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MOLSARI (*MIMUSOPS ELENGI* LINN.): A BOON DRUG OF TRADITIONAL MEDICINE

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ABSTRACT: *Mimusops elengi* L. is an Indian origin herb used in the Unani and other traditional systems of medicine since long time. It is commonly called by the names Spanish cherry, West Indian Medlar or Bullet wood tree. This plant is frequently cultivated throughout India especially in north India for its ornamental appearance and fragrant flowers. All parts of plant such as leaf, root, fruit, seed, bark, flower of *Mimusops elengi* were reported for treatment of various human ailments in traditional system of medicine. Pharmacological activities like antimicrobial, antifungal, antioxidant and free radical scavenging, anti-inflammatory analgesic, antipyretic, antiurolithiatic, cytotoxic, diuretic, neuroprotective, anti-amnesic, cognitive enhancing, antihyperglycemic, antihyperlipidemic, hypotensive, antiulcer, anthelmintic, antitumor, wound healing, larvicidal activities have been scientifically evaluated for various parts of this plant. A number of phytochemical constituents have been identified in this plant that may be responsible for its pharmacological activities. So many articles are available on *Mimusops elengi* L., but from Unani literature the discussion is very limited. This review is an effort to summarize the detailed prospects of ancient Unani literature on *Mimusops elengi* L. along with modern researches. Further studies should be done to make this drug world widely acceptable.

INTRODUCTION: *Molsari* (*Mimusops elengi* L.) is a large glabrous evergreen Indian origin tree attaining a height of 12-15 m distributed in peninsular region, western and eastern ghats and cultivated in the plains e.g., tropical forests in south Asia and in India. Plant is cultivated for its ornamental appearance, elegant look, shade and for fragrant flowers.[1] The Plant has vast description in Unani literature as *Molsari.* It is described as large tree like *mauwah*, *kherni* and *cheeku*.

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This tree gives characteristic cool shade and fragrant flowers. Leaves are dark green, pointed and shiny. The tree bark is blackish. Small, white color, fragrant flowers grow on its branches. Its flowers are also known as *bhara maranand* as fragrance of flowers attracts bumble bees (*bhanwara*) toward it. Flowering time is from April to June every year and fruiting time is from May to September. Fruit is round, smooth, shiny, 0.75 inch long and get yellowish after ripening. Fruit is sweet with slight bitterness in test. [2] It is also are considered as a sacred plant among Hindus. *Mimusops elengi* flowers as symbol of love and beauty.[3] *M. elengi* is used in the Unani and other traditional systems of medicine since long time. Medicinally various parts of *M. elengi* were reported for treatment of several human ailments.[4]

Taxonomy:

Kingdom: Plantae
Order: Ericales
Family: Sapotaceae
Genus: Mimusops
Species: Elengi

Botanical Name: *Mimusops elengi* [5]

Vernacular Names: Urdu: *Molsari*; Sanskrit: *Anangaka, Chirapushpa, Dhanvi, Kesha, Madhupushpa, Bakulah Bakulah, Keshu kesara, Madhugandha, Udumbara*; [4] English: Spenish cherry, Indian medlar tree, Bullet-wood tree; Hindi: *Maulsari, Bakul, Bolsari*; Gujarati: *Babhuli, Bolsari, Varsoli, Vovoli*; [95] Marathi: *Bakhor, Bakula, Barsoli, Ovalli, Owli, Vavoli, Wovali, Wowl.* [4, 5, 6]

Botanical Description: *Mimusops elengi* is a moderate to large size evergreen tree, generally about 15 m high. Stem is ash coloured dark, fissured with densely spreading crown. Leaves are 6.3-10 cm long and 3.2-5 cm broad pointed with serpentile ends or elliptic or obovate and leathery with wavy margins with petioles 1.3-2.5 cm long. Petioles and twigs produce a watery milky exudate. Calyx is 1 cm long, fulvous pubescent. Corolla white coloured, sweet in fragrance, corolla longer than calyx, tube 1.5 mm long, lobes 8 mm long and are twenty four in numbers in two series; filaments short, glaborous, anthers glaborous, slightly twisted, acuminate; staminodes eight in number alternate with the stamens. Ovary silky pubescent; style grooved, slightly longer than corolla. Berry about 2.5 cm long, ovoid, yellow when ripe, contains a juicy pulp. Seeds are solitary, ovoid, compressed, brown and shining. [6]

Habitat: *Mimusops elengi* is native in India, Myanmar and Sri Lanka but cultivated across the tropics including Malaysia, Singapore, and Australia. It is cultivated in South India and central India especially in Madhya Pradesh, Jammu, Bihar, Mewad Awadh forests and Andaman Islands.[6]

Parts Used: Stem, bark, leaves, flowers, fruit seed and gum.[4, 5]

Temperament: Cold and Dry, [7] Cold and Dry 3^{o}; Fruit: Cold and Dry [5, 7]; Flower: Hot and Dry.[5, 7]

Afaal (Functions):

- **Seeds:** Qabiz (constipative), habis (astringent), mumsik mani, dafe jiryaan.[8]
- **Fruit with seed:** Muqawie bah (aphrodisiac), muqawwi meda, qalb wa jigar, (stomach, cardiac and liver tonic).
- **Flower:** Muqawie dandan wa lissa (teeth and gums tonic).[8]
- **Bark:** Mubarrid (cooling), dafe humma (anti-pyretic) muqawie qalb (cardiotonic), tiryaq (alexipharmic), muqawie meda (stomachic), qatile kirme ama (anthelmintic), qabiz (astringent), qate safra (antibilius), nafe suzak (cures gonorrhoea), nafe silanur rahem (cures leucorrhoea).
- **Leaves:** Habisuddam (haemostatic), manae irq (antidiaphrotic) and dafae amraz balghmi wa safrawi (treats phlegmatic and bilious diseases).[5]

Dawai Istemal (Therapeutic Uses): [5, 6, 7, 8]

- Bark decoction of *molsari* bark is used to reduce the fevers.
- Bark powder application on forehead cures headache.
- Gargles with decoction of bark are beneficial in throat pain, irritation and stomatitis.
- Inhalation of its flower powder is beneficial in Headache.
- Syrup prepared from ripen flowers is beneficial in renal and urinary bladder stones. This preparation dissolves and expels the stones.
- Decoction of four to five flowers infused in 100ml of water is used in paediatric dry cough. Its essence is used in palpitation and other heart diseases.
- *Arq molsari* prepared with its flowers is useful in cold diseases and heart problems.
- Taking 10 gm fresh flowers, 3 pieces of almond and 3 gm sugar in morning and evening is beneficial in ejaculation problems.
- Application of ointment prepared of 25 gm of its flowers, fruit and bark in 200gm wax is beneficial in boils, ring worm, and other skin diseases.

- Enema made up of its seed relieves constipation, while the fruit pulp is beneficial in dysentery.
- Eating five to six fruits daily also cures dysentery and diarrhoea. Eating of eight to nine fruit treats burning micturition.

***Mazarrat* (Adverse Effects):** Naffakh (flatulent), [7, 8] qabiz (constipative), hazime (digestive) [7]

***Musleh* (Corrective):** Shahad khalis (pure honey), ghee (butter),[7, 8] use along with hot and wet medicines (har wa ratab advia) [7]

***Badal* (Substitute):** Bhon phalli (Corchorus depressus),[7] babool ki chhaal aur phal (Bark and root of Acacia Arabica) [8]

***Miqdare Khuraq* (Dose):** 9 gm -10 gm[7]

***Mashhoor Murakkab* (Famous Formulation):** Sufoofe sailan. [9]

Phytochemical Constituents:

Stem bark: Taraxerone, taraxerol, betulinic acid and spinasterol, sodium salt of betulinic acid and ursolic acid, fatty acid esters of alpha-spinasterol, farnan-2-one-3 betaol (mimusopfarnanol), farnan-3-one, and olean-18-en-2-one-3-ol and lup-20 (29)-en-3 beta-ol, triterpene 3β-hydroxy-lup-20(29)-ene-23, 28-dioic acid, beta amyrin, lupeol, alpha cadinol, taumuurolol, hexadecanoic acid, diisobutyl phthalate, octadecadienoic acid, new gallic acid esters, (phenyl propyl gallate) are important molecules obtained from stem bark. The tree also yields a gum. Bark also contains tannins, wax, coloring matter and starch. [10]

Fruit and seed: Fruit and seed showed presence of quercitol, ursolic acid, dihydro quercetin, quercetin, β- d glycosides of beta sitosterol, alpha spinasterol, mimusops acid and mimusopsic acid, mimugenone, pentacyclic triterpenes 3beta, 6beta, 19alpha,23-tetrahydroxy-urs-12-ene and 1beta-hydroxy-3beta-hexanoyllup-20 (29)-ene-23, 28-dioic acid, mimusops, mimus, mi-saponin A 16 alpha-hydroxy mi-saponin A, taxifolin, alpha-spinasterol glucoside, Miglycoside 1, mimusopside A and B

Leaves heartwood and roots: Leaves contain hentriacontane, carotene and lupeol. A new steroidal saponin, 5 alpha-stigmast-9(11) en-3-obeta- D - glucopyranosyl (1-5) - o-beta-dxylo furanoside was isolated from the roots of *Mimusops elengi*. Leaves contain qurecitol, lupeol, hentriacontane, β-carotene, d-mannitol, β-sitoserol, β-sitosterol-β-d glucoside and qurecetin. [11] The lipid concentration of leaves was higher in summer (32.7 mg/gm) over that of monsoon (29.75 mg/gm) and winter (30.7 mg/gm). The bark of lipid concentration was ranging from 13.5 to 16.8 mg/gm) summer (16.8 mg/gm) show highest content over other season i.e. monsoon (13.5mg/gm) and winter (14.7 mg/gm). [24]

Seeds: The seed kernels yield 16-25% of a fatty oil qurecitol, dihydroqurecitin, qurecitin, ursolic acid, b sitisterol glycosides.[10] The fat free seed meal yield 2.4% bassic acid ($C_{30}H_{46}O_5$), a characteristic sapogenin of sapotaceae. It also yields a saponin which on hydrolysis yields ramnose (2 mol.), arabinose(2 mol.) and glucose(1 mol.).[11]

Preliminary phytochemical screening revealed the presence of phyto constituents such as terpenoids, saponins, anthraquinone glycoside and cardiac glycoside. [12]

Suchetra Sen *et al.*, isolated two new pentacyclic triterpenes, mimusopgenone and mimugenone from its seeds and characterized as 2β,3β,23-trihydroxy-28-noroleana-5, 12-dien-16-one and 3β, 23- dihydroxyoleana - 5, 12 – dien – 16 - one, respectively, based on their spectroscopic properties.[13]

Sahu *et al.,* isolated a novel minor triterpenoid saponin mimusin {3-O-[β-d-glucopyranosyl-(1→6)-β-d glucopyranosyl]-2β,3β,6β,23-tetrahy droxyolean-12-en-28-oic acid 28-O-α-l-rhamno pyranosyl - (1→3) – β - d-xylopyranosyl - (1→4) – α - l rhamnopyranosyl - (1→2) – α -l-arabino pyranoside} from the seeds, in addition to two known triterpenoid saponins, Mi-saponin A and 16α-hydroxy Mi-saponin A. The structure of the minor saponin was established by comparing its 1 3 C NMR and LS-MS linked-scan, ESI-MS data with FAB-MS of the mimusopsin isolated earlier from the same source.[14]

In another study Lavaud *et al.,* isolated six saponins from the seed kernel of *Mimusops elengi.*

Three of them are new compounds: 3-O-(β-d-glucuronopyranosyl) 28-O-(α-l-rhamnopyranosyl (1 → 3) β-d-xylopyranosyl(1 → 4) [α-l-rhamno pyranosyl (1 → 3)] α-l-rhamnopyranosyl(1 → 2) α-l-arabinopyranosyl) protobassic acid, 3-O-(β-d-glucuronopyranosly) 28-O-(α-l-rhamnopyranosyl (1 → 3) β-d-xylopyranosyl(1 → 4) α-l-rhamno pyranosyl(1 → 2) α-l-arabinopyranosyl) 16-α-hydroxyprotobassic acid and 3-O-(β-d-gluco pyranosyl(1 → 3) β-d-glucopyranosyl) 28-O-(α-l-rhamnopyranosyl(1 → 3) β-d-xylopyranosyl(1 → 4) α-l-rhamno pyranosyl (1 → 2) α-l-arabino pyranosyl) protobassic acid.[15]

Hazra Isolated antibacterial pentahydroxy flavones from the seeds of *Mimusops elengi* Linn.[23]

Oil: The composition of the total fatty acids of the oil is as follows: palmitic, 10.97; stearic10.10; behenic, 0.46; oleic 63.98; and linoleic,14.49%.[16] In a study by Sehgal *et al*, high performance thin layer chromatography method for detection and quantification of quercetin in M*imusops elengi* leaves was developed. The method provided a rapid and easy approach for detection and quantitation of the bio-marker quercetin.[17]

Flower: Fresh flower contain 2-Phenylethanol, 4-hydroxybenzenemethanol and cinnamyl alcohol about 10.49, 8.69 and 6.17%, respectively, whereas dried flowers contain long chain carboxylic acid ester and (Z)-9-octadecenoic acid, 5.37 and 4.71% of ether extract, respectively.[18] Jahan *et al.,* isolated a new triterpene 3β-hydroxy-lup-20(29)-ene-23,28-dioic acid**.** [19] Bhuyan and Saikai extracted dye from *Mimusops elengi*. [20] Akhtar *et al.,* isolated a new farnane-type triterpenoid, farnan-2-one-3β-ol (mimusopfarnanol), from the stem bark of *Mimusops elengi* .[21] New gallic acid esters phenyl propanoxyl gallate (1), beta-D-glucopyranosyl (6'-->1")-beta-D-glucopyranosyl - 4" - (4"-ethylphenyl) gallate (2), 2'-(1'"-geranyloxy) – beta - D-gluco pyranosyl (6'-->1")-beta-D-glucopyranosyl-4"-phenoxy gallate (3), beta-D-glucopyranosyl (6'-->1") - beta-D-glucopyranosyl 3,4,5-trihydroxy benzoate (4), beta-D-glucopyranosyl-(6'-->1")-beta-D-glucopyranosyl-4"-(4'"-n-butylphenyl) 3, 4, 5 –tri hydroxy benzoate (5), beta-D-glucopyranosyl(6'-->1")-beta-D-rhamnosyl 3,4,5-trihydroxy benzoate (6) and beta-D-(2'-phenyl glucopyranosyl)-(6'-->1") - (2", 4"- diphenylrhamnopyranosyl) - 3, 4, 5 - trihydroxylbenzoate (7), along with the known compounds: farnon-3-one, stigmasta-5-en-3-beta-ol, olean-18-en-2-one-3-ol, lup-20(29)-en-3beta-ol and stigmasta-5-en-3beta-D-glucopyranoside were also islated and characterised. [22] Fresh flowers on water distillation yield 0.01% of the oil. The dried flowers of *Mimusops elengi* yields four known compounds namely oleanolic acid, 4-hydroxy benzaldehyde, stigmasterol – 3 – o – β – d - gluco pyranoside and d-quercitol. [3]

Ethnobotanical Uses: [1, 10, 25, 26, 27]

- Its bark is used as a gargle for odontopathy, ulitis and ulemorrhagia and tender stems are used as tooth brushes.
- It is also useful in urethrorrhoea, cystorrhoea, diarrhoea and dysentery.
- Bark is used as an astringent and applied externally too. Bark extract is also given orally to cure diseases of gums and teeth, in biliousness as an anthelmintic, stomachic and cardiotonic. Currently bark extract of *M. elengi* reported for its moderate inhibitory activity against HIV type 1 protease. Bark is also used as a gargle for odontopathy treatment.
- The bark and seed coat are used for strengthening the gum and enter into the composition of various herbal tooth powders, under the name of "Vajradanti",
- The bark is used as snuff for high fever accompanied by pains in various parts of the body.
- Bark is used as a tonic, febrifuge, as a gargle for odontopathy, inflammation and bleeding of gums. Unripe fruit is used as a masticatory and helps to fix loose teeth.
- Seed bark decoction is used as aphrodisiac, cardio tonic and to treat mouth ulcer.
- Internally bark skin is benevolent in leucorrhoea, menorrhagia and is also known to have antiulcer activity.
- Flowers are used for preparing a lotion for wounds and ulcers.
- The flowers are considered expectorant and smoked in asthma.
- The flowers are used for preparing lotion for wounds and ulcers. Powder of dried flowers is a brain tonic, expectorant, disease of nose, and their smoke is good in asthma.

- The flowers are also used in distilling anotto used in perfumes.
- Powder of dried flowers is a brain tonic and is useful as a snuff to relieve cephalgia.
- The extract of the flower is salutary not only in heart diseases but also used as anti diuretic agent in polyuria condition. It alleviates the toxins, hence used as an anti-toxin.
- Floral part of the plant produce copious discharge from nose, sniffing is employed to relieve headache.
- Unripe fruit is used as a masticatory and help to fix loose teeth.
- Seeds are used for preparing suppositories in cases of constipation especially in children.
- The seed is known for its medicinal properties, such as in constipation, diabetes, hydrophobia, piles etc. The folklore mentions seeds to have spermicidal properties.
- A lotion prepared from unripe fruits and flowers is used for smearing on sores and wounds.
- In Ayurveda, the important preparation of Mimusops is bakuladya taila, applied on gum and teeth for strengthening them, whereas in Unani system, the bark is used for the diseases of genitourinary system of males.
- Seeds bruised and locally applied within the anus of children in cases of constipation.
- The roots are used as diuretic, astringent, cardiotonic and stomachic. Flowers are used as an expectorant and in liver complaints and asthma. *Mimusops elengi* bark showed antiulcer activity.
- It is also used to prepare lotion for wounds and ulcers; dried powder is a brain tonic and is useful to relieve cephalagia.
- Latex is applied to treat scabies and skin sores.
- Leaves are used as an antidote in snakebite.

FIG. 1: DRY GUM EXUDATE OF MOLSARI (*MIMUSOPS ELENGI* LINN.)

Pharmacological Activities: Following studies are carried out on different parts of this plant:

1. Antioxidant activity: Saaha *et al.*, evaluated the Antioxidant potential of the methanol extract of the leaves of *Mimusops elengi* by using 1, 1-diphenyl-2-picrylhydrazyl (DPPH) scavenging assay, reducing power and total antioxidant capacity. The extract showed significant activities in all antioxidant assays compared to the reference antioxidant ascorbic acid in a dose dependent manner. In DPPH scavenging assay the IC_{50} value of the extract was found to be 43.26µg/ml while the IC_{50} value of the reference standard ascorbic acid was 58.92µg/ml. Total antioxidant activity was also found to increase in a dose dependent manner. *M. elengi* extract also showed strong reducing power. Study proved that it act as a chemo-preventative agent offering effective protection from free radicals. [27] In another study antioxidant capacities of the phenolic compounds extracted from immature, mature and ripe fruits of *Mimusops elengi* were investigated. The antioxidant capacity of each fraction was determined by radical scavenging (DPPH and ABTS) assays. The antioxidant capacity values of these fractions, expressed as gallic acid equivalents (GAE) by ABTS assay for immature and mature fruits were in the range of 13.5 ± 0.1 -441.7 ± 4.8 mg/ g extract

with relative capacities being F2 > F3 > F1. The GAE values for ripe fruits were in the range of 192.3 ± 1.0 – 212.5 ± 4.6 mg/g extract with relative values of F2 ≈ F3 > F1. This study showed that *Mimusops elengi* fruits is a good source of natural antioxidant. [28]

Protective effect of leaf extract on lipid peroxidation and activities of both enzymatic and non-enzymatic antioxidants in plasma and tissues were also studied for this plant and the oxidative stress was measured by plasma and tissue lipid peroxidative markers levels, non enzymatic antioxidants and enzymatic antioxidants. Study showed promising antioxidant properties by significant quenching impact on the extent of lipid peroxidation, along with enhancement of antioxidant defense system in pancreas tissues. [29]

2. *In-vitro* anti-inflammatory activities: Kar *et al.,* assessed the antioxidant and in vitro anti-inflammatory activities of alcoholic extract of *Mimusops elengi* leaves. The leave extract exhibited dose dependent free radical scavenging property in peroxynitrite, superoxide and hypochlorous acid models and the IC_{50} value were found to be (205.53 ±2.30), (60.5±2.3), (202.4±5.3) µg/mL respectively. Total phenolic content was found to be 97.3 µg/mg of extract. The maximum membrane stabilization of *M. elengi* L was found to be (73.85±0.80 %) at a dose of 1000 µg/0.5 ml and that of protein denaturation was found to be 86.23 % at a dose of 250 µg/ml with regards to standards in the anti-inflammatory activity. [30]

3. Diuretic activity/Anti Urolithiatic activity: Koti *et al.,* studied, petroleum ether, chloroform, and alcoholic extracts of *Mimusops elengi* bark (200 mg/kg body weight, p. O.) for diuretic activity on five groupes of six animals each. The first group received only 0.9% sodium chloride solution (25 ml/kg body weight) and the second group received the standard drug furosemide (20 mg/kg body weight) in 0.9% sodium chloride solution. Rest of the three groups received each of extracts viz. petroleum ether, chloroform, and alcohol of *M. elengi* bark in a dose of 200 mg/kg body weight suspended in 0.9% sodium chloride solution p.o. After oral administration, urine was collected and volume was recorded at 5 hours. The highest diuretic activity was noted in the alcoholic extract however no duretic activity was observed in chloroform and petroleum ether extracts. [31] Katedeshmukh *et al.,* evaluated the diuretic activity of ethyl acetate, ethanol and water extract of *Mimusops elengi* in male wistar rats (175-200g) by measuring the urine volume at 1, 2, 4, 6 and 24 hrs. The extracts were administered orally at the dose of 250 mg/kg b.w. Researchers observed that Na^+ / K^+ ratio was higher in aqueous extract and followed by ethanol and ethylacetate extracts. The aqueous extracts showed a significant diuretic activity when compared with other extracts. From results they concluded that all the extracts tested have a diuretic potential

In another study Petroleum ether, chloroform, and alcohol extracts of bark were evaluated for antiurolithiatic and antioxidant activity in male albino Wistar rats. Oxalate, calcium, and phosphate were monitored in the urine and kidney. Serum BUN, creatinine, and uric acid were also recorded. *In vivo* antioxidant parameters such as lipid peroxidation (MDA), glutathione (GSH), superoxide dismutase (SOD), and catalase (CAT) were also monitored. All the extracts of *M. elengi* were found safe orally and exhibited no gross behavioral changes in the rats. In hypercalculi animals, the oxalate, calcium, and phosphate excretion grossly increased. However, the increased deposition of stone forming constituents in the kidneys of calculogenic rats were significantly ($P < 0.001$) lowered by curative and preventive treatment with alcohol extract. It was also observed that alcoholic extract of *M. elengi* produced significant ($P < 0.001$) decrease in MDA, increased GSH, SOD, and CAT.[32]

4. Larvicidal activity: Ruikar *et al.,* studied the larvicidal potential of *M.elengi* against *Aedes aegypti* and *Culex quinque fasciatus.* The compound 1, cubebin, 3,4 bis (1,3-benzodioxol- 5-yl methyl) tetrahydrofuran-2-ol was isolated. Hexane (hex) and ethyl acetate (ea) extracts showed promising larvicidal activity. [34]

5. Cytotoxic activity: The cytotoxic effect of ethanolic extract of barks of *M. elengi* was investigated on meristimatic cells of root tips of *Allium cepa.* The experiment was carried out by using different concentrations (2.5, 5, 10 mg/ml) of

standard cytotoxic drug cyclophosphamide and ethanolic extract. After 48 h and 96 h root length and mitotic index were calculated. Study revealed that there is a significant decrease in percent mitotic index and root length of *A. cepa* with respective time and with increasing concentration. [35]

6. **Antiinflammatory, Analgesic and Antipyretic activities:** The antiinflammatory activity of alcohol extract of *Mimusops elengi* was evaluated using acute (carrageenan-induced paw oedema) and sub acute (cotton pellet) *in vivo* models of inflammation. The study revealed that 70% ethanol extract of *Mimusops elengi* has significant antiinflammatory activities in experimental animals at a dose of 200 mg/kg. [36] Sehgal *et al.*, investigated the antipyretic and analgesic activity of methanolic extract of leaves of *Mimusops elengi.* Antipyretic and analgesic activity was carried out on yeast induced pyrexia and tail immersion model in rats respectively at 100 and 200 mg/kg doses. The methanolic extract produced significant antipyretic effect in a dose dependent manner and an appreciable antipyretic effect was noticed at 200 mg/kg dose. A dose dependent analgesic activity was observed with significant effect at 200 mg/kg dose. [37]

7. Neuroprotective activity: The study investigated the neuroprotective effect of hydroalcoholic extract of *Mimusops elengi* against cerebral ischemic reperfusion injury in rats. Pretreatment with extract at doses of 100 and 200mg/kg significantly improved the neurobehavioral alterations and reduced the infarct volume, edema and extent of BBB disruption induced by ischemia reperfusion injury. It also prevented the alteration in the antioxidant status and reduced the nitrite levels when compared to ischemic animals. The results indicated the neuroprotective effect of extract against stroke like injury. Researchers concluded that the observed protective effect might be attributed to the polyphenolic compounds and their antioxidant and anti-inflammatory property. [38]

8. Anti-amnesic activity/Anxiolytic activity: Joshi and Parle investigated the reversal of memory deficits by ethanol extract of *Mimusops elengi* in mice. Extract [100 and 200 mg/kg] was administered orally for 8 successive days to both young and aged mice. Elevated plus maze and passive avoidance paradigm were employed to assess short term and long term memory respectively. Light and dark box test, Open field test and Social interaction test were used to assess the possible anxiolytic potentials of plant mtrial. Extract [100 and 200 mg/kg, p.o.] significantly attenuated amnesic deficits induced by diazepam [1 mg/kg, i. p.], scopolamine [0.4 mg/kg, i. p.] and natural aging. *M. elengi* [100 and 200 mg/kg] decreased transfer latencies and increased step down latencies significantly in the aged mice. It also reversed amnesia induced by diazepam and scopolamine in young mice. *M. elengi* exhibited significant anxiolytic activity in mice. It also decreased whole brain acetyl cholinesterase activity significantly. [39]

9. Free radical scavenging and skin fibroblast proliferation activities: The study investigated the biological activities of the *M. elengi* flower extracts prepared by the two non-heated processes ($scCO_2$ and hexane maceration). The extracts from the $scCO_2$ method showed higher free radical scavenging and normal human skin fibroblast proliferation activities than those by the hexane maceration.[40]

10. Acute toxicity activity: In an acute toxicity study, the single administration of these extracts up to 2 g/kg b.w. did not produce any mortality or adverse reaction after the administration of a single limit dose.[32]

11. Antitumor activity: Kar *et al.*, investigated the methanol extract of *M. elengi* (MEME) leaves for antitumor activity in Swiss albino mice against Ehrlich ascites carcinoma cells (EAC) cell line. Twenty-four hours after intraperitoneal (i.p.) inoculation of EAC in mice (n = 12), MEME was administered at 200 and 300 mg/kg body weight daily for 9 consecutive days. On day 10, half of the mice were dissected and the rest were kept alive for assessment of increase in life span. MEME showed significant ($p<.001$) decrease in tumor volume, packed cell volume, and viable cell count, and increased the life span of EAC bearing mice. Hematological, biochemical profile, and *in vivo* antioxidant parameters were significantly restored toward normal levels in MEME-treated mice as

compared to EAC control. MEME also showed direct cytotoxicity on EAC cell line in a dose-dependent manner. [41]

12. Antibacterial activity: The antibacterial activity of petroleum ether, chloroform, ethyl acetate and methanol extracts of the flowers of *Mimusops elengi* were screened against various pathogenic Gram positive and Gram negative bacterial strains viz. *Bacillus cereus*, *Enterobacter faecali*, *Salmonella paratyphi*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Serratia marcescens* by 'agar well diffusion' method. Methanolic flower extract of Mimusops elengi showed pronounced antibacterial activity against all the microorganisms tested with 25-30mm/50µL inhibition zone. [42]

In another study aqueous petroleum ether, toluene, methanol, ethanol and chloroform extract of leaves was investigated against five pathogenic bacteria *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Vibrio cholera* and *Streptococcus pneumonia* by using agar cup diffusion method. The aqueous extract showed a strong antibacterial activity. Maximum and highly significant activity was observed in methanol and ethanol extract. [43] The bark extracts in aqueous and acetone solvents were also evaluated and compared for antibacterial activity against salivary microflora using paper disc diffusion method. The aqueous and acetone extracts did not show any significant zones of inhibition in this study.[44]

The ethanolic extract of bark was tested for antibiotic activity using the well method on 16 clinical bacterial isolates seeded in Mueller Hinton Agar. The antibiotic activity were tested for their Minimum Inhibitory Concentrations (MICs) using the MIC agar dilution method. The ethanol bark extract shows significant activity against three *Staphylococcus* isolates including *Staphylococcus aureus*.[45] The bark was extracted successively with petroleum ether, benzene, chloroform, acetone, methanol and water in a Soxhlet extractor for 18 hours. Individual extracts of bark were prepared with chloroform, methanol and water. The extracts were evaluated for antibacterial activity against different Gram positive, Gram negative microorganisms and organisms isolated from tooth tartar of dental patients by ditch plate technique. Chloroform extract showed prominent antibacterial activity in preliminary screening.[46]

The antibacterial activities of both aqueous and ethanolic extracts of leaf were screened against medically important bacterial strains by using both agar disc diffusion and agar well diffusion methods. The ethanol extracts were more potent than aqueous extracts.

M. Hazra *et al.*, detected, two antibacterial compounds from the seeds of *mimusops elengi*, In order to isolation of antibacterial pentahydroxy flavones from the seeds of *mimusops elengi t*he compounds were extracted by ethyl acetate and purified by column chromatography. The compounds showed strong inhibitory activity against gram positive and gram negative bacteria.[16]

Anti microbial effect was also tested by hexane, ethyl acetate, ethanol and methanol extracts against the dental caries causing bacteria *Streptococcus mutans* isolated from caries infected patients. The all extracts showed antibacterial activity against *Streptococcus mutans*.

The petroleum ether, acetone, methanol and water extracts of bark were tested for their antibacterial activity against five dental infection microorganisms such as *Staphylococcus aureus*, *Streptococcus mutans*, *Streptococcus salivarius*, *Streptococcus sanguis*, *Lactobacillus acidophilus* and *Candida albicans* by well diffusion method. Methanolic and aqueous extracts showed greater activity as compare petroleum ether and acetone extracts because more phytoconstituents were leached in it. Petroleum ether, ethyl acetate, methanol, kanamycin solvent extracts of bark, fruits and leaves were screened for their antibacterial against some pathogenic bacteria. Fruit extracts were less potent against most of the tested organisms compared to those obtained from bark and leaves and were inactive against the fungus *Trichoderma viride*. Leaves extracts displayed good activity against *Bacillus subtilis* and *Trichoderma viride* and were inactive against *Helminthosporium sativum*. [50]

13. Antifungal effect: The hexane, ethyl acetate, ethanol and methanol extracts were tested against the dental caries fungus *Candida albicans* isolated from caries infected patients. The extracts did not show any antifungal activity against *Candida albicans*.[56] The petroleum ether extract, ethyl acetate, methanol, fluconazole solvent extracts of bark, fruits and leaves were screened for their antifungal activities against some pathogenic fungi. The bark extracts were found to be active against most of the tested fungal strains and the all extracts obtained from fruits displayed weak activity against most of the fungi whereas the extracts of leaves showed considerable inhibitory effect against most of the tested fungi .[51]

14. Wound Healing Activity: In an study wound healing activity of extract of bark part of *Mimusops elengi was* evaluated. A methanolic extract was examined in the form of ointment in three types of wound models on mice: the excision, the incision and dead space wound model. The extract ointments showed considerable response in all the above said wound models as comparable to those of a standard drug Betadine ointment in terms of wound contracting ability, wound closure time, tensile strength and dry granuloma weight. Histological analysis was also consistent with the proposal that *Mimusops elengi* bark extract exhibits significant wound healing. This study showed that the methanolic extract ointment of *Mimusops elengi* effectively stimulated wound contraction; increase tensile strength of incision and dead space wounds as compared to control group. [52]

15. *In vitro* antioxidant and *in vivo* antihyperglycemic activity: Ganu and Jadhav evaluated the in vitro antioxidant and antihyperglycemic property of aqueous extract *Mimusops elengi* in alloxan-induced diabetic rats. Extract exhibited reducing power as well as DPPH and OH radical scavenging activity *in vitro*. Onset of action of antihyperglycemic activity of extract was at the 2nd hr and duration of action was before the 24th hr. Authers concluded that extract may act by increasing peripheral utilization of glucose.[52]

16. Hypotensive activity: The methanolic extract of *Mimusops elengi* showed hypotensive activity in anaesthetized rats. On intravenous administration (i.v.) at a dose range of 2–16 mg/kg, it produced about a 7–38% fall in mean arterial blood pressure, in a dose-dependent manner. The effect was independent of adrenergic, muscarinic and histaminergic receptors. The hypotension was also unchanged after autonomic ganglion or angiotensin -converting-enzyme blockade. Administration of calcium channel blockers, including nifedipine (0.9 mg/kg) and verapamil (3.9mg/kg), caused corresponding reductions of 81 and 64% in extract-induced hypotension. These data imply that *M. elengi* might possess calcium-blocking activity which would explain its hypotensive effect.[53]

17. Anti ulcer activity: Shah investigated the effect of 50% alcoholic extract of *Mimusops elengi* against experimental gastric ulcers. The *Mimusops elengi* extract and its different fractions namely ethyl acetate n-butanol methanol and aqueous were studied (p.o.) against ethanol-induced gastric damage. Extract at the doses of 10, 50 and 100mgkg showed dose-dependent inhibition of gastric lesions against ethanol-induced gastric damage. In 19h pylorus-ligated animals, Extract at 50 and 100mgkg doses showed significant reduction in ulcer index ($P<0.05$). Significant reduction was also observed in total acidity, volume of gastric acid secretion, total acid output and pepsin activity ($P<0.05$) when compared with the control group. Besides, Extract also showed increase in the mucosal glycoproteins that was evident from significant rise in total carbohydrates to protein ratio (TC:PR ratio) ($P<0.05$). Extract also showed protection against water-immersion plus stress-induced gastric lesions. [54]

18. Anthelmintic activity: The methanolic extract and its fractions were evaluated for anthelmintic activity by using adult Indian earthworms *Pheretima posthuma*. The results indicated that the methanolic extract and ethyl acetate fraction of the leaves has significant anthelmintic activity with respect to standard and control. Albendazole was included as standard reference and distilled water as control. [55]

19. Antihyperlipidemic activity: The methanolic extract of bark was used for the evaluation of antihyperlipidemic activity on wistar rats. The groups treated with methanolic extract showed

significant reduction in levels of triglyceride and total cholesterol as compared to hyperlipidemic group after 7 and 24 h of induction which indicates its antihyperlipidemic potential. [56]

20. Anticonvulsant activity: The anticonvulsant activity of methanolic, aqueous, and n-butanolic extract of bark were evaluated using maximal electroshock test in rats and isoniazid induced convulsions in mice and concluded that methanolic, aqueous, and n-butanolic extract possess significant anticonvulsion activity. [57]

21. Anti-atherosclerotic activity: The methanol extract of the leaves was evaluated by performing assay of HDL cholesterol, triglycerides, catalase, and superoxide dismutase. It showed potent anti-atherosclerotic activity .[58]

CONCLUSION: *Mimusops elengi* L. is truly a medicine with a long history of human usage for the treatment of a variety of disorders like fevers, headache, throat pain, irritation and stomatitis, dysentery and diarrhea, burning micturition, renal and vesical stones, ejaculation problems, skin diseases, palpitation and other heart diseases etc. Pharmacological activities like antimicrobial, antifungal, antioxidant and free radical scavenging, anti-inflammatory analgesic and antipyretic, antiurolithiatic, cytotoxic, diuretic, neuroprotective, anti-amnesic, effect on memory, cognitive enhancing, antihyperglycemic, antihyperlipidemic, hypotensive, antiulcer, anthelmintic, antitumor, wound healing, and larvicidal activities have been scientifically evaluated.

It contains a number of phytoconstituents, which are the key factors in the medicinal value of this plant. Further investigations should be carried out to isolate and characterize the specific active components of this plant which are responsible for these actions. Almost all parts of this plan such as leaf, fruit, seed, bark and flowers are used to cure a variety of diseases. As its importance is explained in classical literature and modern science, no doubt it is a blessed drug, but it's therapeutic activity needs explanation. As the world is looking towards new drugs from natural sources, it elicits on all aspects of herb and throws the attention of the researchers to carry out the work for developing the new formulations which can be beneficial for the treatment of various ailments

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