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A Review on Gambhari (*Gmelina arborea* Roxb.)

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Abstract
Gmelina arborea Roxb is one of the important medicinal plants most widely propagated and cultivated species of the family *Verbenaceae*. It is commonly known as "K*ashmarya*" and one of the herbs mentioned in all ancient scriptures of *Ayurveda*. It is a beautiful fast growing avenue tree that grows throughout India. This medicinal plant is highly valued from time immemorial because of its vast medicinal properties. *Gambhari*, an essential component among *Dashamuala*. *Rasayana* (rejuvunative), *Medhya* (Memory enhancer) & *Vrishya* (Aphrodisiac) activities have been related to its fruits, which are edible in nature. It is extensively used traditionally as antihelmintic, antimicrobial, antidiabetic, diuretic, hepatoprotective and antiepileptic agent. The present article provides review on *Gambhari* and pharmacological studies conducted till date.

Keywords: Kashmarya, Dashamula**,** Gambhari**,** Gmelina arborea Roxb, Verbenaceae.

1. Introduction
Gambhari (*Gmelina arborea* Roxb.) belongs to the family Verbinaceae. It is found throughout greater part of India, Western Ghats, and from foot of North-West Himalaya to Chittagong & throughout Deccan Peninsula [1]. It is a medium sized to rarely large deciduous tree attaining a height of 15-20m [2]. This plant is planted in gardens and also as an avenue tree. *Gmelina arborea* Roxb. Is one of the ingredients of most famous group *Dashamoola* and in particular *Brihath panchamoola* [3]. It is popularly known as Coomb teak, Cashmeri tree, Candhar tree in english.[1] *Kashmarya, Kashmeeri, Gambhari* in Sanskrit. Different parts of the plant can be used medicinally like root, fruit, leaf, flower, bark. The family Verbinaceae consists of 2,600 species, among them 107 species are found in India [4]. The present review deals with the classical uses, microscopic, botanical descriptions and also the pharmacological activities carried on *Gmelina arborea* Roxb.

2. Taxonomical Classification [5]
Taxonomy is the science of systematically naming and organizing organisms in to similar groups. Plant taxonomy is an old science that uses the gross morphology (flower form, leaf shape, fruit form etc.) of plants to separate them in to similar groups. Taxonomical classification of plant *Gmelina arborea* Roxb. (*gambhari*), is tabulated (Table 1).

Table 1: Showing Taxonomical classification

Kingdom	**Plantae**
Class	Angiosperms
Sub class	Eudicots
Super order	Asterids
Order	Lamiales
Family	Verbinaceae
Genus	*Gmelina*
Species	*Arborea*

3. Vernacular Names [1, 9]
Ever since man understood the importance of plants, he started grouping them in to edible, non-edible, medicinal, non-medicinal, poisonous, non-poisonous etc. and naming them to recognize each individually from the language he is familiar with. Thus today the most useful plants have their names derived from the regional languages, popularly called vernacular names. Vernacular names of *Gambhari (Gmelina arborea* Roxb.*)* are tabulated below (Table 2).

Table 2: Showing vernacular names

INDIA		FOREIGN	
ASSAM	Gamari	ENGLISH	Coomb teak, Cashmeri tree, Candhar tree
BENGAL	Gambhar, Gamar	BURMA	Kyunboc, Kywonpho, Yamanai, Yemene
GUJARAT	Seevan	HAZARA	Sewan
MARATI	Sivan, Shewan	KADIR	Kumala
HINDI	Kambhari, Ghambhar, Gamhar, Gambhar, Sewan, Gambhari, Gamari	KOLAMI	Gumher, Kasamar
KANNADA	Shivanigida, Shivani, Kumbalamara	KOYA	Gumudu
MALAYALAM	Kumizhu, Kumpil, Kumil, Kumbil, Kumilu	NEPAL	Gambari, Khamari
ORRIA	Gambhari, Bodhroparnni		
PUNJAB	Gumhar, Kumhar, Ban		
TAMIL	Kumizhan, Kumishan, Perumkumbil, Komizhpazham, Perunkurmizh, Kumadi		
TELUGU	Peggummadi, Peggummudu, Gummadi, Gumaditeku		

4. Paryaaya Naama (Synonyms) [6, 7]

A single name is given to, many drugs and also a drug may have many names which are called as Paryaayas. Names and synonyms are the tools to specify the salient features of the plants. Likewise Gambhari also have paryaayas. They are tabulated (Table 3).

Table 3: Showing *paryaaya naama* (Synonyms)

S. No	Synonym	Nirukti
1	*Kaashmari*	It is a beautiful tree
2	*Kashmiri*	It is found Kashmir
3	*Krishnavrintha*	It has blackish petiole
4	*Pitarohini*	It has yellowish bark
5	*Bhadraparni*	It has beautiful leaves
6	*Mahaakusumaka*	It has long inflorescence
7	*Vaatahrut*	It is good remedy for *vatika* disorders
8	*Shreeparni*	It has beautiful leaves
9	*Sarvatobadhra*	Each part of this tree has medicinal values
10	*Suphala*	Fruits are wholesome
11	*Sthoolatvaca*	It has thick stem bark
12	*Heera*	Fruits are used as *Rasayana*
13	*Madhuparni*	Its leaves are sweet as honey or its leaves are glabrous, shining like honey

5. Distribution [1]

Found throughout India, from north-west Himalaya to Chittagong and throughout Deccan peninsula.

6. Family Features [4, 8]

Over 2,600 species, 107 species are found in India.

Herbs, shrubs**,** trees or climbers. Often prickly and some are xerophytic in habit. They are usually strong smelling. The stem is sometimes 4- angled.

Leaves: simple, opposite or whorled and sometimes pinnately or palmately compound.

Inflorescence: Raceme, panicle or spike (long or condensed), or a dichasial cyme.

Flowers: Bisexual, medianly zygomorphic, hypogynous and pentamerous. Bracts are sometimes in the form of involucres, as in *Lantana.*

Calyx: Sepals usually 5, rarely 4 or more and gamosepalous. The calyx is persistent.

Corolla: Petals usually 5, gamopetalous. They are initially 2-lipped and later 5 lobed. The tube may be long or short and the limb oblique is aestivation imbricate.

Androecium: Stamens are 4, didynamous and epipetalous (rarely 2 or 5). Often inserted or sometimes exserted and alternate with corolla lobes.

Gynoecium: Carpels are 2, rarely 4 and syncarpous. Superior ovary, entire or lobed, 2-locular with 1 or 2 ovules in each chamber or 4-locular with 1 ovule in each chamber. Terminal style.

Fruit: Drupe (2 or 4 pyrenes) and rarely capsule.

Seed: Exalbuminous seed.

Floral Formula: ·|· ♀♂ K $(_5)$ C $(_5)$ A_4 $\underline{G}$ $(_2)$

7. Morphology [9]

A moderate sized unarmed deciduous tree, reaching 18m high, with young parts densely velvety tomentose. Bark is greyish yellow, rather corky. Branchlets clothed with fine white mealy pubescence. Leaves are 10-20 by 7.5-15cm, broadly ovate, acuminate, entire, glabrous above when mature, stellately fulvous-tomentose beneath, base cordate or sometimes truncate and shortly cuneate. Petioles 5-7.5cm long, cylindric, puberulous, and glandular at top. Flowers appear with or sometimes before the young leaves, usually in small cymes of about 3 flowers arranged along the branches of a densely fulvous, hairy panicle reaching 30cm long. Buds are clavate and angular. Bracts are 8mm long, linear lanceolate. Calyx 5mm long, broadly campanulate, densely fulvous-hairy. Corolla brownish yellow, densely hairy outside reaching 3.8cm long, 5 lobed, 2 lipped. Upper lip more than 1cm long, deeply divided into 2 oblong, obtuse lobes. Lower lip nearly 2.5cm long, 3 lobed, the middle lobe projecting forward, ovate, subobtuse, with irregularly crenulate margin, much longer and broader than the obovate rounded lateral lobes. Orange yellow or brownish yellow in color. Fruits are drupes 2-2.5cm long ovoid or pyriform or obovoid-oblong, 1-1.5cm long, green when unripe, orange-yellow or blackish when ripe, 1 or 2 seeded. (Figure 1, Figure 2, Figure 3)

Fig 1: *Gmelina arborea* Roxb. Flower

Fig 2: *Gmelina arborea* Roxb. Fruits (Drupes)

Fig 3: *Gmelina arborea* Roxb. Plant

8. Part Used - Root, bark, leaf, flower, and fruit [1].

9. Rasa Panchaka

Rasa panchaka of different parts of *Gambhari* according to various *Nighantus* are enlisted in the Tables (Table 4, 5)

Table 4: Showing *Rasa panchaka* of *Gambhari*

	Bp.N [10]	***R.N*** [11]	***D.N*** [12]	***P.N*** [13]	***M.N*** [14]	***K.N*** [15]	***Sha.N*** [16]	***N.A*** [17]
Rasa (Taste)	*Tikta* (Bitter)	*Katu* (Pungent) *Tiktha*	*Tiktha*	*Tikta kashaya* (Astringent) *(Phala - Madhura)*	*Madhura*	*Madhur Tiktha Kashaya*	*Tiktha*	*Madhura Kashaya Katu Tiktha*
Guna (Property)	*Guru* (Heavy)	*Guru*	*Guru*	*Guru*	*Guru*	*Guru*	*Guru*	*Guru*
Veerya (Potency)	*Ushna* (Hot)	*Ushna*	*Ushna*	*Ushna*	*Ushna*	*Ushna*	*Ushna*	*Ushna*
Vipaka (Taste at the end of digestion)	*Madhura* (Sweet)						*Madhura*	*Madhura*
Doshakarma		*Tridosha*	*Tridosha*	*Tridosha*		*Tridosha*		*Vatakapha*

Table 5: Showing *Rasa panchaka* of fruits & flowers of *Gambhari*

	Fruit [13]	***Flower*** [12, 17]
Rasa	*Kashayamla, Madhura*	*Kashaya, madhura, tiktha*
Guna	*Snigdha* (Unctuous)*, Guru*	-
Veerya	*Sheetha* (Cold)	*Sheetha*
Vipaka	*Madhura*	*Madhura*
Doshakarma	*Kaphapitta shaamaka, Vata vardhaka*	*Pittahara*
Karma (Action)	*Hrudya, rasayana, brimhana* (Nourishment), *shukrala* (Spermatogenic), *keshya* (Promoting hair growth), *medhya, mootrala* (Diuretic), *balya, raktapittashamaka, vrushya, dahaprashamana, rasayana, vishagna, sthanyajana*(Galactagogue), *sandhaneeya, thrishnashaamaka* (Thirts quenching).	*Balya* (Strengthening),*vrushya*

Karma: Deepana (Appetizer), paachana (Digestive), medhya, bhedana, shosha, vedanasthapana, anulomana, snehana, shothahara [10, 11, 12, 13, 14, 15, 17].

Rogagnatha: shirahshoola, brama, mastishkadourbalya, palitya, vatarakta, vatavikara, agnimandhya, vibandha, arsha, trishna, raktatisaara, shotha, hridroga, sheetapitta, kshaya, raktakshaya, motrakrichra, jwara, samanyadourbalya, sarpavisha, vrishchikavisha, anguliveshta, jwarottaradourbalya, sutikaroga, shukradourbalya, pooyameha [1, 10, 11, 12, 13, 14, 15, 17].

Maatra: phala swarasa 10-20gm [1]
Phala and twakkwatha 50-100gm [11]
Pushpa churna 4-10gm [1]
Root bark juice 10-20ml [1]

10. Microscopic Description [2]

TS of the bark shows outer 10 to 20 rows of lignified and suberised cork cells, cambium is distinct; wide parenchymatous cortex is traversed with oil globules, isolated or groups of stone cells and fibres often associated with idioblast containing prismatic crystals of calcium oxalate. Some of the stone cells often are embedded with prismatic crystals also. Phloem is very wide, shows multiseriate medullary rays, embedded with acicular crystals of calcium oxalate, few stone cells, fibres and tangentially running narrow bands of ceratenchyma, inner parenchymatous zone of the phloem being totally devoid of lignified elements; acicular and prismatic crystals of calcium oxalate and oil globules. Simple and compound starch grains traversed throughout the parenchymatous cells of the section.

11. Powder Microscopy [2]

Shows fragments of transversely cut cork cells and in surface view, isolated or groups of stone cells and sclereids of various sizes, shapes and thickness, longitudinally radially and tangentially cut medullary rays embedded with acicular crystals of calcium oxalate. Simple and compound starch grains, oil globules and prismatic and acicular crystals of calcium oxalate scattered as such throughout or embedded in

the parenchymatous cells and also consists of crystal fibers and idioblast with stone cells.

12. Chemical Constituents [1]

Gmelo furan-a furanosesquiterpenoid, sesquiterpene, cerylalcohol, hentriacontanol-1, β-sitosterol, n-octacosanol, gmelinol, apiosylskimmin-a apiofuranosyl-(1-6)-β-D-glucopyranosyl (1.0.7)-umbelliferone

Root: cluytylferulate, *n*-octacosanol, gmelinol, arboreol, 2-0-methyl arboreal, 2-0-ethylarboreol, isoarboreol,gmelanone, β-sitosterol, paulownin, 6"-bromoisoarboreol, 4-hydroxysesamin, 4,8-dihydroxysesamin, 1,4-dihydroxysesamin (gummadiol), 2-piperonyl-3-(hydroxymethyl)-4 (α-hydroxy-3-,4-methylenrdioxybenzyl)-4-hydroxy tetrahydro furan (1), 4-epigummadiol-4-0-glucoside, 1,4-dihydroxy-2,6-dipiperonyl-3,7-dioxabicyclo [3,3,0]-octane, gmelanone, palmitic, oleic and linoleic acids, stigmasterol, stigmastanol, campesterol, α-2-sitosterol, butulinol.

Leaf: luteolin, apigenin, quercetin, hentriacontanol, β-sitosterol, quercetogenin and other flavons.

Fruits: Butyric and tartaric acids, saccharine substances and little tannin, β- sitosterol, ceryl alcohol, gmelinol, arborone, arboreal, luteolin, apigenin, quercetin, hentriacontanol, quercetogenin.

13. Pharmacological Activities

13.1. Toxicity Study [19]

Acute and sub acute toxicity study of powder of fruits of *Gmelina arborea* Roxb (test drug) was conducted in two schedules (Acute and sub acute toxicity studies) with different doses of 300mg, 500mg and 1g/kg for 28 days. None of the doses of this test drug produced mortality or behavioral changes. Thus the test drug at a dose of 2g/kg was proved to be non toxic without causing any kind of variations among behavior, hematology, bio-chemistry and histology of vital organs.

13.2. Antioxidant Activity [20]

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

13.3. Anthelmintc Activity [20]

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 that produced hyper polarization and reduced excitability that lead to muscle relaxation and flaccid paralysis.

13.4. Anti Microbial Activity [20]

The crude leaf and stem bark extracts of *Gmelina arborea* Roxb. showed significant anti-microbial activities against gram positive and gram negative organism and the activity could be due to the presence of bioactive compounds such as alkaloids, saponins, carbohydrates, phenolics, tannins and anthraquinone but no cardiac glycosides in leaf while in stem bark possessed alkaloids, saponins, carbohydrates, tannins and anthraquinone but no phenolics. In *Vitro* study of both stem bark and leaf extracts shown significant activity against E. *coli,* K. *pnemoniae,* P. *dysentria* and S. *typhi.*

13.5. Diuretic Activity [20]

Gmelina arborea Roxb. methanolic extract have shown significant diuretic activity on albino rats. Extracts were given at the dose of 250mg/kg and 500mg/kg body weight. Sodium (Na^+), Potassium (K^+) and chloride (Cl^+) output in urine markedly increased as compared to normal saline. The *Gmelina arborea* Roxb. Extract exerted its diuretic activity due to synergistic action of ($HCO3^-/Cl^-$), ($HCO3^+/H^+$) exchangers and the (N^+/H^+) antiporter by inhibiting tubular re-absorption of water and accompanying anions to cause dieresis. There was an increase in the ratio of concentration of excreted sodium and potassium ions after methanolic extract of *Gmelina arborea* Roxb. treatment.

13.6. Cardioprotective [20]

Ethanolic extract of *Gmelina arborea* Roxb. has shown potential protective effect against doxorubicin (DOX) induced cardiactoxicity by increasing cardiac markers activities in plasma. The significant increased the activities of cardiac markers such as SGOT (Serum glutamic oxaloacetic transaminase), SGPT (Serum glutamic pyruvic transaminase) and ALP (Alkaline phosphate test) in plasma of DOX (20mg/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 in to the systemic circulation.

13.7. Anti Diabetic Activity [20]

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

13.8. Immuno Modulatory Activity [20]

Methanolic extract of *Gmelina arborea* Roxb. 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 normalizing the levels of neutrophils and lymphocytes. The results indicates that the *Gmelina arborea* Roxb. 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.

13.9. Antipyretic and Analgesic Activity [20]

Gmelina arborea Roxb. bark extract was evaluated and the ethanolic and aqueous extract found to reduce the hyperthermia at the rate of 420mg/kg body weight 1hrs after the administration and its effect is comparable to that of the standard antipyretic drug paracetamol at the dose of 50mg/kg body weight. Whereas chloroform and benzene extract reduced the temperature 3h after their administration but have mild effects. However the analgesic activity of ethanolic and

aqueous extract (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 25mg/kg and thus it appear that the test compounds inhibit predominantly the peripheral pain mechanism.

14. Propagation and Cultivation [1, 21, 22]

Gmelina arborea Roxb., is a fast growing plant due to its excellent medicinal and wood properties, is emerging as an important plantation species. Most potent and medicinally used part of this plant is its root part. This is the reason; the whole plant is being killed. Natural reproduction of *Gmelina arborea* Roxb., takes place in rainy season soon after the drupes fall to the ground. Alternate heat and moisture are necessary to stimulate seed germination. Artificial reproductions may be carried out by direct sowing the seeds or by transplanting vegetative propagation. To reproduce a healthy progeny of *Gmelina arborea* Roxb., there are certain agroclimatic conditions where the plant thrive, are to be followed. They include moist, fertile soil with good drainage. This plant is a light demander and intolerant of shade. It grows in areas receiving rainfall ranging from 750-4500mm or more. 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. As these requirements plays prominent role in growth and production of *Gmelina arborea* Roxb., they should be fulfilled and we should make sure that the plant grows in these conditions. (Figure 4)

Fig 4: *Gmelina arborea* Roxb. Seedlings in polybags

14.1. Seed Propagation

Seed propagation is the simple, common and best method for propagation of most of the plants. In case of *Gmelina arborea* Roxb., ripe brown fruits are collected from the ground, duly rejecting the green and black ones. They are heaped under or buried in a pit for four to five days and then washed to remove the pulp. They are allowed to rot by putting them in ditch filled with water. Seeds are separated and dried under sun. Seeds should be allowed to rot or fed to cattle and excreted stones are collected, washed and dried under sun. They should be soaked in water for forty eight hours, before sowing for better germination. Seeds are dibbled to a depth of two cm at a spacing of 7.5x7.5 cm in raised seed beds for proper drainage of water. They should be covered with a layer of hay to generate heat and moisture alternatively to stimulate germination. Germination duration is about twenty days.

14.2. Vegetative Propagation

The root suckers growing around the mature plants can be separated and planted.

14.3. Clonal Propagation

The efficient way to regenerate *Gmelina arborea* Roxb. on large scale is through clonal propagation. In this procedure the shoot apexes of mature trees of *Gmelina arborea* Roxb. are collected. After sterilization of these shoot apexes they should be cultured in a test tube by using benzyl amino purine (BAP) or indole-3-butyric acid (IBA). These solutions induce multiple shoots from these shoot apexes, each having a large number of either definite buds or adventitious buds or both and also could promote shoot elongation, rooting efficiently from these proliferated multiple shoots. The plantlets thus generated should be transplanted to pots containing soils. The transplanted plantlets in the pots were made to grow in an acclimatization box placed in a greenhouse for one month. After one month established plants are planted in the field.

15. Conclusion

The present review indicates the importance of *Gmelina arborea* Roxb. (*gambhari*), as one of the classical medicinal plants. As it is a fast growing multipurpose medicinal plant there is a need to eradicate the usage of its adulterants and substitutes by propagating & cultivating them on large scale using standard techniques. The pharmacological activities proved are yet to be further evaluated and revalidated by clinical trials.

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