana bark is used to eradicate pediculi.

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Pharmacology of Gymnospora Species : Various species of Gymnosporia (family Celastraceae) contain numerous bioactive compounds with significant pharmacological activities. These include sesquiterpene pyridine alkaloids known for their antitumor and immunosuppressive effects, triterpenoid quinonemethides (celastroloids) exhibiting cytostatic and antibiotic properties, and diterpene triepoxides with notable antileukemic and immunosuppressive actions. Two well-known anticancer constituents reported from this group are the quinone triterpene celastrol and the diterpenoid epoxide triptolide. Additionally, the plant has been found to produce an anticancer agent capable of prolonging the "S" phase of the cell cycle, thereby contributing to its antineoplastic potential.

In traditional medicine, the leaf juice of Gymnosporia is widely used for treating jaundice in the Saurashtra region of Gujarat, India. Similarly, in Bhadra, Karnataka, locals consume a mixture of G. montana leaf extract and cow's milk each morning for three consecutive days as a remedy for jaundice. The root bark of G. montana is also traditionally valued for its therapeutic Properties.

The residents of Bhadra, Karnataka, India, traditionally use a leaf extract of G. montana mixed with cow's milk every morning for three days to manage jaundice. The root bark of G. montana is also believed to be effective in treating dysentery. Experimental studies by Bhavita Dhru reported that the methanolic extract of G. montana leaves exhibits strong analgesic and antiinflammatory effects. Further investigations showed that petroleum ether, 70% methanolic, and aqueous extracts of the leaves and stems possess antibacterial activity, with the aqueous leaf extract demonstrating the greatest effectiveness against E. coli. A hydroalcoholic extract of G. montana leaves and stems also revealed significant antioxidant potential. More recently, NI Kochar demonstrated that administration of G. montana to rats could either restore or prevent learning and memory impairment induced by scopolamine.

Phytochemical Analysis of Gymnospora Montana :

Numerous sesquiterpene pyridine alkaloids—such as emarginatine A, B, E, F, and G—and a sesquiterpene ester, celahin B, have been reported within the Celastraceae family. Researchers have identified a wide range of chemical compounds from different parts of G. montana. Phytochemical screening of the petroleum ether, 70% methanolic, and aqueous extracts of the plant's stem and leaves revealed the presence of sterols, triterpenoids, flavonoids, phenolic compounds, and carotenoids. The 70% methanolic extract of G. montana specifically showed flavonoids and alkaloids, while the aqueous extract tested positive for saponins.

The saponins in the aqueous extract produced abundant and stable foam, attributable to their structural composition—consisting of a hydrophilic portion made up of one or more sugars that imparts detergent-like behavior, and a lipophilic portion known as the aglycone or sapogenin. Overall, phytochemical evaluation of G. montana stem and leaf extracts confirmed the presence of constituents such as phenols, flavonoids, alkaloids, carbohydrates, and proteins.

PHARMACOGNOSY:

The A large, woody, glabrous shrub—occasionally developing into a small tree—with young branches that appear crimson to purple in colour and often end in spines, bearing both leaves and flowers.

Flowers: Small, white, and numerous, occurring in the axils. The calyx consists of five oblong to broadly elliptic lobes; the corolla has five elliptic-oblong white petals measuring about 3 mm in length, along with five stamens.

Fruit: When mature, the fruits turn purple to nearly black. They are globose capsules, about 6–7 mm in diameter (roughly the size of a small pea), containing two to three valves, with each cell holding 1–2 seeds. The seeds are brown, covered entirely by a white aril, and have green, fleshy cotyledons.

The pharmacognostic features of the leaves and stem of Gymnosporia montana have been documented by De et al.

Activities of Pharmacology

Antimicrobial: Prevents the growth of bacteria and fungi

Free radicals are scavenged by antioxidants.

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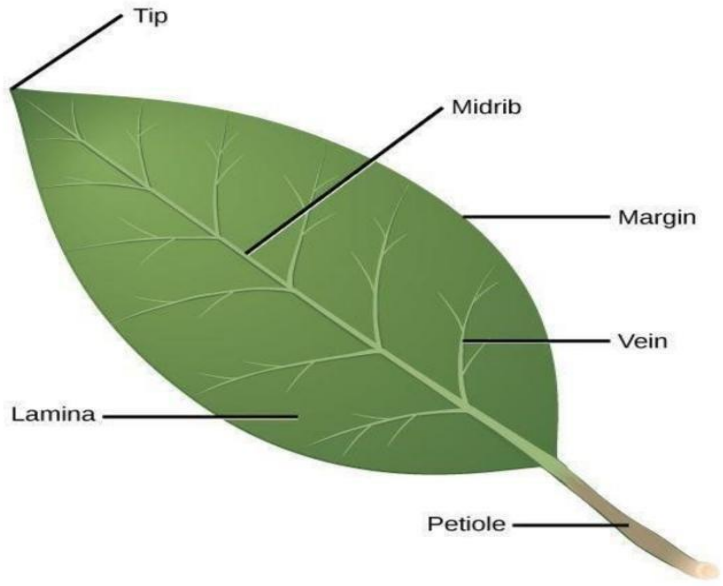
3.Reduces inflammation: Anti-inflammatory
Analgesic: Reduces discomfort
Reduces blood sugar levels; anti-diabetic
Anti-cancer: Prevents the formation of cancer cells
Cardiovascular: Lowers elevation
Neuroprotective: Prevents degenerative illnesses of the brain Mechanisms of Pharmacology
Microbial enzyme inhibition Secondly, free radical scavenging
Inhibition of mediators of inflammation 3. The way opioid receptors interact
4. Reduction of the absorption of glucose
5.Causing cancer cells to undergo apoptosis
6.Cardiovascular protection and vasodilation
7.Neuronal effects of antioxidants and anti-inflammatory
Safety and Toxicology :
1. Oral LD50 > 2000 mg/kg indicates acute toxicity. 2. Sub-acute toxicity: No notable negative consequences 3. Non-mutagenic genotoxicity 4. Carcinogenicity: Not a cause of cancer

MORPHOLOGY
LEAF: Simple, alternating, or clustered leaves can be found on small branches, in the axils of spines, or on the spines themselves
The leaves are glabrous, nearly sessile, and exhibit considerable variation in shape. They typically have an acute apex, with the lower half showing a mucronate or obtuse base, while the upper
half



displays a crenulate margin. Their size ranges from 3–8 cm in length and 1–3 cm in width.
Stem: The stems are modified branches bearing a single node from which leaves emerge. They are reddish-brown in colour and bear firm, straight, pointed spines. The bark is thin, with a creamy white interior and fine longitudinal wrinkles on the outer surface. **Microscopy of the leaf** :
A transverse section of the lamina across the midrib shows an approximately isobilateral structure. The lower epidermis is biseriate, covered by a waxy cuticle, and composed of round to rectangular cells. The upper epidermis is also two-

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layered, bearing a thick, striated cuticle and having relatively fewer stomata. Both the upper and lower regions of the leaf contain two layers of palisade parenchyma, which hold abundant yellowish-black deposits and calcium oxalate cluster crystal

In the midrib region, the epidermis is single-layered, supported on both sides by three to four layers of collenchymatous tissue. The underlying parenchymatous cells contain calcium oxalate cluster crystals along with simple, hilum-less starch grains and rosettes. A discontinuous ring of sclerenchymatous pericyclic fibres surrounds the crescent-shaped, conjoint, collateral vascular bundle in the midrib. The xylem fibres are small, angular, and arranged radially, containing colouring matter, while the xylem vessels are narrow. The vascular bundle's characteristic curved

Stem :

The immature stem's transverse slice shows large solitary, prismatic, squarish, and rhomboidal calcium oxalate crystals, single, thin xylem arteries, uniseriate medullary rays, and virtually continuous, sclerenchymatous pericyclic fibers. The majority of the cells have dark coloring material deposited in them. Older stems exhibit annular rings with small, compressed xylem vessels leading to the pith. The leaf and stem of G have recently been shown to have similar pharmacognostic characteristics by Dhru etc .

CHEMISTRY :

The family Celastraceae has been reported to include a number of sesquiterpene pyridine alkaloids, including emarginatine A, B, E, F, and G as well as a sesquiterpene ester, celahin B4,21–23. Several workers from various regions of Gymnosporia montana have documented a number of substances with varying chemical natures

The leaves of G. montana have yielded a number of chemicals that have been isolated, including tingenone, 3-O-acetyl oleanolic acid, hexacosane, hexacosanol, n-triacontanol, betulin,β-amyrin, δ-amyrin, β-sitosterol, celacinnine, and kaempferol. De et al. (15) have also documented the presence of seven free amino acids, including arginine, glutamic acid, alanine, proline, and γ-aminobutyric acid, as well as galactose as a free sugar. According to the same group, the leaf contains seven fatty acids, with palmitic acid accounting for the majority (72.03%).

LEAVES: From the leaves of G. montana, a number of chemicals have been identified, including tingenone, 3-O-acetyl oleanolic acid, hexacosane, hexacosanol, n-triacontanol, betulin, β-amyrone, β-amyrin, δ-amyrin, β-sitosterol, celacinnine, and kaempferol. De et al. (15) have also documented the presence of seven free amino acids, including arginine, glutamic acid, alanine, proline, and γ-aminobutyric acid, as well as galactose as a free sugar.According to the same group, the leaf contains seven fatty acids, with palmitic acid accounting for the majority (72.03%).

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ROOT:

Joshi et al. have isolated iguesterin, pristimerin, tingenone, β-amyrin, and β-sitosterol (24, 29). While Akshaya Kumar et al.25 reported the presence of (-)epigallocatechin, Emarginatine A33, and Emarginatine G22, two more sesquiterpene pyridine alkaloids have also been extracted from this plant. Satyanarayana and his team32 have recovered dukidol and β-amyrin. Other Gymnosporia (Maytenus) species have yielded a number of chemicals. The timber, root, and leaf extracts of Gymnosporia emarged contain triterpene quinone-methides, lupenone, β-amyrin, dulcitol, and sitosterol, as well as (-) 4'-O-methyl-epigallocatechin, proanthocyanidin-A, and dulcitol from the roots of M. ovata Laws34, Maytansine from G. diversifolia (Grey) Maxim35, sesquiterpenes from M. chubutensis36, M. disticha37, and nepetricin38, triterpenoids, and maintain, pristimerin, 22-hydroxy maitenin, rigidenol, and nepetricin.

Samples of G. Montana leaves and stems have extractive value data and other preliminary phytochemical analyses available 15, 19, and 20. The leaf and stem have corresponding ash values of 9.6–12.5% and 7.9% w/w. With petroleum ether, methanol/alcohol, and water, the leaf's extractive values were 5.1-6.5%, 10.5-12.1%, and 14.5% w/w, respectively, whereas the stem's were 5%, 10.3%, and 9% w/w. Steroid/triterpenes, alkaloids, flavonoids, and saponins were all present in the leaf and stem. The leaf has also been shown to contain iron, calcium, magnesium, sodium, and potassium. According to research by Nagaraju and Karimulla41, G. montana leaves have the capacity to accumulate significant levels of Ca, K, Mg, B, Ba, Cu, Mn, Sr, and Zn.

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PHARMACOLOGY:

Numerous bioactive compounds with diverse pharmacological activities have been identified from various species of the Celastraceae family. These include sesquiterpene pyridine alkaloids with immunosuppressive or antitumor effects, triterpenoid quinonemethides (also known as celastroloids) possessing cytostatic and antibiotic properties, and diterpene triepoxides known for their strong antileukemic and immunosuppressive actions. The Chinese medicinal plant Tripterygium wilfordii Hook (Family: Celastraceae) contains two notable anticancer molecules— the quinone triterpene celastrol and the diterpenoid epoxide triptolide. The methanolic extract of Celastrus orbiculatus has exhibited potent sedative and antinociceptive activity, while leaf extracts of Gymnosporia rothiana have shown dose-dependent gastroprotective effects against ethanol- and indomethacin-induced gastric ulcers, in addition to exhibiting notable anticancer activity.

In contrast, there are only a limited number of studies on the pharmacological properties of Gymnosporia montana. De and colleagues evaluated the leaf extracts for possible antiinflammatory and hepatoprotective effects based on its traditional use in managing inflammation and jaundice. Anti-inflammatory activity was assessed using carrageenan-induced rat hind paw oedema; the extracts did not reduce the oedema, indicating an absence of antiinflammatory activity.

Hepatoprotective potential was investigated by examining the influence of the extracts on carbon tetrachloride (CCl_4)-induced prolongation of pentobarbitone sleeping time in mice. The methanolic extract of the defatted leaves significantly counteracted the CCl_4-induced increase in sleeping time and markedly reduced elevated serum transaminase levels. The same research group further assessed the extract's ability to reverse CCl_4-induced alterations in various serum and liver biochemical markers as well as its effect on liver micro cytoarchitecture. The primary parameters studied included transaminase activity, liver and serum lipid profiles, serum orosomucoid levels, and liver glycogen and phospholipid content. The extract restored most of the CCl_4-induced biochemical changes and substantially improved liver cytoarchitecture.

Later, Patel et al. (50) reported that pre-treatment with the alcoholic extract (100 mg/kg) of G. montana leaves in Wistar rats produced hepatoprotective effects comparable to those of silymarin (100 mg/kg) against paracetamol-induced hepatotoxicity.

The methanolic extract of the defatted dried leaf powder has also demonstrated notable antioxidant activity, as shown by assays measuring lipid peroxidation (FTC method), total antioxidant capacity (thiobarbituric acid method), DPPH radical scavenging activity, and nitric oxide scavenging activity, indicating that it possesses significant source of

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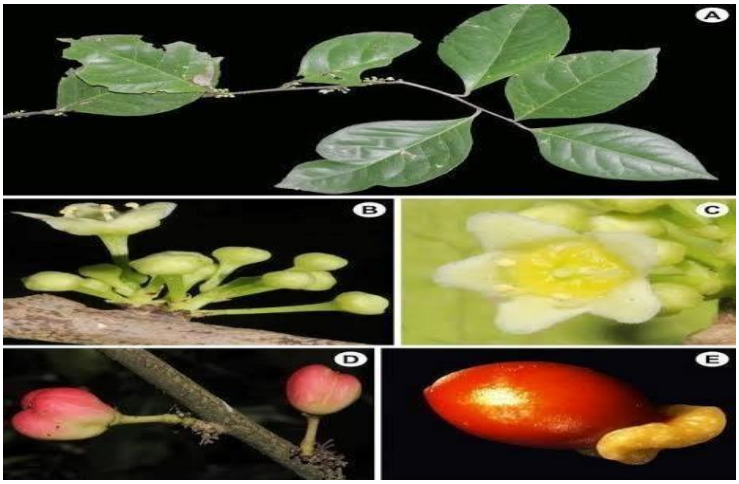
antioxidants. Recently Dhuru et al. have reported the antiinflammatory, analgesic and antibacterial activity of the plant. ofPresence of antispasmodic activity has been reported by Dharetal.

According to this review, Gymnosporia montana possesses a number of biological activities, including hepatoprotective, antioxidant, anticancer, antibacterial, analgesic, and antispasmodic properties. It also has a lot of promise as a hepatoprotective and anticancer medication.



II. CONCLUSION

study successfully examined the phytochemical, pharmacological, and ethnobotanical properties of Gymnosporia montana, supporting its traditional uses and highlighting its potential relevance in modern medicine.

Key Findings:
Identification of bioactive compounds with therapeutic potential.
Demonstration of significant antibacterial, anti-inflammatory, and antioxidant activities.
Documentation of diverse traditional uses, including treatments for fever, digestive disorders, and wound healing.

Implications:
Gymnosporia montana shows promise for drug development, particularly for conditions associated with oxidative stress and infections.
Validation of traditional knowledge reinforces the importance of ethnobotanical studies.
Further exploration of the plant's pharmacological characteristics is essential for its potential
Therapeutic applications Future Directions:
Isolation and characterization of additional bioactive constituents.
In vivo studies to substantiate pharmacological effects.
Clinical trials to evaluate safety and therapeutic efficacy

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