



PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF *Gmelina arborea*: AN OVERVIEW

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ABSTRACT

Gmelina arborea Roxb (Family- Verbenaceae) commonly known as ‘Gamhar’ is a beautiful fast growing deciduous tree throughout in India and one of the herbs mentioned in all ancient scriptures of Ayurveda. It is known to have been used in traditional Indian medicine having important source of chemicals of immense medicinal and pharmaceutical importance such as flavonoids, alkaloids, arboreol, isoarboreol, methyl arboreol, gummadiol, gmelanone, gmelinol, n-hexacosanol, n-octanol, β -sitosterol and luteolin. Various studies indicated that it possesses antioxidants, diuretic, anthelmintic activity, cardioprotective, antidiabetic, immunomodulatory, antipyretic and analgesic, antimicrobial and in the treatment of jaundice, headache, useful in hallucination, piles, fever and ‘Tridosha’ as a folk remedies. The review focuses on the detailed phytochemical composition and medicinal uses along with pharmacological properties of different parts of *G. arborea*.

Keyword: *Gmelina arborea*, Verbenaceae, Phytochemical constituents, Pharmacological activity

INTRODUCTION

By witnessing the traditional background from many civilizations of the herbal medicine and natural remedies are the thirteenth area of research due to its potency and apparent safety profile. World Health Organization has listed over 2100 plant species used around the world for medicinal purposes. In India, about 2500 plant species belonging to more than 1000 genera are being used in indigenous system of medicine. India is blessed with 12 mega biodiversity centres of the world with 16 agro-climatic zones with the claiming of 7000 species of medicinally potential herbs. In spite of having rich heritage and the knowledge of the use of plant drugs, use of only 40 plant species currently by the pharmaceutical industries indicates the lack of attention towards this tremendous therapeutic option in modern therapy¹. The use of plants, plants extracts or pure compounds isolated from natural products to treat disease is a therapeutic modality, which has stood the test of time even if much of the science behind such therapy is still in its infancy. In modern therapy use of synthetic drugs is in priority but some of the potential constituents such as morphine, digoxin, quinine, atropine, reserpine, physostigmine, pilocarpine, vinblastin, vincristine, artemisinin, taxol which has been isolated from the herbal source documented for remarkable pharmacological profile. More over some of the pathological condition where the scientific drugs become crippled but traditional herbal therapy can be a satisfying option which demands an ample amount of research². The attempt is made to present an overview of phytochemical and pharmacological activities of the plant *Gmelina arborea*.

***Gmelina arborea* Roxb.**

Gmelina arborea Roxb belongs to family Verbenaceae a plant of Indian origin having tremendous therapeutic potential is not fully utilized. It known with different names in different languages. *Gamhar* (Hindi); *White teak*, *Candahar tree* (English); *Kumbuda* (Kannada); *Shewan* (Gujarati); *Shivani* (Kashmiri); *Gambhari* (Sanskrit); *Kumla* (Tamil); *Gumartek* (Telugu), *Gamari* (Bengali). *Gmelina arborea* Roxb. is a fast-growing species and is known to have been used in traditional Indian medicine. *Gamhar* is one of the herbs mentioned in all ancient scriptures of Ayurveda as one

of the member of brhat pancamulas. Acharya Vagbhata has cited *Gambhari*, one of the members from the group *dasamulas*, as a pacifier of vata dosa (vata samsamana). The great sage Charaka has categorized *Gambhari* as *sothahara* – relieves oedema, *virecanopaga* – adjunct to purgation and its fruit as *dahaprasamana* – relieves burning sensation of the skin³.

Ethnobotany^{4,5}

Gmelina arborea is a beautiful fast growing deciduous tree occurring naturally throughout greater part of India up to 1500 m. *G. arborea* occurs extensively from the Ravi eastwards in the sub-Himalayan tracts, common throughout Assam and adjoining areas of Northern West Bengal, also in South Bihar and Orissa, sporadically found in western and southern India and planted elsewhere on a large scale. It also occurs naturally in Myanmar, Thailand, Laos, Cambodia, Vietnam, and in southern provinces of China. It is a fast growing tree, which though grows on different localities and prefers moist fertile valleys with 750-4500 mm rainfall. It does not thrive on ill drained soils and remains stunted on dry, sandy or poor soils; drought also reduces it to a shrubby form. It grows best in climates with mean annual temperature of 21–28°C.

Plant (Figure 1)

The tree attains moderate to large height up to 30 m with girth of 1.2 to 4.5 m with a clear bole of 9-15 m. It is a tree to see the *Gmelina arborea* tree standing straight with clear bole having branches on top and thick foliage forming a conical crown on the top of the tall stem.

Bark

Bark light grey coloured exfoliating in light coloured patches when old, blaze thick, a chlorophyll layer just under the outer bark, pale yellow white inside.

Leaves

Leaves are simple, opposite, more or less heart shaped, 10-25 cm long, and 5-18 cm wide.

Flower

Flowering takes place during February to April when the tree is more or less leafless. The yellow or brown flowers are arranged in panicked cymes 15-30 cm long, which appears after leaf fall. The trumpet-shaped flowers are 4 cm long and

hairy and short-stalked. The trumpets flare open into a gaping mouth with 5 distinct lobes.

Fruits

Fruiting starts from May onwards up to June. The fruit is a drupe 2-2.5 cm long and contains 1-4 seeds.

Traditional Uses^{3,5,6}

- Gamhar timber is reasonably strong for its weight. It is used in constructions, furniture, carriages, sports, musical instruments and artificial limbs. Once seasoned, it is a very steady timber and moderately resistant to decay and ranges from very resistant to moderately resistant to termites.
- The bark of *Gmelina arborea* are stomachic, galactagogue, laxative and anthelmintic, improve appetite, useful in hallucination, piles, abdominal pains, burning sensations, fever, 'Tridosha' and urinary discharge. It is also recommended with other drugs for the treatment of snake-bite and scorpion-sting.
- Leaf paste is applied to relieve headache and juice is used as wash for ulcers. Gamhar leaves, Apamarga roots and bark skin of Saimali are mashed with cow's milk and are given orally to treat hyperacidity. The leaves juice, milk and sugar are recommended in inflammatory condition of urinary bladder and dysuria.
- Flowers are sweet, cooling, bitter, acrid and astringent which is useful in leprosy and blood diseases.
- Fruit is acrid, sour, bitter, sweet, cooling, diuretic, tonic, aphrodisiac, promote growth of hairs, useful in 'Vata', thirst, anaemia, leprosy, ulcers and vaginal discharge. It is also recommended in raktapitta, excessive thirst, sexual debility in males and habitual abortion. The ripened fruit is valuable in heart disease of vata imbalance. The cold infusion of tea prepared from gamhar fruits is extremely beneficial, mixed with honey and sugar in fever of pitta origin.
- The roots are described in the ayurvedic texts as mild laxatives which treats flatulence and increase appetite, lactation and reliever of menstrual irregularities. The cold infusion of candana, ustra and gamhar works well with sugar to alleviate the thirst. It is also useful in piles, burning sensation, fever and 'Tridosha'.

Active Constituents⁷⁻¹¹

The bark, leaves, fruits and roots having some of the potential chemical constituents which is responsible for the medicinal importance of the herb. It contains large concentration of alkaloids and flavonoids as well as variety of phytochemicals and the concentration of these phytochemical may depend on the factor of which it is being extracted. The methanolic extract contains alkaloids, flavonoids, saponins, steroids, glycosides whereas chloroform extract contains alkaloids, saponins and steroids. The stem bark and heartwood contains number of chemical constituents such as lignans, gmelinol, n-hexacosanol, n-octanol along with β -sitosterol. Alkaloids and benzoic acid are found in the root, while the leaves contain luteolin as a flavonoids. The fruits have tartaric acid, which is an antioxidant commonly found in wine. The parent compound is arboreol which is chemically known as 2a, 6e-dipiperonyl-1e,2e-dihydroxy-3,7-dioxabicyclo-[3,3,0]-octane and accompanied by isborneol. The extraction of heartwood has yielded a number of lignans including arboreol, isoarboreol, methyl arboreol, gummadiol, gmelanone, arborone and 7-oxo-dihydrogmelinol. (Table 1)

Pharmacological Activity

Antioxidant activity¹²

Effect of antioxidant activity of methanolic extracts of stem bark of *G. arborea* Roxb (MEGA) was studied using various in vitro assays method which shown free radical scavenging activity 85.20% while at the same concentration to that of standard ascorbic acid was 89.58% due to proton donating ability and could serve as free radical inhibitors or scavengers.

Anthelmintic activity¹³

Effect of anthelmintic activity of alcoholic and aqueous leaves extracts of *Gmelina arborea* Roxb exhibited anthelmintic activity in dose dependent manner giving shortest time of paralysis and death compared to piperazine citrate especially with 100mg/ml concentration for *Pheretima posthuma* and *Ascardia galii* worms by increasing chloride ion conduction of worm muscle membrane produces hyperpolarization and reduces excitability that leads to muscle to relaxation and flaccid paralysis.

Anti microbial activity¹⁴

The Crude leaf and stem bark extracts of *G.arborea* showed significant antimicrobial activities against Gram positive and gram negative organism and the activity is due to presence of bioactive compounds such as alkaloids, saponins, carbohydrates, phenolics, tannins and anthraquinone but no cardiac glycosides in leaf while in stem bark possessed saponins, carbohydrates, alkaloids, tannins and anthraquinone but no phenolics. *In vitro* studies of both extract of leaf and stem bark shown significant activity against *E.coli*, *K.Pneumoniae*, *P.dysentria* and *S.typhi*.

Diuretic activity¹⁵

Effects of *G.arborea* methanolic extract have shown significant diuretic activity on albino rats. The test extracts were given in the dose of 250 mg/kg and 500 mg/kg body weight. Sodium (Na^+), Potassium (K^+) and chloride (Cl^-) output in urine markedly increased as compared to normal saline. The *G.arborea* extract exerted its diuretic activity due to synergistic action of the $[\text{HCO}_3^-/\text{Cl}^-]$, $[\text{HCO}_3^-/\text{H}^+]$ exchangers and the $[\text{N}^+/\text{H}^+]$ antiporter by inhibiting tubular reabsorption of water and accompanying anions to cause diuresis. There was an increase in the ratio of concentration of excreted sodium and potassium ions after methanolic extract of *Gmelina arborea* treatment. This indicates that the extract increases sodium excretion to larger extent than potassium which leads to hyperkalaemic side effect¹¹⁸.

Cardioprotective¹⁶

Effect of ethanolic extract of *G.arborea* shown potential protective effect against doxorubicin (DOX) induced cardiac toxicity by increasing cardiac markers activities in plasma. The significant increases the activities of cardiac markers such as SGOT, SGPT and ALP in plasma of DOX (20 mg/kg) treated rats might be due to enhanced susceptibility of myocardial cell membrane to the isoproterenol mediated peroxidation damage resulting in increased release of these diagnostic marker enzyme into the systemic circulation.

Anti diabetic activity¹⁷

Effect of antidiabetic activity of ethanolic extract of *G.arborea* bark at dose of 420 mg/kg and chlorpropamide at dose of 200 mg/kg ($P < 0.05$) was found to reduce the increase of blood sugar in streptozotacin (50 mg/kg) induced diabetes due to the increased blood GSH levels reinforcing the role of GSH as free radical scavenger and in the repair of free radical caused biological damage.

In diabetes, oxidative stress is due to both an increased production of plasma free radical concentration and a sharp

reduction of antioxidant defences. GSH, being the most important biomolecule against chemically induced toxicity can participate in the elimination of reactive intermediates by reduction of hydro peroxides in the presence of Glutathione peroxidase. GSH also functions as free radical scavenger and in the repair of free radical caused biological damage. The important mechanism implicated in the diabetogenic action of STZ is by increased generation of oxygen free radicals, which causes a decrease in plasma GSH concentration. Hence, drugs that could prevent the generation of these oxygen free radicals or increase the free radical scavenging enzymes may be effective in STZ induced diabetes.

Immunomodulatory activity¹⁸

Effect of methanolic extract of *Gmelina arborea* and ethyl acetate fraction of methanolic extract have been found to increase the total WBC count, which was lowered by cyclophosphamide, a cytotoxic drug. The drug is also capable of normalising the levels of neutrophils and lymphocytes. The results of the present study indicate that the test drug can stimulate the bone marrow activity. As the drug is capable of reducing the cyclophosphamide induced toxicity, it can be useful in cancer therapy also.

Antipyretic and analgesic activity¹⁹

The effect of bark extract of *G. arborea* was evaluated and the ethanolic and aqueous extract found to reduce the hyperthermia at a dose of 420 mg/kg body weight 1hrs after administration and its effect is comparable to that of the standard antipyretic drug paracetamol at a dose of 50 mg/kg body weight. Whereas chloroform and benzene extract reduced the temperature 3h after their administration but have mild effects. However the analgesic activity of test compounds was found to be more significant on acetic acid induced test than tail flick test as compared to standard diclofenac sodium at a dose of 25 mg/kg and thus it appear that the test compounds inhibit predominantly the peripheral pain mechanism.

CONCLUSION

The ancient literature of traditional Indian medicine indicating the potential medicinal values of *G. arborea*. Some of the recent phytochemical and pharmacological investigation of the herb documenting the same trend. The exciting findings of the previous studies must provoke the researchers for checking other pharmacological profile. The documented profiles also widening the chances of proceed with clinical studies and development of commercial drugs.

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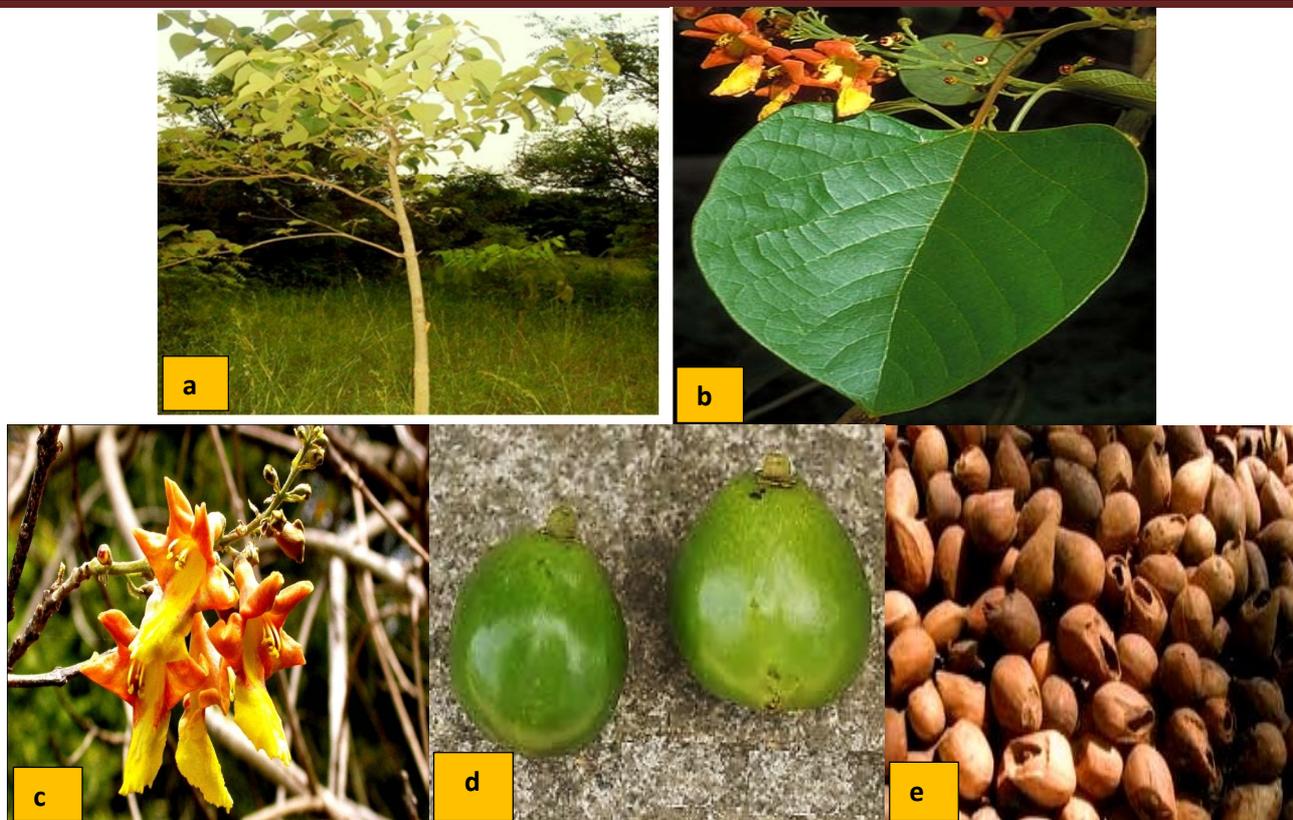
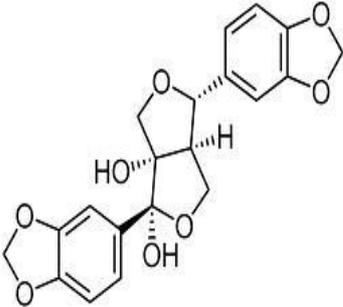
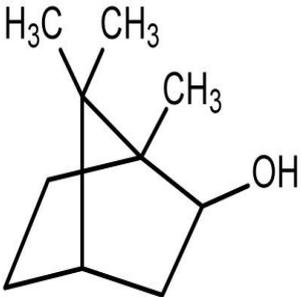
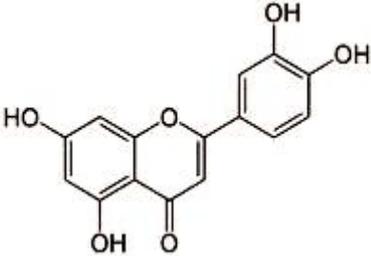


Figure 1: *G.arborea* plant and its parts
 a. Whole plant; b. Leaf; c. Flower; d. Fruits; e. Seeds

Table 1: Structure of chief active constitute of *G.arborea*

 <p>The structure of Arboreal is a complex polycyclic molecule. It features a central bicyclic core with multiple hydroxyl groups and a benzodioxole ring system attached to one of the carbons.</p>	 <p>The structure of Isoborneol is a bicyclic molecule consisting of a decalin ring system with a hydroxyl group (-OH) and three methyl groups (-CH₃) attached to the ring carbons.</p>	 <p>The structure of Luteolin is a flavone molecule. It consists of a chromone core with two hydroxyl groups on the A-ring and two hydroxyl groups on the B-ring.</p>
<p>Arboreal</p>	<p>Isoborneol</p>	<p>Luteolin</p>