TANG [HUMANITAS MEDICINE]

Review

Ethnomedicinal and pharmacological activities of *Mochrus (Bombax ceiba* Linn.): An overview

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ABSTRACT

Traditional system of medicine mentioned the use of plants in treatment of various human ailments. *Mochrus* (*Bombax ceiba* Linn.) is one of the medicinal plants used in Unani medicine since time immemorial. It is a very tall tree with approximately 150 feet height. It is widely found in temperate Asia, tropical Asia, Africa and Australia. In India, it can be found at altitudes up to 1500 m. In peninsular India, the tree is very common in the dry as well as moist deciduous forests and near rivers. It is reported to possess *qabiz* (constipative); *mujaffif* (siccative); *muqawwi rehm* (uterine tonic); *nafi sailan rehm* (beneficial in leucorrhea); *mumsik wa mughalliz mani* (increase consistency of semen); *muallide mani* (production of semen); *habise tams* (amenorrhoic); *dafi fasaad khoon wa safra* (purifies blood and bile); *taskeen hiddat aza* (hotness of organs); *muqawi asnan wa lissa* (tonic to teeth and gums) etc. Ethnobotanical studies prove that it is used in diarrhoea, asthma, impotency, boils, wounds, leprosy, pimples and many other skin diseases. It is an anthelmintic remedy since ancient time. Pharmacological studies like hypotensive, antioxidant, analgesic, anti-inflammatory, antipyretic, antiangiogenic, anti-bacterial, cytotoxic, hepatoprotective, diuretic, anthelmintic, anticancer, spermatogenic and anti-helicobacter pylori activities have been evaluated for various parts of this plant that confirms to its use in classical medicine.

Keywords ethnomedicinal, *Mochrus*, traditional, pharmacological

INTRODUCTION

Bombax ceiba (Bombacaceae) is an important medicinal plant of tropical and subtropical India. "*Bombax*" is a Latin word means splendid or marvellous may be named after its very tall height whereas species name "*ceiba*" is a Latinized form of the South American name for Silk Cotton. It belongs to the family Bombacaceae which includes around 30 genera (25 genera after Heywood et al.) with about 250 species of tropical trees. It is commonly known as Simbal, Simul, Indian bombax or Red Silk cotton and found widely in temperate Asia, tropical Asia, Africa and Australia. In India, it can be found at altitudes of sea level to 1500 m elevation. The tree is a strong light-demander, fast growing and grows best on deep sandy loams or other well-drained soils throughout the year (Rajendra, 2010).

Medicinal usage of *Bombax ceiba* has been reported in many traditional systems of medicine such as Ayurveda, Siddha and Unani medicine since ancient times (Chakraborty et al., 2010). This plant has been extensively evaluated for various pharmacological activities to treat diseases condition such as anti-inflammatory, anti-HIV, hepato-protective, hypotensive, antiangiogenic, antioxidant activities etc (Chaudhary and Khadabadi, 2012).

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Taxonomy:

Kingdom:	Plantae
Subkingdom:	Viridiplantae
Infrakingdom:	Streptophyta
Superdivision:	Embryophyta
Division:	Tracheophyta
Subdivision:	Spermatophytina
Class:	Magnoliopsida
Superorder:	Rosanae
Order:	Malvales
Family:	Malvaceae (Bombacaceae)
Genus:	*Bombax*
Species:	*ceiba* (ITIS Report, 2015)

Binomial name:
Bombax ceiba Linn (ITIS Report, 2015).

Synonym:
Bombax ceiba Linn, *Bombax malabaricum* Dc, *Salmalia malabarica* (DC.) (Schott & Endl.), *Gossampinus malabarica* (DC.) Merr (Ghani, 1971).

Vernacular names:
Assam: *Semul*; Ayurvedic: *Shaalmali*, *Mochaa*, *Mochaahva*, *Pichhila*, *Raktapushpa*, *Sthiraayu*, *Kankataadhya*, *Tuulini*, *Shaalmali-veshtaka* (gum); Bengali: Shimul, Simul; Cambodia: Roca; Chinese: *Mu Mien*; English: Cotton Tree, Red Silk, Cotton tree; French: *Bombax de Malabar*, *Cottonier Mapou*, *Kapoiker du*; Gujrati: *Shemalo*; Hindi: *Semal*, *Semar*; Kannada: *Kempuburunga*; Malyalam: *Mullilavu*; Sanskrit: *Moca*, *Picchila*, *Raktapu apa*; Marvadi: *Samvar*, *Katesavar*; Punjabi:

Simble; Siddha: *Mul Ilavam, Ielavampisin* (gum); Tamil: *Elavam*; Telugu: *Buruga*; Trade Name: *Semal*; Urdu: *Semblal, Mocharu* (gum); Unani: *Semal, Mochras* (gum) (Ghani, 1971).

Plant description in classical literature (*Mahiyat*):
Mochras is a plant exudates obtained from *Semblal* tree. *Semblal* is a very tall tree with approximately 150 feet height. Bark is whitish; leaves are like a *jamun* leaf, flowers are red in color and patels are very thick. Dry fruits are filled with very soft silky cotton like material (Hakeem, 2002).

Semblal tree exudate (*mochras*) is a gummy material obtained from stem barks eaten by insects (Hakeem, 2002). Exudate is thick, white while depositing on the bark and becomes blackish red after drying. It is mostly tasteless but some time slightly bitter. It is available in easily breakable tear shaped dry particles.

Botanical description:
Bombax ceiba is a deciduous tree of up-to 45 m high, bole straight, buttress 1 – 2 m high, bark 20 – 30 mm thick, grey mottled with white color; branches horizontal and more or less whorled. Leaves are digitately-compound, alternate, stipulate; stipules small, lateral; rachis 12 – 25 cm, glabrous; leaflets 5 – 7, whorled; lamina 10 – 20 x 2 – 6 cm, elliptic, elliptic-obovate; margin entire, glabrou. Flowers are bisexual, dark crimson, 6 – 7 cm across, solitary or 2 – 5 together; calyx campanulate, lobes 3 – 4 x 3 cm, glabrous outside, silky inside; petals 5, 8.5 – 18 x 3.5 – 5 cm, elliptic-obovate, fleshy; stamens 65 – 80, 3 – 7.5 cm long; ovary conical, tomentose, 5-celled; ovules many; style exceeding the stamens; fruit a capsule, 8 – 10 x 3 cm, downy tomentose, cylindrical, blackish and glabrous at maturity; seeds numerous, pyriform, smooth, dark brown, embedded in white cotton (ITIS Report, 2015).

Habitat:
It is widely found in temperate Asia, tropical Asia, Africa and Australia. In India, it is found at altitudes up to 1500 m. In peninsular India, the tree is very common in the dry as well as moist deciduous forests and near rivers. The tree is a strong light-demander, fast growing, grows best on deep sandy loams or well-drained soils, particularly in valleys and regions receiving 50 to 460 cm annual rainfall well distributed throughout the year.

Part used:
Fruits, heart wood, stem bark, gum, and root (Hakeem, 2002).

***Mizaj* (Temperament):**
Cold 2°C Dry 3°C (Ghani, 1971) (Hakeem, 2002), Cold and Dry, Cold and Dry in 3°C, (Nabi, 2007) (Hakeem, 2009).

***Afaal* (Functions):**
Qabiz (constipative) (Ghani, 1971; Hakeem, 2002; Nabi, 2007); *mujaffif* (siccative), *muqawwi rehm* (uterine tonic) (Ghani, 1971); *nafi sailan rehm* (beneficial in leucorrhea) (Ghani, 1971) , *mumsik mani* (avaricious) (Ghani, 1971; Nabi, 2007); *mughalliz mani* (increase consistency of semen) (Ghani, 1971; Hakeem, 2002); *muallide mani* (semen procreator); *habise tams* (amenorrhoeic) (Nabi, 2007); *dafi fasaad khoon wa safra* (purifies blood and bile); *muqawi asnan wa lissa* (tonic to teeth and gums) (Nabi, 2007).

Medicinal use in ethno-medicine

Fruits: Fruit is cooling, digestible, stimulant, diuretic, tonic, aphrodisiac, expectorant, blood purifier and good for leprosy. It has great beneficial effect over the membranes of the genitor-urinary organs, It is used for chronic inflammation of bladder, kidney and for calculus affections.

Flowers:
The flowers are bitter, acrid cooling, dry, astringent to the bowels, removes bile and phlegm, purify the blood, benefit the spleen and good for leucorrhoea. It is topically applied to skin affections as cooling and astringent.

Leaves:
It is applied topically as a paste to relive inflammation as well as given in the form of decoction.

Bark:
Stem bark is sprinkled topically in bleeding wound and applied as a paste in water to skin eruptions, boils, acne, pimples etc. Decoction of bark is used as demulcent, styptic and used to removes *phlegmatic*. Aqueous extract with curd is given for dysentery with blood.

Seeds:
Seeds are used for chickenpox, smallpox, catarrhal affections, chronic cystitis and genitourinary diseases.

Gum:
The gum is acrid, astringent, demulcent, tonic, aphrodisiac and removes black bile. In powder form alone or with other herbs it is used internally to treat haemoptysis, diarrhoea, dysentery, bleeding piles, menorrhagia, leucorrhoea, spermatorrhoea and blood disorders. Topically it is applied as styptic, astringent, demulcent in stomatitis, dermatological ailment and burn wound.

Root:
The root is sweet and cooling, demulcent tonic, slightly diuretic and astringent to the bowels. It is useful in biliousness, inflammations and excessive heat of the body. It is also employed in low vitality and debility (Jain and Verma, 2014).

Therapeutic uses in Unani medicine:
In Unani system of medicine more emphasise is given to the use of gummy exudates known as *mochras* obtained from its branches and stem. Due to its hot and dry temperament it is employed in disorders occurring due to cold and moist temperament. It is used in phlegmatic cough due in respiratory disorders. Tooth powder containing *mochrus* is beneficial for loosen teeth and bleeding gums (Ghani, 1971). *Mochras* powder 1.25 – 2 gm along with sugar is given to cure diarrhoea in children. It also cures dysentery and other gastro intestinal track disorders with loose motion. It has astringent action on uterus if kept in vagina as a pessary, thus used in leucorrhoea. To reduce or stop puerperal discharge and menorrhagea *mochras* is used with *rasot* orally. Nocturnal enuresis of children can be treated by this drug (Ghani, 1971). *Mochras* alone or mixed with other drugs is used to treat *jiryan* (spermatorrhoea) and *sulsul bol* (urinary incontinence). It cures the stomatitis if applied locally (Ghani, 1971). It improves the skin complexion when used as face wash (Ghani, 1971). Bark purifies the blood and diminishes the burning sensation owing to *hiddat dam wa safra*. For this purpose its decoction is taken internally and paste is applied as plaster (Ghani, 1971).

***Muzarrat* (advers effect):**
Mujaffif (desiccant) (Nabi, 2007; Hakeem, 2009; Hakeem, 2002).

***Musleh* (corrective):**
Roghan gul (*Rosa damascene oil*) (Hakeem, 2002), *darchini* (*Cinnamomum zeylanicum*), *shaker* (sugar), *roghan badam* (*Prunus dulcis oil*) (Hakeem, 2002; Nabi, 2007).

***Badal* (substitute):**
Samaag dhaak (*Butea monosperma*) (Hakeem, 2002; Nabi, 2007) and *mastagi* (*Pistacia lentiscus*) (Hakeem, 2009).

***Miqdare khuraq* (dose):**
4 – 6 gm (Hakeem, 2002), 2 – 3 gm.

***Mashoor murakkabaat* (formulations):**
Majoone mochras, sufoofe sailan (National Formulary of Unani Medicine, 2006).

PHYTOCHEMICAL STUDIES

All parts of the plant gave betasitosterol and its glucosides; seeds, bark and root bark-lupeol; flowers-hentriacontane, hentriacontanol; root bark-hydroxycadalene. The seed oil yields arachidic, linoleic, myristic, oleic and palmitic acids; Seeds contain carotenes, *n*-hexacosanol, ethylgallate and tocopherols; the gum contains gallic and tannic acids, yields L-arbinose, D-galactose, D-galacturonic acid, and D-galactopyranose. Younger roots contain more sugars (arabinose and galactose) and peptic substances than the older ones. They contain mucilage, starch, mineral matter, tannins and non-tannins, along with other constituents (Khare, 2007). The alcoholic and water extracts of flowers of *Bombax ceiba* Linn, indicate the presence of alkaloids, flavonoids, glycosides, proteins and amino acids and coumarins (Antil et al., 2013).

Gums:
Hydrolysis of gum yields arabinose, galactose, galacturonic acid, rhamnose, and partial hydrolysis yields 6-o-(β-D-galactopyranosyl-uronic acid)-D-galacto pyranose; 2,3,4,6-tetra-, 2,6-di, and 2,4-di-o-methyl-o-D-galactose and 2,3,5-tri and 2,5-di-o-methyl-L-arabinose. Methylated gum on hydrolysis has been found to yield 2,3,4,6-tetra-, 2,6-di-, and 2,4-di-o-methyl-D-galactose and 2,3,5-tri- and 2,5-di-o-methyl-L-arabinose (Faizi et al., 2006).

Khan et al. (2011) isolated and characterise a new flavone from the flower extract of *Bombax ceiba* using mass, NMR, IR and UV. They also screened isolated compound for its antibacterial and anti fungal activity (Khan et al., 2011).

Fig. 1. Flower of Mochrus (*Bombax ceiba* Linn).

Root:
The phytochemical studies on the root of *Bombax ceiba* showed presence of n-triacontanol, β-sitosterol. New glycosides identified as 5,7,3,4 tetrahydroxy-6-methoxy flavon-3-O-β-D glucopyranosyl-D-xylotyranoside sesquiterpenoids, isohemigosspol-1-2-dimethyl ether, 8-formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1, 4-naptha quinine, 7-hydroxy cadaleve, and new sesquiterpene lactone, 6-dihydroxy-3-methyl 5-{1-methyl ethyl 1-7-methoxy naphthalene-8-carboxylic acid (8→1)} lactone were also isolated. Root bark was reported to yield lupeol, β-sitosterol and a napthoquinone.

A sesquiterpene lactone isolated from roots was previously identified as hemigossylic acid lactone-7-methyl ether. 2D NMR experiments have shown this was a new compound, isohemigossylic acid lactone-2-methyl ether. Phytochemical investigation of the chemical constituents of the roots of this plan afforded nine cadinane sesquiterpenoids, including five new compounds (bombamalones A-D, 1-4; bombamaloside, 5), and four known compounds (isohemigossypol-1-methyl ester, 6; 2-O-methylisohemigossylic acid lactone, 7; bombaxquinone B, 8; and lacinilene C, 9).

Stem bark:
Bark was reported to contain lupeol and β-sitosterol. In another studies, the presence of flavonoides, glycoside, sterol and terpenoids and absence of alkaloids and saponins was reported in the stem bark. Shamimicin, 1‴, 1⁗⁗⁗-bis-2-(3, 4-dihydroxyphenyl)-3, 4-dihydro-3, 7-dihydroxy-5-O-xylopyranosyloxy-2H-1-benzopyran along with lupeol were also isolated from its stem bark.

The flower:
Chemical constituents in the n-hexane fraction from the flowers of this plant were investigated using gas-liquid chromatography analysis. Analysis of the fatty acid esters established the majority abundance of the saturated fatty acid over their unsaturated form. The polar methanol fraction showed presence of seven flavones i.e. vicenin 2, linarin, saponarin, cosmetin, isovitexin, xanthomicrol and apigenin. Structures of all these molecules were also established by intensive studies of various spectral data (H-NMR, mass spectroscopy and UV) and compared with authentic samples. These compounds were described for the first time from this plant.

Extracts of n-hexane and methanol exhibited presence of β-D-glucoside of β-setosterol, free β-setosterol, hentriacontane, hentriacontanol, kaempferol, quercetin and trace of an essential oil. A polysaccharides consisting of D-glactose, L-arabinose and L-rhamnose in the molecular ratio of 5:4:3 was isolated of the dried stamens of the flower. The fresh petals of flower were reported to yielded two anthocyanidine glycoside named A and B which characterized as pelargonidin-5β-D-glucopyranoside and cyaniding-7 methyl-ether-3β-glucopyranoside respectively.

The seed:
Seed contain *n*-hexacosanol, palmitic acid, octadecyl palmitate, gallic acid, tannic acid, 1-gallayl-β-glucose, ethyl gallate and a mixture of α, β-and γ-tocopherol. The oil from the seed was found to contain 94.5% mixed fatty acid composed of oleic acid as a major constituent, along with myristic, palmitic, arachidic and linoleic acid.

The leaves:
Shamimin a flavonol C-glycoside has been isolated from the

ethanolic extract of fresh, undried leaves of *Bombax ceiba* and elucidated as 2-(2, 4, 5-trihydroxyphenyl)-3, 5, 7-trihydroxy-6-C-glucopyranosyloxy-4H-1-benzopyran-4- one through extensive spectroscopic and 2D-NMR methods. Mangiferin, a xanthone was isolated from 70% ethanol of the dried leaves of this plant by repeated column chromatography of the n-BuOH fraction. Further accurate NMR spectral assignments have been made of the acyl and methyl derivatives of mangiferin (Faizi and Shamimin, 1999).

ETHNO BOTANICAL STUDIES

Abortion:
Oraon tribe in West Bengal use preparation of 30 g of seed powder of *Bombax ceiba* and about 10 g Hing (*Ferula foeitida*) as an abortifacient (Mitra and Mukharjee, 2009).

Sexual debility and rejuvenator:
Ethanolic extract of *Bombax ceiba* bark and flower was given for 3 days in various sexual diseases like gonorrhea leucorrhea, and menstrual disorders in women and to increase sperm count, treat impotency and hydrocele in man. Another study carried out in Chittorgarh and Udaipur district located in Rajasthan (India) showed that bark, flower and root barks powder of this plant are used in these disorders. Apart from sexual diseases these plant material are also used to regularize menstruation and urinary problems (Jain et al., 2004). Kandha tribe of Orissa use juice of fresh stem bark of *Bombax ceiba* , juice of fresh root of *Asparagus racemosus*, powder of seven black peppers and one teaspoon of sugar or gum taken orally before meals twice a day for 21 days to cure impotency, spermatorrhea, reduced sperm count, sterility, nocturnal emission, gonorrhoea and leucorrhoea (Behera and Misra, 2005). Another ethno-botanical study showed an infusion of the bark of *Bombax ceiba* is used as a tonic (Sebastian and Bhandari, 1984).

Anti-inflammatory activity:
A study carried out by Namsa et al. (2009) found that Lohit community of Arunachal Pradesh use fresh paste prepared from the bark of *Bombax ceiba* mixed with cow dung applied over back muscle of leg at night to treat hotness and inflammation (Namsa et al., 2009).

Impotency, asthma and small-pox boils:
Tribes of the Sonbhadra district in Uttar Pradesh used 10 g of root powder of *Bombax ceiba* with a glass of milk as a tonic to treat impotency. One spoonful powder of stem with a glass of cow's milk or fresh water, daily morning for 3 – 4 months was used to treat asthma. Boils due to small-pox was treated with local application of seed paste prepared in water (Singh et al., 2002).

Wounds healing:
Classical literature from Mysore and Coorg districts, Karnataka, India mentioned the use of paste of its bark for cattle wounds topically (Kshirsagar and Singh NP, 2001). Field observations in three villages in Nawalparasi district of central Nepal showed that Tharu, an ethnic group indigenous to the Terai, the southern foothills region of The Himalayas in Nepal uses the local application of bark juice of *Bombax ceiba* for the treatment of wounds (Ghimire and Bastakoti, 2009).

Diarrhoea:
Tharu people also drink the bark juice of *Bombax ceiba, Mangifera indica* and *Psidium guajava* mixed together to cure dysentery and intestinal spasm. *Bombax ceiba* bark exudates are also taken orally to treat worms and diarrhoea (Ghimire and Bastakoti, 2009). The native people of Mizoram state of India use decoction of the leaves of *Bombax ceiba* and the bark of *Mangifera indica* was taken 2 – 3 times daily orally to treat diarrhoea (Sharma et al., 2001). People of Parinche valley, Pune district, Maharashtra use paste made-up of inner part of root of this plant administered in the morning, preferably before meals for 2 days to treat diarrhoea (Tetali et al., 2009).

Leprosy:
Seeds and roots of *Bombax ceiba* were used by traditional practitioners and religious healers of Bangladesh in the treatment of leprosy (Mollik et al., 2009).

Dermatological disorders:
The tribal communities of North-West Frontier Province of Pakistan employ *Bombax ceiba* in the treatment of skin diseases and in folk cosmetics. For this purpose crushed fresh bark of *Bombax ceiba* was applied locally on pimples, carbuncles and boils (Abbasi et al., 2010). Pawara tribal people in the Satpuda hills of Maharashtra apply concentrated bark decoction of *Bombax ceiba* in the treatment of dermatological disorders. They also use decoction of bark of *Bombax ceiba* orally twice a day for 7 days to treat leucorrhoea (Kosalge and Fursule, 2009).

Helminthiasis:
Flowers of *Bombax ceiba*, 25 – 50 g as feedstuff were fed to the animal as anthelmintics in southern Punjab, Pakistan, to by the herdsmen (Jabbar et al., 2006).

Miscellaneous Uses:
In Eastern Rajasthan tender twig is used as a toothbrush to cure mumps and powdered flowers mixed with honey was given to treat menorrhagia. The thorn was rubbed on stone with unboiled milk, made into paste and applied for 5 – 6 days on the face to treat acne. The thorn was chewed to cure mouth sores. The roots powdered with those of *Chlorophytum, Capparis sepiaria* and fruits of *Pedalium murex* were taken with water as a tonic for 7 – 8 days to calm body heat. Root bark extract was given as a tonic in case of sexual debility and also as nervine tonic. Root powder mixed with sugar candy and milk was taken to avoid impotency (Upadhyay et al., 2010).

PHARMACOLOGICAL STUDIES

Hypotensive and hypoglycemic activity:
A novel constituent, Shamimicin, a C-flavonol glucoside from *Bombax ceiba* leaves showed significant hypotensive potency at the doses of 15 mg/kg, 3 mg/kg, 1 mg/kg and significant hypoglycaemic activity at 500 mg/kg in Sprague-Dawley rats, however toxicological studies revealed that 500 mg/kg is a lethal dose but it did not cause any mortality in mice at the dose of 1 g/kg (Saleem et al., 1999). In further study Saleem et al. (2003) isolated and studied the hypotensive and toxicological activities of shamimicin, 1‴, 1⁗⁗⁗-bis-2-(3,4-dihydroxyphenyl)-3,4-dihydro-3,7-dihydroxy-5-O-xylopyranosyloxy-2H-1-benzopyran and lupeol constituents from *Bombax ceiba* stem bark. Fraction BCBMM have emerged as potent hypotensive constituents of *Bombax ceiba* stem bark while shamimicin found devoid of any activity at the dose of 15 mg/kg this time. Intravenous administration of 15 mg/kg of BCBMM caused 65% fall in blood pressure of rats for 4 min, while oral administration of 200 mg/kg/d for five

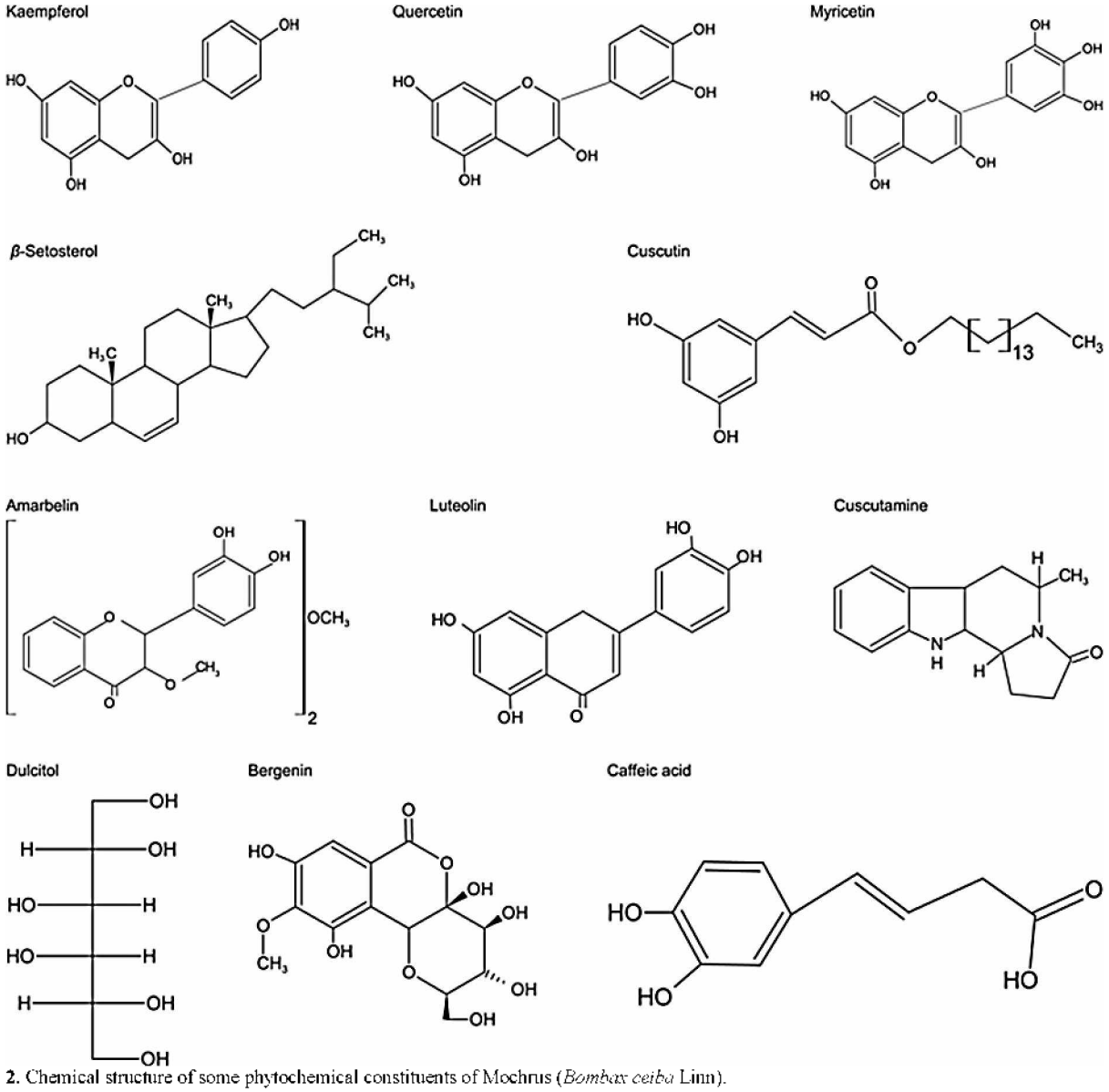

Fig. 2. Chemical structure of some phytochemical constituents of Mochrus (*Bombax ceiba* Linn).

days showed significant hypotension of 13.18%. Toxicology of BCBMM determined 1000 mg/kg/d as lethal dose (LD100) killing all mice by affecting their vital organs including heart, kidneys and liver. Dose at 100 mg/kg/d is also not safe in mice as it caused expiry of three animals. Researchers conclude that low doses of BCBMM (smaller than 100 mg/kg) can be useful in reducing blood pressure safely (Saleem et al., 2003).

Antiangiogenic activity:

You et al. (2003) has evaluated the angiogenic activuity of methanol extract of the stem barks of *Bombax ceiba* and found that extract exhibits significant antiangiogenic activity on *in vitro* tube formation of human umbilical venous endothelial cells (HUVEC). In further study it was found that lupeol fractionated product of the extract has a marked inhibitory activity at 50 and 30 μg/mL on HUVEC tube formation while it does not affects the growth of tumor cell lines like SK-MEL-2, A549, and B16-F10 melanoma (You et al., 2003; Nam et al., 2003).

Antioxidants activity:

Mangiferin a molecule obtained from methanolic extracts of *Bombax ceiba* leaves demonstrated strong antioxidant activity using DPPH assay which was comparable to rutin. Moreover, mangiferin showed hepatoprotective activity against carbon tetrachloride induced liver injury further supporting the free radical scavenging property in the *in vivo* system. Another molecules acetyl and cinnamoyl derivatives were found to be less active than mangiferin whereas, methyl and 3,6,7-trimethylether tetraacetate derivatives were inactive (Dar et al., 2005). Vieira et al. (2009) also evaluated the antioxidant activity of methanolic extract of *Bombax ceiba* using (i) ability to scavenge DPPH and hydroxyl free radicals; (ii) action against lipid peroxidation and (iii) effect on myeloperoxidase activity. The extract showed significant antioxidant activity in all assays. The extract showed very low toxicity toward Vero cells (Vieira et al., 2009). Methanolic extract of roots of *Bombax ceiba* was evaluated using DPPH radical scavenging assay and reducing power assay. Extract of the roots showed a very good DPPH radical scavenging activity and reduction ability in dose dependent manner. Research concludes that antioxidant activity was due the higher percentage of phenolic compounds and tannins. Further in healthy human volunteers significantly increased in total antioxidant level was noted at the end of 4 hours after taking 3 gm of root powder (Jain et al., 2011)

Antioxidant and antihemolytic activities:
Divya et al. (2012) investigated antioxidant and antihemolytic activities of aqueous, methanol, chloroform and ethyl acetate extracts of spike and young fruit of *Bombax ceiba*. DPPH and TBARS methods were used to assess the antioxidant competence of extracts. Antihemolytic assay was determined using erythrocytes model and the extent of membrane damage was determined by quantifying malondialdehyde. Among all the four extracts studied, methanolic extract exhibited significant antioxidant and antihemolytic activities (Divya et al., 2012).

Analgesic activity:
Crude plant extract displayed significant analgesic effect in acetic acid induced writhing and hot plate test in mice. This analgesic effect was independent to opioid receptor but Mangiferin demonstrated significant interaction with the receptor at a peripheral site, with a slight contribution at the neuronal level (You et al., 2003).

Anti-inflammatory activity:
Kumar evaluate the membrane stabilizing property and the antioxidizing property of ethyl acetate soluble fraction of the gynaceum part of *Bombax ceiba* on human red blood cells and sheep red blood cells and correlate it as a probable mode by which *Bombax ceiba* arbitrate its effects on inflammatory conditions. The results of the study revealed that though the fraction of *Bombax ceiba* possesses significant anti-inflammatory property however, the extract did not showed any membrane stabilizing property (Kumar et al., 2011).

The study by Hossain et al. (2013) also confirmed the anti-inflammatory activity of methanol extract of *Bombax ceiba* leaves in carrageenan-induced acute inflammation rat model. It was found that extract was non-toxic up to a dose of 2 g/kg for mice and rats, orally. It reduced lipopolysaccharide induced (NO) production in macrophages in a dose-dependent fashion ($p < 0.001$). Study confirms that, MEBM possesses anti-inflammatory activity, mediated through inhibition of (NO) production (Hossain et al., 2013).

Antipyretic activity:
Hossain et al. (2011) has carried out screening of antipyretic activity of the methanol leaf extract of *Bombax ceiba* in Baker's yeast induced pyrexia in Wistar rats. It was concluded that extract has significant antipyretic activity and inhibition of the synthesis and/or release of inflammatory mediators may be its main mechanism of action (Hossain et al., 2011).

Hepatoprotective activity:
Ravi et al. (2010) have evaluated the hepatoprotective effect of methanolic extract of flowers of *Bombax ceiba* against isoniazid and rifampicin induced hepatotoxicity in rats. They found a significant decrease in alkaline phosphates, alanine transaminases, aspartate transaminases and total bilirubin levels, but increase in the level of total protein in comparison to control. They also noted that extract significantly decreases the level of TBARS and elevated the level of GSH at all doses as compared to control. Histology of the liver tissue of the animals treated with extract showed protection from hepatotoxicity caused by antitubercular drugs. Researchers concluded that extract could limit the effect of antritubercular drugs to the extent of necrosis but not able to revert completely the hepatic injury (Ravi et al., 2010).

Diuretic activity: Jalapure et al. (2011) investigated the diuretic effects of aqueous and crude ethanol extracts of *Bombax ceiba* fruits using acute model in rats. A single individual dose of aqueous and ethanol extract of *Bombax ceiba* fruit (200 mg/kg and 400 mg/kg, oral, each), frusemide and hydrochlorothiazide (25 mg/kg, oral, each) as reference diuretic drugs, were administered orally to dehydrated rats. Control group rats were fed with normal saline (25 ml/kg, orally). Both extracts significantly increased the urine output in higher doses. Although, the onset of diuretic action was gradual (within 5 h) and lasted up to 24 h. Further, the intensity of diuresis induced by aqueous extract, 400 mg/kg in 5 h was almost similar to that of frusemide and hydrochlothiazide. It was also observed that aqueous extract also caused marked increase in urinary Na^+ and K^- levels (Jalalpure and Gadge, 2011).

Aphrodisiac activity:
The aphrodisiac activity *of Bombax malabaricum* root extract was investigated at 400 mg/kg body weight for mount latency, intromission latency, ejaculation latency, mounting frequency, intromission frequency, ejaculation frequency, and post-ejaculatory interval parameters for a month. Parameters observed before and during the sexual behavior study exhibits extract reduced significantly Mount latency, intromission latency, ejaculation latency and post-ejaculatory interval. The extract also increased significantly mounting frequency, intromission frequency and ejaculation frequency. These effects were observed in sexually active and inactive male mice (Chaudhar and Khadabadi, 2015).

Antimicrobial and antibacterial activity:
Multi-drug resistant *Salmonella typhii* was found highly susceptible to methanol extracts of *Bombax ceiba* while acetone and aqueous extracts were found less effective (Rani and Khullar, 2004).

In another study methanol and acetone extracts showed potent antibacterial activity against *Klebsiella pneumonia* (Vaghasiya and Chanda, 2009).

Digge et al. (2015) evaluate the antibacterial activity of aqueous extracts of the bark of *Bombax ceiba* using the Pour plate method against six medically important bacterial strains, namely Gram-positive Bacteria (*Bacillus subtilis, Bacillus aureus* and *Staphylococcus aureus*) and Gram-negative bacteria (*Escherichia coli*, K *pneumoniae*, and *Pseudomonas aeruginosa*) and compared the antibacterial potency the potency with Gentamicin. They found that the aqueous extract was more significant against Gram-positive bacteria than against Gram-negative bacteria. The 100 µg/ml showed the best antibacterial activity as compared to the standard. They further commented that the presence of tannins may be responsible for significant antibacterial activity of the extract (Digge et al., 2015).

Nagamani et al. (2003) evaluate the aqueous, methanol, acetone, diethyl ether, chloroform and hexane extracts of seeds for the antibacterial property against five bacterial species namely *Escherichia coli*, *Bacillus Subtilis*, *Staphylococcus aureus*, *Enterococcus faecalis*, and *Alcaligenes faecalis*. Antimycotic study was performed against the fungal cultures namely *Candida albicans*, *Aspergillus niger*, *Aspergillus flaves*, and *Aspergillu fumigatus*. Among the six solvent extracts studied acetone and methanol extract exhibited significant antibacterial and antimycotic activity (Nagamani et al., 2014).

Anti-*Helicobacter pylori* activity:
Ethanolic extracts of *Bombax ceiba* evaluated strong anti-*Helicobacter pylori* activities. The minimum inhibitory concentration values of the anti-*Helicobactor pylori* activity

given by the ethanolic extracts ranged from 0.64 to 10.24 mg. (Wang and Huang, 2005).

Anticancer effect:
Effects of mangiferin in rat colon carcinogenesis induced by chemical carcinogen, azoxymethane (AOM) were evaluated by Yoshimi et al (2001). They performed a short-term assay to investigate the effects of mangiferin on the development of preneoplastic lesions by AOM, aberrant crypt foci (ACF). In the short-term assay, 0.1% mangiferin in a diet significantly inhibited the ACF development in rats treated with AOM compared to rats treated with AOM alone. In continuation long-study they evaluate the effect of mangiferin on tumorigenesis induced by AOM. In the long-term assay, the group treated with 0.1% mangiferin in initiation phase of the experimental protocol had significantly lower incidence and multiplicity of intestinal neoplasms induced by AOM. Same time the cell proliferation in colonic mucosa was reduced in rats treated with mangiferin. They opined that mangiferin has potential as a naturally occurring chemopreventive agent (Yoshimi et al., 2001).

Cytotoxicity:
Aqueous extracts of the plant *Bombax ceiba* exhibit mild cytotoxic effect in brine shrimp lethality test (Alluri and Gottumukkala, 2005).

CONCLUSION

This literature survey shows that *Bombax ceiba* plant has been extensively used in Unani system of medicine as well as different ethno-medicines since antiquity. Use of this plant by various ancient Unani scholars and tribal people is not just a myth but this practice was time tested. Its pharmacological effects were well confirmed by its repeated use in human beings and cattle. Various part of this plant is used as anti-diarrheal, siccative, blood purifier, anti-asthmatic, avaricious, to increase consistency of semen, semen procreator, uterine tonic, amenorrhoea, abortifacient, anti-leucorrhoic etc. Scientific validation regarding antioxidant, analgesic, anti-inflammatory, antipyretic, anti-carcinogenic, cytotoxic, antibacterial activities on modern scientific parameter further authenticate the wisdom of ancient Unani scholars and tribal peoples. However there is further need to identify and isolate the pharmacologically active molecules from different parts of this plant so as it can be better utilized.

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CONFLICT OF INTEREST

The authors have no conflicting financial interests.

REFERENCES

Abbasi AM, Khan MA, Ahmad M, Zafar M, Jahan S, Sultana S. Ethnopharmacological application of medicinal plants to cure skin diseases and in folk cosmetics among the tribal communities of North-West Frontier Province, Pakistan. J Ethnopharmacol. 2010;128:322-335.

Krishnaraju AV, Rao TVN, Sundararaju D, Vanisree M. Assessment of bioactivity of Indian medicinal plants using brine shrimp (*Artemia salina*) lethality assay. IJASE. 2005;3:125-134.

Antil V, Sinha BN, Pandey A, Diwan A, Saini P. *Bombax malabaricum* Dc: A salutary boon. IJPI. 2013;3:17-28.

Behera SK, Misra MK. Indigenous phytotherapy for genito-urinary diseases used by the Kandha tribe of Orissa, India. J Ethnopharmacol. 2005;102:319-325.

ITIS Report. *Bombax ceiba* L. Taxonomic serial no. 21593. Generated: Wednesday 5th August, 2015, Available at: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=21593 (accessed on 7th August 2015).

Chakraborty DD, Ravi V, Chakraborty P. Phytochemical evaluation and TLC protocol of various extracts of *Bombax ceiba* Linn. IJPSR. 2010;1:66-73.

Chaudhary PH, Khadabadi SS. Aphrodisiac activity of *Bombax Ceiba* Linn. Extract in Male Mice. Pharmatutor.org Available at: http://www.pharmatutor.org/articles/aphrodisiac-activity-of-bombax-ceiba-linn-extract-in-male-mice?page=0,0 (accessed on 6th May 2015).

Chaudhary PH, Khadabadi SS. *Bombax ceiba* Linn.: Pharmacognosy, Ethnobotany and Phyto-pharmacology. Phcog Commn. 2012;2:2-9.

Dar A, Faizi S, Naqvi S, Roome T. Analgesic and antioxidant activity of mangiferin and its derivatives: the structure activity relationship. Biol Pharm Bull. 2005;28:596-600.

Digge VG, Kuthat SS, Hogde MG, Poul BN, Jadge DR. Screening of antibacterial activity of aqueous bark extract of *Bombax ceiba* against some gram positive and gram negative bacteria. AJPCT. 2015;3:551-555.

Divya N, Nagamani JE, SUMA P. Antioxidant and antihemolytic activities of *Bombax ceiba* Pentandra spike and fruit extracts. IJPPS. 2012;4:311-5.

Faizi S, Ali M. Shamimin: A new flavonol C-glycoside from leaves of *Bombax ceiba*. Planta Med. 1999;65:383-385.

Faizi S, Zikr-ur-Rehamn S, Ali M, Naz A. Temperature and solvent dependent NMR studies on mangiferin and complete NMR spectral assignments of its acyl and methyl derivatives. Magn Reson Chem. 2006;44:838-844.

Ghani N. Khazainul Advia. Vol. 1. (New Delhi, India: Idara Kitabus Shifa), 1971.

Ghimire K, Bastakoti RR. Ethnomedicinal knowledge and healthcare practices among the Tharus of Nawalparasi district in central Nepal. Forest Ecol Manag. 2009;257:2066-2072.

Hakeem MA. Bustanul Mufradat. (New Delhi, India: Idara Kitabus Shifa), 2002.

Hakeem MAH. Mufradat Azeezi. (New Delhi, India: Central Council of Research in Unani Medicine), 2009.

Hossain E, Mandal SC and Gupta JK. Phytochemical Screening and In-vivo Antipyretic Activity of the Methanol Leaf-Extract of *Bombax Malabaricum* DC. (Bombacaceae). TJPR. 2011;10:55-60.

Hossain E, Sarkar D, Chatterjee M, Chakraborty S, Mandal SC, Gupta JK. Effect of methanol extract of *Bombax malabaricum* leaves on nitric oxide production during inflammation. Acta Pol Pharm. 2013;70:255-260.

Jabbar A, Raza MA, Iqbal Z, Khan MN. An inventory of the ethnobotanicals used as anthelmintics in the southern Punjab (Pakistan). J Ethnopharmacol. 2006;108:152-154.

Jain A, Katewa SS, Chaudhry BL, Galav P. Folk herbal medicines used in birth control and sexual diseases by tribal of southern Rajasthan, India. J Ethnopharmacol. 2004;90:171-177.

Jain V, Verma SK, Katewa SS, Anandjiwala S, Singh B. Free radical scavenging property of *Bombax ceiba* Linn. Root. Research journal of medicinal Plants. 2011;5:462-470.

Jain V, Verma SK. Assessment of credibility of some folk medicinal claim on *Bombax ceiba* L. IJTK. 2014;13:87-94.

Jalalpure SS, Gadge NB. Diuretic effects of young fruit extracts of *Bombax Ceiba* L. in rats. Indian J Pharm Sci. 2011;73:306–311.

Khan PMA, Hussain S, Mohsin M, Farooqui M, Zaheer A. *Bombax ceiba* flower extract: Biological screening and application as pH indicator. JCBPS. 2011-12;2:43-48.

Khare CP. Indian Medicinal Plant: An Illustrated Dictionary. (Verlag, Berlin: Springer), 2007.

Kosalge SB, Fursule RA. Investigation of ethnomedicinal claims of some plants used by tribals of Satpuda Hills in India. J Ethnopharmacol. 2009;121:456–461.

Kshirsagar RD, Singh NP. Some less known ethnomedicinal uses from Mysore and Coorg districts, Karnataka state, India. J Ethnopharmacol. 2001;75:231-238.

Kumar NS. Evaluation of RBC Membrane stabilization and antioxidant activity of *Bombax ceiba* in an in vitro method. Int J Pharm Bio Sci. 2011;2:220-226.

Mitra S, Mukharjee SK. Some abortificient plants used by the tribal people of West Bengal. NPR. 2009;8:167-171.

Mollik MAH, Hossain MF, Sen D, Hassan AI, Rahman MS. Traditional Asian medicine and leprosy in Bangladesh. Eur J Integr Med. 2009;1:191-192.

Nabi MG. Makhzane Mufradat wa Murakkabat. (New Delhi, India: Central Council of Research in Unani Medicine), 2007.

Nagamani JE, Vidya sri D, Syeda HB. A study on antioxidant and antimicrobial properties of *Bombax ceiba pentandra* seed extract. World Journal of Pharmacy and Pharmaceutical Sciences. 2014;3:692-706.

Nam NH, Kim HM, Bae KH, Ahn BZ. Inhibitory effects of Vietnamese medicinal plants on tube-like formation of human umbilical venous cells. Phytother Res. 2003;17:107-111.

Namsa ND, Tag H, Mandal M, Kalita P, Das AK. An ethnobotanical study of traditional anti-inflamtory plants used by the Lohit community of Arunachal Pradesh, India. J Ethnopharmacol. 2009;125:234-245.

Anonymous. National Formulary of Unani Medicine. Part 1. (New Delhi, India: Central Council of Research in Unani Medicine), 2006.

Rajendra KC. A brief introduction to Semal (*Bombax ceiba* Linn). Available at http://www.forestrynepal.org/images/simal_present_report3.pdf (accessed on 23th June 2015).

Rani P, Khullar N. Antimicrobial evaluation of some medicinal plants for their anti-enteric potential against multi-drug resistant *Salmonella typhi*. Phytother Res. 2004;18:670-673.

Ravi V, Patel SS, Varma NK, Dutta D, Saleem TSM. Hepatoprotective activity of *Bombax ceiba* Linn against isoniazid and rifampicin-induced toxicity in experimental rats. IJARNP. 2010;3:19-26.

Saleem R, Ahmad M, Hussain SA, Qazi AM. Hypotensive, hypoglycaemic and toxicological studies on the flavonol C-glycoside shamimin from *Bombax ceiba*. Planta Med. 1999;65:331-334.

Saleem R, Ahmad SI, Ahmed M, Faizi Z. Hypotensive activity and toxicology of constituents from *Bombax ceiba* stem bark. Biol Pharm Bull. 2003;26:41-46.

Sebastian MK, Bhandari MM. Medico-ethno botany of Mount Abu, Rajasthan, India. J Ethnopharmacol. 1984;12:223-230.

Sharma HK, Chhangte L, Dolui AK. Traditional medicinal plants in Mizoram, India. Fitoterapia. 2001;72:146-161.

Singh AK, Raghubanshi AS, Singh JS. Medical ethnobotany of the tribals of Sonaghati of Sonbhadra district, Uttar Pradesh, India. J Ethnopharmacol. 2002;81:31-41.

Tetali P, Waghchaure C, Daswani PG, Anita NH, Birdi TL. Ethnobotanical survey of antidiarrhoeal plants of Parinche valley, Pune district, Maharashtra, India. J Ethnopharmacol. 2009;123:229-236.

Upadhyay B, Parveen, Dhaker AK, Kumar A. Ethnomedicinal and ethnopharmaco statistical studies of Eastern Rajasthan, India. J Ethnopharmacol. 2010;129:64-86.

Vaghasiya Y, Chanda S. Screening of same traditionally used Indian plants for antibacterial activity against *Klebsiella pneumoniae*. JHMT. 2009;3:161-164.

Vieira OT, Said A, Aboutabl E, Azzam M, Creczynski-Pasa TB. Antioxidant activity of methanolic extract of *Bombax ceiba*. Redox Rep. 2009;14:41-46.

Wang YC, Huang TL. Screening of anti-*Helicobacter pylori* herbs deriving from Taiwanese folk medicinal plants. FEMS Immunol Med Microbiol. 2005;43:295-300.

Yoshimi N, Matsunaga K, Katayama M, Yamada Y. The inhibitory effects of mangiferin, a naturally occurring glucosylxanthone, in bowel carcinogenesis of male F344 rats.

Cancer Lett. 2001;163:163-170.

You YJ, Nam NH, Kim Y, Bae KH, Ahn BZ. Antiangiogenic activity of lupeol from *Bombax ceiba*. Phytother Res. 2003;17:341-344.