

Assessment of credibility of some folk medicinal claims on *Bombax ceiba* L.

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The present paper is an attempt to assess the credibility of various folk claims on medicinal uses of *Bombax ceiba* L. in view of scientific studies done so far. Almost all parts of the plant are widely used by tribal communities for gastrointestinal and skin diseases, gynecological and urino-genital disorders, general debility, diabetes and impotence. There are direct evidences of scientific validation for six pathological conditions while its anti-microbial, anti-inflammatory, antioxidant, analgesic and oxytocic potential provides indirect evidences for some of the folk medicinal claims and both these evidences authenticate the credibility of folk wisdom on *B. ceiba* L.

Keywords: Diabetes, Impotence, Anabolic, Antioxidant, Hepato-protective

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Traditional knowledge of various indigenous communities is based on their necessities, instincts, observations, trial and error and long experience. In this regard, multi-locational and multi-ethnic medicinal use of any plant, is a good criterion which definitely increases the credibility of the plant to possess medicinal potential against particular disease¹.

Bombax ceiba L. [syn.: *Bombax malabaricum* DC.; *Salmalia malabarica* (DC.) Schott & Endl.; *Gossampinus malabarica* (DC.) Merr.]; a member of family Malvaceae, is a lofty, deciduous tree. It is popularly known as Red Silk Cotton tree, Indian Kapok tree, *Shalmali*, *Semal*, *Simal*, *Shemul* and well distributed in Temperate and Tropical Asia, Africa and Australia. It has a place among the five sacred plants of 'Panchwati' and is an important multipurpose tree providing food, fodder, fuel and fibre. Besides, spiritual, ecological and commercial importance; it also possesses socio-cultural and ethno-medicinal importance in various tribal

communities of the world. Almost all parts of the plant i.e. root, stem-bark, leaf, flower, fruit, seed, gum, thorns and silk-cotton are reported to possess medicinal potential in various ethnobotanical studies. However, its roots, stem-bark and flowers are employed maximally to treat various ailments²⁻³.

The plant is used mostly for the treatment of gastrointestinal and skin diseases, gynecological and urinogenital disorders, general debility, diabetes and impotence. Many of these folk claims have been validated scientifically in animal and human studies world wide. Moreover, the folk medicinal claims on *B. ceiba* have been reported by distant ethnic communities which further enhance the credibility potential of the plant for medicinal properties. This paper is an attempt to check the credibility of these folk medicinal claims in view of scientific studies done so far.

Methodology

Two online database namely, Pubmed and Google Scholar, six scientific journals, viz. Indian Journal of Traditional Knowledge, Journal of Ethnopharmacology, Ethnobotany, Journal of Economic and Taxonomic Botany, Indian Journal of Natural Product and Resources and Ethnobotanical leaflets along with Dictionary of Indian Folk Medicine and Ethnobotany⁴, Ethnobiology in Human Welfare⁵, Reviews on Indian Medicinal Plants² and

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Abbreviations: ABTS: 2,2'-Azino-di-[3-ethylbenzthiazoline sulphonate]; ACE: Angiotensin converting enzyme; ALT: Alanine transaminases; AST: Aspartate transaminases; ALP: Alkaline phosphatase; CCL₄: Carbon tetrachloride; DPPH: 1, 1-diphenyl-2-picryl-hydrazyl; FRAP: Ferric reducing ability of plasma ; GSH: Reduced glutathione; IC: Inhibitory concentration; I.P.: Intraperitoneal; MIC: Minimum inhibitory concentration; ORAC: Oxygen radical absorbance capacity; TBARS: Thiobarbituric acid reactive substance

Pharmacology of *Bombax ceiba* L.³ were searched thoroughly to know the ethnomedicinal uses of *Bombax ceiba*. More than 200 research papers were scrutinized out of which 105 references were found to possess such ethnomedicinal uses which have been validated scientifically and thus included for the assessment of credibility. Due to paucity of space, it was not possible to cite all of them in the text and for details readers can go through the above-mentioned sources or contact the authors. These references were also analyzed in perspective of similarity of uses among distant ethnic communities in different regions.

Results

A detailed analysis of scientific studies done on various parts of *B. ceiba* which are co-relating with their folk medicinal claims has been presented in this paper. Folk claims on diseases such as diabetes, impotence, spermatorrhoea, acne, urinary stones and liver diseases have shown direct evidences of validation in scientific studies. However, some of the diseases for example diarrhoea, dysentery, asthma, rheumatism, leprosy, leucorrhoea, body pain, wounds are included in anti-inflammatory, analgesic, antioxidant, anti-microbial and oxytocic activities of the plant as indirect evidences of scientific validation.

Validation of therapeutic claims direct evidences

Diabetes mellitus

B. ceiba has high reputation as an therapeutic agent for the treatment of diabetes (*Bahumutra* and *Madhumeha*) in tribal communities of Siran valley and Hazara region of Pakistan and Madhya Pradesh, Uttar Pradesh, Orissa, Chattisgarh, Bihar, Jharkhand and Tamilnadu states of India. Various parts of the plant such as root, stem, leaf, fruit and heartwood and seeds are claimed to possess therapeutic potential to treat patients with polyurea, glycosuria and asthenia- the clinical symptoms suggestive of diabetes mellitus^{2-3, 6-9}.

Scientific validation came from Dhar and associates who have first time reported hypoglycemic activity of fifty percent ethanolic extract of its stem bark and flowers at maximum tolerated dose of 50 and 250 mg/Kg respectively in albino rats. Further research in this direction has led to isolation of a hypoglycemic compound Mangiferin (earlier named as *Shamimin*) from its leaves and flowers which has shown a significant reduction in fasting blood sugar (26.6 %) in a dose of 500 mg/Kg at the end of 6 hrs in Sprague-Dawley rats²⁻⁵. Aqueous extract of sepals has

also demonstrated significant hypoglycemic effect in another animal study¹⁰.

Maximum ethnomedicinal claims for hypoglycemic activity have been observed from the root. Verma and associates have demonstrated significant anti-hyperglycemic effect of roots in a single blinded, placebo controlled study in type 2 diabetics. They have supplemented root powder (1.5 gm) in Group I and supplanted (3 gm) in Group II in two divided doses for 8 weeks and found significant ($p < 0.02$) reduction in the fasting blood glucose levels in both the groups. However, the anti-hyperglycemic effect was more pronounced when it was supplemented to conventional oral hypoglycemic regimen, than when it was the sole therapeutic agent (30% in Group I v/s 19% in Group II)³.

It is interesting to note that although there are no reports of using flowers for reducing blood sugar, still this part possesses good hypoglycemic potential¹⁰ which can reduce the brunt from its roots and may prove very important from conservation point of view. Claims on stem bark, heart wood, fruit and seeds are still need to be validated scientifically for their hypoglycemic potential.

Sexual problems

Young roots of *B. ceiba*; popularly known as *Semal-musli* or *Semar-kanda* are used traditionally as an aphrodisiac and for the treatment of impotence, spermatorrhoea and frequent nocturnal seminal emission among many tribal communities. Its juice is considered nutritive, restorative and sexual stimulant. Out of the 105 citations, 16 citations were claiming use of its roots for male sexual problems^{2-6, 11-15} from different regions of India and Bangladesh.

In 2011, first time effect of lyophilized aqueous extract of its roots was studied on sexual behavior and spermatogenesis in albino rats. Root extract has demonstrated significant ($p < 0.05$) improvement in mount, intromission and ejaculation frequencies, penile erection index, seminal fructose content and epididymal sperm counts as compared to control group³. It has also observed that root powder significantly increases sperm count, concentration and motility in a patient of oligospermia and cures functional erectile impotence (Unpublished data).

Debility

Roots of *B. ceiba* are widely used as a tonic and cure for debility^{4, 16-18}. Bhargava *et al.* (2011) have

shown anabolic effect of roots in an animal study. Recently, anabolic effect of root powder has been demonstrated by Verma *et al.* (2011) in a patient of involuntary weight loss without any detectable cause. Administration of 1.5 g *B. ceiba* root powder with milk led to a progressive weight gain and achievement of normal body mass index of 19.9 kg/m² at the end of six months along with marked improvement in fibrinolytic activity and total antioxidant status without any undesirable side effects³.

Urolithiasis

Young fruits of *B. ceiba* are given in calculus affections and chronic inflammation and ulceration of the bladder and kidneys including strangury and other forms of dysurias³. Recently, Gadge and Jalalpure¹⁹ have shown significant lithontriptic activity of its fruits in an animal study. Aqueous and ethanol extract of fruit (400 mg/kg body weight) significantly (p<0.05) reduced the elevated urinary oxalate induced by ethylene glycol. The increased deposition of stone forming constituents in kidneys of calculogenic rats was also significantly lowered with treatment of aqueous and ethanol extract. Besides this, diuretic effect of aqueous and crude ethanol extracts (200 and 400 mg/kg) has also been demonstrated in an acute study in rats²⁰ which further validates the folk claim of using fruits for treatment of urinary stones.

Acne

Thorns of *B. ceiba* have been employed to treat acne or pimples of the face in many tribal communities. It has also been shown to be related with doctrine of similarity as the thorns of the plant look alike the acne on the face^{6,12, 21-25}.

Patnagar²⁶ has studied *in-vitro* and *in-vivo* anti-acne potential of leaves, bark and thorns of *B. ceiba*. Results have shown that alcoholic extract of bark and thorns possess very good anti-acne potential against *Propionibacterium acnes* with MIC value of 250 µg/ml while MIC value of leaf was 500 µg/ml which was better as compared to MIC of standard clindamycin (1mg/ml). All three extracts have reduced *P. acnes* induced granulomatous inflammation on rat ear and in this regard, bark and thorn extracts were quite comparable to the standard drug. It is interesting to note that thorns of *B. ceiba* are now an important ingredient of Himalaya's acne-n-pimple cream²⁷.

Hepatic disorders

Various liver complaints have been treated with root², stem-bark²⁸ and seeds²⁹. This has been confirmed by many animal studies suggesting its hepato-protective effect.

In 1992, Chiu *et al.* have shown that aqueous extract of bark (1 gm/kg of body weight i.p.) significantly (p<0.0001) reduced AST and ALT levels in CCL₄ induced hepato-toxicity in rats and also demonstrated a significant hepato-protective effect on liver fatty degeneration, diffused sinusoid enlargement and cell necrosis. Lin *et al.* (1992) have shown that bark and root of the plant has the best protective capacity against CCL₄ induced hepatotoxicity. Aqueous extract of stem bark and roots significantly decreased CCL₄ induced AST and ALT enzyme levels in wistar rats. Mangiferin; isolated from leaves also significantly decreased CCL₄ raised serum AST and ALT levels in dose dependent manner in Wistar rats³.

Although the flowers are not recommended ethnomedicinally for treatment of hepatic disorders, yet, various scientific investigations have revealed their hepato-protective potential. Methanolic extract of flowers in a dose of 150, 300 and 450 mg/kg i.p. has significantly decreased AST, ALT, ALP and total bilirubin levels in rats induced by isoniazid and rifampicin. It also significantly decreased the level of TBARS and elevated GSH and total protein levels³. Said and associates (2011) have shown that oral administration of 70% methanolic extract of flowers (250 and 500 mg/kg body weight) significantly reduced paracetamol induced elevated hepatic enzymes (AST and ALT) levels in rats³. These all scientific studies confirm the hepato-protective nature of the plant and its implications in liver ailments.

Validation of therapeutic claims - Indirect evidences

Anti-inflammatory activity

The plant is used for the treatment of rheumatism (root, stem, leaf, heartwood,), swellings (leaf, stem-bark), bone fracture (stem bark, root), osteomyelitis (heartwood), asthma (gum, thorns), snake bite (root, stem, leaf, flower, fruit, heartwood), oedema (stem), hotness and inflammation of legs (stem bark), mouth ulcers (flower) in various ethnic groups of Pakistan, Bangladesh and Maharashtra, Madhya Pradesh, Gujarat, Rajasthan, Orissa, Kerala, Himachal Pradesh, Uttaranchal, Uttar Pradesh,

Arunachal Pradesh, Assam, Nagaland states in India^{2-5,11,13,30-41}. Anti-inflammatory action of the plant is possibly the mechanism responsible for its beneficial effects in all these conditions.

Aqueous extract (10 mg/kg body weight) of root, stem xylem and stem bark of the plant has shown significant ($p < 0.01$) anti-inflammatory action by reducing carrageenan-induced paw edema by 79%, 74% and 46% respectively as compared to standard indomethacin in wistar rats³. Ethyl acetate soluble fraction of alcoholic extract (200-500 mg/kg i.p.) isolated from its flowers markedly inhibited hind paw edema induced by injection of fresh egg white or carrageenan in rats³.

Significant anti-inflammatory action of 70% methanolic extract (25 and 50 mg/100 gm body weight) of its flowers has also been demonstrated which has reduced carrageenan induced rat hind paw edema by 22.9 and 37%, respectively. Aqueous extract of gum (270 mg/kg) has significantly reduced the ulcer score and myeloperoxidase activity in indomethacin and iodoacetamide induce colitis in Sprague-Dawley rats. In a dose of 500 mg/kg, it also significantly reduced the ulcer score and myeloperoxidase activity in acetic acid induced colitis in Swiss albino mice besides reducing edema of the intestinal tissue in a dose dependent manner³. These scientific studies strongly support that the anti-inflammatory effect of various parts of the plant is able to benefit in many of the above-mentioned diseases.

Analgesic effect

Root is used for treatment of abdominal pain^{13,42} and waist pain⁴³, stem-bark for colic pain²⁸, headache², toothache⁴⁴ and sprains⁴⁵, leaf for body pain⁴⁶, flower for stomach pain³ and headache⁴⁷, fruits as pain killer¹³ and thorns for headache^{34,48}. In these folk claims of pain relieving property of the plant, analgesic effect of its gum, leaves and flowers have been established in animal studies while no scientific study has done so far to evaluate analgesic effect of its root, stem bark, fruits and thorns.

In a preliminary study, gum has shown analgesic activity as tested by rat tail hot wire technique². Dar *et al.* have demonstrated significant and dose-dependent analgesic effect of methanolic extract of leaves, its fractions and isolated compound mangiferin in acetic acid writhing and hot plate test in mice. Mechanism behind the analgesic effect has shown that

the analgesic effect of methanolic extract of leaves was independent of opioid receptors. Recently, 70% methanolic extract (25 and 50 mg/100 gm body weight) of flowers have also shown to possess significant analgesic effect in the hot plate test and also reduced the acetic acid induced writhing score by 27.3 and 47.6% respectively in mice indicating the peripheral analgesic effect³.

Restorative and tonic properties

Stem bark of *B. ceiba* is employed as a heart tonic in Chattisgarh, India²⁸. Roots are used as general tonic¹⁶⁻¹⁷ as well as brain tonic³. Flowers are also employed as tonic⁴⁹ and for treatment of colitis⁵⁰. It is difficult to propose the mechanism behind all these restorative and revitalizing effects of *B. ceiba* on body, mind and heart. However, its strong antioxidant property might be the basis for all these healthful benefits. Various *in-vitro* and *in-vivo* scientific studies done world over have shown a very good antioxidant potential of almost all parts of *B. ceiba* as compared to standard antioxidants.

Methanolic extract of whole plant material of *B. ceiba* has shown significant DPPH radical scavenging activity along with effective prevention of hydroxyl radical induced DNA damage. Mangiferin; isolated from methanolic extract of leaves has also shown good DPPH scavenging activity with an IC₅₀ value of 5.8±0.96 µg/ml. Eighty percent methanolic extract of its gum has also demonstrated very good antioxidant activity in three *in vitro* assays i.e. ABTS, DPPH and FRAP with a very good total phenolic content³.

Vieira *et al.* have reported strong antioxidant potential of defatted methanolic extract of its flowers in DPPH radical scavenging assay and lipid peroxidation of rat liver microsomes and soy bean phosphatidylcholine liposomes induced by ascorbyl and peroxy nitrite radicals and it also inhibited myeloperoxidase activity. Antioxidant activities of water, 50% ethanol and 80% acetone extracts of flowers has also been assessed by Yu *et al.* which has shown very good DPPH radical scavenging, ORAC, reducing power ability and inhibition on phosphatidylcholine liposome peroxidation as compared with ascorbic/gallic acid³.

Roots of the plant have also been evaluated for antioxidant activity by Jain and associates who have shown that root possess high amounts of phenolics and tannins as well as dose dependent *in-vitro* DPPH radical scavenging and reducing power capacity. They have also shown for the first time that root

powder of *B. ceiba* has significantly increased serum total antioxidant status in healthy human volunteers and patients with ischemic heart disease^{3,51}. The strong antioxidant potential of the plant as evident from many scientific studies may contribute to its restorative and tonic properties.

Anti-microbial activity

Various parts of *B. ceiba* have been used to treat infective conditions of human body. Almost all parts of the plant (root, stem bark, gum, petiole, leaf, flower, heart wood, fruit and seed) are recommended in diarrhea, dysentery and stomach troubles in folk medicine^{2-4,13,42,52-56}. Besides these, it is also employed for treatment of urinary troubles, leucorrhoea, gonorrhoea, boils, body wash, herpes, chicken pox, dental caries, conjunctivitis, guinea worm, cough, leprosy, wound and injury in various ethnic groups^{2-3,13, 24,35,46,57-63}. These infective conditions are cured due to antimicrobial action of the plant.

Mangiferin (100 µg) isolated from ethanolic extract of its leaves have shown antibacterial potential against *Listeria monocytogenes*, *Bacillus subtilis*, *Streptococcus pyogenes*, *Shigella sonnei*, *Shigella flexneri*, *Salmonella typhi*, *Enterobacter cloacae* and *Pseudomonas aeruginosa*. It also inhibited growth of *Candida albicans* in *in-vitro* antifungal assay³. Methanolic extract of leaves have shown antibacterial activity against *Klebsiella pneumoniae*⁶⁴. Mishra & colleagues⁵ have reported the antifungal effect of water extract of its leaves against *Epidermophyton floccosum*, *Tricophyton mentagrophytes* and *Microsporum gypsum*.

Methanolic and aqueous extract of stem-bark has shown strong antibacterial activity against multidrug resistant *Salmonella typhi* strains MTCC 531 and B330 with a minimum inhibitory concentration of 256 µg/ml for methanolic extract. On the other hand, methanolic extract of leaves have shown the antibacterial potential only against strain MTCC 530³.

Ethanolic extract (95%) of root has shown anti *Helicobacter pylori* activity against all the ten strains used with MIC values ranging from 1.28 to 5.12 mg/ml. Islam *et al.* have reported significant antibacterial activity of different extracts of root against *Bacillus cereus*, *B. megaterium*, *Sarcina lutea*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *S. paratyphi*, *Vibrio mimicus* and *V. parahemolyticus* and antifungal

activity against *Aspergillus niger* and *Candida albicans*. Recently, methanolic extract of root in five concentrations (50, 25, 12.5, 6.25, 3.12 mg/ml) has shown a significant dose dependent antibacterial potential against *Staphylococcus aureus*, *Bacillus subtilis*, *E. coli* and *Klebsiella pneumoniae*³. Eighty percent methanolic extract of gum has shown *in vitro* anti-bacterial potential against *E. coli* and *Shigella dysenteriae*⁶⁵.

In a nutshell, it has wide range of antimicrobial activity from Gram + to Gram – bacteria to multidrug resistant *Salmonella* and fungi to *Helicobacter pylori*. These studies provide indirect scientific evidences for employing various parts of *B. ceiba* for gastrointestinal, urinogenital, respiratory and dermatological affections in folk medicine.

Oxytocic activity

Stem bark of the plant is used to facilitate delivery in cattle^{5,66} while seeds are used as an abortifacient³. Misra *et al.*² has reported that hot aqueous extract of seeds have moderate oxytocic activity on gravid and non-gravid isolated rat uteri, guinea pig, rabbit's uterine strips and on pregnant human uterine strips. However, folk claim on the stem-bark needs to be validated.

Besides these properties, the plant has also shown to possess hypotensive, anti-hyperlipidemic, ACE inhibitory, anti-angiogenic, cytotoxic, antipyretic, anthelmintic, larvicidal and fibrinolysis enhancing activities in various animal models and human studies^{3,51}.

Scientific validation of efficacy and safety of folk medicinal knowledge is needed to establish and support the use of traditional medicine. On the basis of modern scientific evidences obtained for many traditional therapies; it has been proved that folk knowledge have resulted from some keen observations, intuitional science and age old experience. However, it is always important that disease identity should be correctly interpreted in terms of its traditional therapeutic use and also in light of modern medicine before scientific validation of any folk medicinal claim.

The present paper will pave the way for researchers to further validate many of other traditional medicinal knowledge associated with *B. ceiba* which has not yet scientifically evaluated; for example, role of its various parts in sterility, fertility and menstrual disorders, use of gum for management

of asthma, tuberculosis & scabies, leaf for curing debility & anemia, flower for treatment of paralysis & cancer, root as brain tonic, stem bark as heart tonic, seeds as anti-diabetic³ etc. Based on the research results, novel therapeutic drugs could be developed and farmers can be benefited economically by growing and selling the plant at large scale. However, the benefit should also reach to the actual knowledge providers.

Conclusion

Scientific validation of folk claims in animal and human studies further authenticate age old wisdom of indigenous communities who not only utilize various plants for their food and fuel requirements but also use them for their own and livestock diseases. Many of the commercially available plant based drugs are result of systematic scientific researches done on the keen observations of native people. *B. ceiba* is one such plant; considered sacred as well as a store house of immense medicinal potential. Various scientific studies world over have confirmed the scientific basis of using various parts of *B. ceiba* for different diseases in man and animal as suggested in folk medicine. Compilation of these scientific studies in the present paper provides direct and indirect evidences which authenticate the credibility of age old folk medicinal claims on *B. ceiba*.

Besides the medicinal potential, it is an important timber and fibre yielding plant. However, there is still need for further research to scientifically unveil its medicinal potential. It is hoped that future scientific work may bring important plant based active ingredients from this tree for the treatment of many diseases of modern era safely and successfully. Unfortunately, over-exploitation of this species in some parts of the world has raised questions on its conservation and needs urgent attention³.

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