REVIEW

**Mimusops elengi** Linn. (Maulsari): a potential medicinal plant

**Kanchan Lata Singh**¹, **Priya Srivastava**², **Shiv Kumar**¹, **D. K. Singh**¹, **V. K. Singh**¹*

¹Malacology Laboratory, Department of Zoology, DDU Gorakhpur University, Gorakhpur - 273 009, U.P., India, ²Department of Zoology, St. Xavier’s College, Ranchi - 834 001, Jharkhand, India.

* Corresponding author: e-mail: vinaygkpuniv@gmail.com; drvksingh_gpu@yahoo.in; Phone: +91-9415855488 (Mobile)

Received: 19 February 2014; Accepted: 23 April 2014; Published: 30 April 2014

**ABSTRACT**

*Mimusops elengi* Linn. (Maulsari) has been used in traditional medicine to provide alternative therapy for the treatment of many disorders. The active components in different parts of *M. elengi* are tannin, saponin, quercitol, d-mannitol, quercetin, alkaloids, taraxerol and inorganic salts. Studies on the medicinal and biological importance of *M. elengi* have been reported in different parts of the world. In traditional medicine system of Ayurveda *M. elengi* bark is used as Danta Pavana. In modern study its medicinal properties is demonstrate that *M. elengi* used as antimicrobial, antiviral, anthelmintic, antiulcer, antiinflammatory, diuretic, antianxiety, antihyperlipidemic, anticonvulsant, analgesic, antipyretic, antioxidant, cytotoxic, antidiabetic and hypertensive activity. *Mimusops elengi* can be used as larvicidal and molluscicidal agent against harmful pests/vectors. Seed of *M. elengi* has mimusopic acid exhibited anti HIV reverse transcriptase activity. The present review focuses on the advancement of research on the medicinal and biological aspects of *M. elengi*.

**Key words:** *Mimusops elengi*; Maulsari; Plant; Antimicrobial; Anthelmintic; Larvicidal; Molluscicidal; Cytotoxicity.

1. **INTRODUCTION**

*Mimusops elengi* contains a variety of active components possess various kinds of biological and pharmacological activities. It has some biological and pharmacological activities such as antibacterial, antifungal, anticarcinogenic, antihyperglycemic, antiviral, antihemorrhoidal and cytotoxic activities. It have been previously reported as antiulcer, antiinflammatory, antianxiety, antihyperlipidemic, anticonvulsant, analgesic, antipyretic, antioxidant, cytotoxic, antidiabetic, diuretic and hypertensive activity (Table 1) [1, 2]. Chewing of a twig of *M. elengi* is as Danta Pavana [3]. Powder of dried flower is a brain tonic and is useful for cleaning teeth and antipyretic [4]. The root, fruits extract is also used sweet and sour, in aphrodisiac, diuretic, astringent to the bowels, good for gonorrhea, urethrorrhaea, cystorrhoea, diarrhea and dysentery [5, 6]. Flowers are used for preparing lotion for wound and ulcer [7]. They are used for expectorant, cure biliousness, liver complaints; disease of nose, headache and their smoke is good in asthma [2, 8, 9]. Unripe fruit and seed are used for to fix loose teeth.

In Sushruta literature leaf is used as antivenom [10, 11]. Fresh leaf juice is poured in to the nostril in stupor and coma [11]. The flower valued for making garlands, are sometimes used for stuffing pillow and the attar distilled from them is steamed as a perfume [12]. The seed reduce to paste and mixed with old ghee, is used as a suppository in case of constipation of children. Decoction of the bark is an excellent astringent
Table 1. Pharmacological/toxicological effect of *Mimusops elengi* plant

<table>
<thead>
<tr>
<th><em>M. elengi</em></th>
<th>Parts used</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiprotozoal</td>
<td>Stem</td>
<td>Aswal et al. [80]</td>
</tr>
<tr>
<td>Antimicrobial</td>
<td>Bark</td>
<td>Gami [13]; Sahwar and Raza [30]</td>
</tr>
<tr>
<td>Antiviral</td>
<td>Bark</td>
<td>Hattori et al. [37]; Kusumoto et al. [38]</td>
</tr>
<tr>
<td>Antulcer</td>
<td>Bark</td>
<td>Prakash et al. [55]</td>
</tr>
<tr>
<td>Anthelmintic</td>
<td>Leaf</td>
<td>Manjeshwar et al. [10]; Jana et al. [53]</td>
</tr>
<tr>
<td>Antipyretic</td>
<td>Leaf</td>
<td>Kar et al. [61]</td>
</tr>
<tr>
<td>Anti-inflammatory</td>
<td>Leaf, bark</td>
<td>Kar et al. [61]; Rajkumara et al. [13]</td>
</tr>
<tr>
<td>Antihyperlipidemic</td>
<td>Bark</td>
<td>Ghaisus et al. [81]</td>
</tr>
<tr>
<td>Antihyperglycemic</td>
<td>Bark</td>
<td>Ganie et al. [46]</td>
</tr>
<tr>
<td>Antioxidant</td>
<td>Leaf, fruit</td>
<td>Manjeshwar et al. [2]; Purnima et al. [15]; Chaiyan et al. [42]; Rao et al. [43]</td>
</tr>
<tr>
<td>Antihypertensive</td>
<td>Leaf</td>
<td>Manjeshwar et al. [2]</td>
</tr>
<tr>
<td>Antiurolimatic</td>
<td>Bark</td>
<td>Ashok et al. [45]</td>
</tr>
<tr>
<td>Antidiabetic</td>
<td>Stem bark, Leaf</td>
<td>Ganie et al. [46]; Mamatha et al. [63]</td>
</tr>
<tr>
<td>Analgesic</td>
<td>Leaf</td>
<td>Sakshi et al. [9]</td>
</tr>
<tr>
<td>Antianxiety</td>
<td>Bark</td>
<td>Ganie et al. [46]</td>
</tr>
<tr>
<td>Anticonvulsant</td>
<td>Bark</td>
<td>Ganie et al. [46]</td>
</tr>
<tr>
<td>Cytotoxic</td>
<td>Leaf, Bark</td>
<td>Santosh et al. [82]; Karmakar et al. [58]; Nasrin et al. [59]</td>
</tr>
<tr>
<td>Diuretic</td>
<td>Bark</td>
<td>Kati and Ashok [51]; Katedeshmukh et al. [50]</td>
</tr>
<tr>
<td>Neuropharmacological</td>
<td>Bark</td>
<td>Karmakar et al. [58]</td>
</tr>
<tr>
<td>Wound healing</td>
<td>Stem bark</td>
<td>Gupta and Jain [68]</td>
</tr>
<tr>
<td>Larvicidal activity</td>
<td>Bark</td>
<td>Ruikar et al. [79]</td>
</tr>
<tr>
<td>Molluscicidal activity</td>
<td>Leaf, Bark, Seed</td>
<td>Singh et al. [23]; Singh et al. [72, 78]</td>
</tr>
</tbody>
</table>

gargle and plant used as ethnomedicine diarrhea disease [12]. Ripe fruit are given orally to a pregnant woman to promote a delivery. Sometimes they are used as abortifacient [13, 14, 15]. The purpose of the present review is highlighting the various traditional uses and pharmacological reports on *Mimusops elengi*.

2. REVIEW

*Mimusops elengi* (family Sapotaceae) is called Maulsari in Hindi Bakul in Sanskrit, Elengi in Malayalam and Ranja in Kanada. The common name in English is Spanish Cherry and Bullet wood [16]. *M. elengi* is the native of western peninsula. It is a medium sized evergreen plant found in tropical forest. It is evergreen a height of 16 m found in Andaman, Martaban, Burma and the western Ghat, India and Pakistan [17-19]. The leaves are glossy and are dark green oval shaped when old with 6.3-10 cm in long and 3.2-5 cm in wide. The new leaves mostly appear in February when the trees often appear bright vivid green. Leaves are variable, elliptic, oblong or oblongate, short or long acuminate, margin undulate, closely but faintly veined. Petioles 1.2-2.5 cm long, whereas the dried leaves are blackish green in colour [20]. The fresh bark is grayish black, channeled, occurs in pieces of 15-25 cm long and 10-15 cm broad. Externally rough due to the presence of vertical lenticels, cracks and longitudinal fissures. The dried bark is black, curved, thin, fibrous and longitudinally striated fracture along with [18, 20, 21]. Berry ovoid, 2.5 cm long with. It turns yellow and it tastes astringent and sweet. Fruits occur in rainy season,
when ripe containing 1, rarely 2 seeds. Seeds are grayish brown, solitary, ovoid, compressed and shining [4, 22].

2.1. Chemical constituent

The main constituents of ethanolic extract of M. elengi leave contain quercitol, hentriacontane, β-carotene and glucose. D-mannitol, β-sitosterol, β-sitosterol-β-D-glucoside and quercetin [2, 3, 13]. Bark contains alkaloids, starch, saponins, tannin, some caoutchoue, wax coloring matter, starch and ash forming inorganic salts [8, 23]. A new triterpene 3β-hydroxy-lup-20(29)-ene-23, 28-dioic acid, β-amyrin, lupeol obtained from bark of M. elengi [24]. Fruit and seed of M. elengi showed presence of quercetol, urosolic acid, dihydroquercetin, quercetin, β-d glycosides of β-sitosterol, α-spinasterol after saponification [25]. Two novel triterpenoid saponin and mimusin was isolated along with two known triterpenoid saponins, mi-saponin and 16 α-hydroxymi-saponin [26]. A new steroidal saponins 5α-stigmast-9(11)en-3-o-beta-D-glucopyranosyl (1-5)-o-beta-D-xylofuranoside was isolated from the roots of M. elengi [2, 27]. Chemical formulas of saponin and mimusopic acid are presented on Fig. 1.

![Figure 1. Saponin](image1.png)

![Figure 1. Mimusopic acid](image2.png)

2.2. Biological Effects

Prabhat et al. [28] reported that leaf extract of Mimusops elengi inhibited in in vitro against Bacillus anthracis, B. pumilus, B. subtilis, B. mycoides, Salmonella paratyphi, Staphylococcus albus, Vibrae chlorae and Xanthomonas malvacearum among all the X. malvacearum and B. anthracis was significantly inhibited. The bark extracts of M. elengi against Staphylococcus aureus, Streptococcus mutans, S. salivarius, S. sanguis, Lactobacillus acidophilus and Candida albicans in in vitro antimicrobial activity was significantly inhibited. Lalitha et al. [29] noted that the aqueous and solvent extracts of leaves of M. elengi have significantly inhibitory activity against five pathogenic bacteria viz. Escherichia coli, Pseudomonas aeruginosa, Salmonella typhi, Vibrio cholera and Streptococcus pneumoniae at 10, 20, 30, 40 and 50 µl concentrations. Among all five pathogens Streptococcus pneumoniae and Escherichia coli showed a maximum inhibition of 26.9 and 24.4 mm at 50 µl concentration with respect to standard antibiotics. In organic solvent 10-50 µl concentration methanol and ethanol observed a maximum inhibition of 32.2 mm and 31.3 mm against Streptococcus pneumoniae and Escherichia coli [29]. The aqueous extract and organic solvent of leaf of M. elengi inhibited gram positive and gram negative strains. The stem bark extracts of M. elengi showed strong antibacterial activity against all six bacterium, while the fruit and seed extracts were found inactive [30]. The ethanol extract of bark was tested on sixteen 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 S. aureus [31]. Nair and Chanda [32] noted that the antibacterial activities of both aqueous and ethanolic extracts of leaf 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 [32]. In in vitro study supports in traditional application as a preventive remedy for the treatment of microbial disease. Hazara et al. [33] were isolated two antibacterial compounds from the seeds of M. elengi. The compounds were extracted by ethyl acetate and
purified by silica gel into two compounds HE-a and HE-b. After spectral analysis HEa was identified as 2,3-dihydro-3,3',4',5,7-pentahydroxyflavones (C₁₅H₁₀O₇) and HEb was 3,3',4',5,7-penta-hydroxyflavone (C₁₅H₁₂O₇). These compounds showed strong microbial activity [33].

Satish et al. [34] noted that the aqueous and different solvent extracts viz. petroleum ether, benzene, chloroform, methanol and ethanol isolated constituents of *M. elengi* leaves was tested *in vitro* for antifungal activity by poisoned food technique against certain phytopathogenic fungi *Alternaria alternata*, two species of *Drechstera*, eight species of *Aspergillus* and three species of *Penicillium*, which are frequently associated with sorghum (*Sorghum bicolour*), maize (*Zea mays*) and paddy (*Oriza sativa*) seeds. Aqueous, methanol and ethanol extracts recorded highly significant associated antifungal activity against all tested fungi. Methanol extract was subsequently fractioned and monitored by antifungal activity guided assay leading to the isolation of an active fraction and was reported as alkaloids by phytochemical analysis [34]. The antifungal activity of alkaloid fraction from *M. elengi* leaves was highly significant with compared to synthetic fungicides. Ali et al. [35] reported that *in vivo* antifungal activity of organic solvents viz petroleum ether, ethyl acetate and methanol extracts of bark, fruits and leaves of *M. elengi* against six fungi such as *Penicillium* species, *Aspergillus niger*, *A. flavus*, *Trichoderma viridae*, *Candida albicans*, *Helminthosporium sativa*. The ethyl acetate extract showed maximum antifungal activity against *Penicillium* species, whereas *M. elengi* fruit extract showed weak activity against most of the fungi [35]. All organic solvent extracts were found to be inactive against *Trichoderma viridae*, however leaf extract screened out good activity against *T. viridae*. Kumar et al [36] observed that the aqueous extracts of leaf and bark of *M. elengi* on radial growth and sclerotic development (number and size) of *Sclerotinia sclerotiorum* in *in vitro*. The medium is Potato Dextrose Agar (PDA). The aqueous leaf and bark extracts of *M. elengi* significantly inhibited radial growth, number and size of sclerotic developments of *S. sclerotiorum* [36]. The effect of unsterilized aqueous bark extract of *M. elengi* showed significantly higher (p<0.05) inhibition of radial growth and number and size of sclerotia compared to the sterilized and unsterilized aqueous leaf extract. The unsterilized aqueous bark extract at 30% concentration showed highest sensitivity reducing radial growth by 56.54%, sclerotia number by 65.15% and sclerotic size by 68.90-73.11%. [36]. Bark extract of *M. elengi* showed moderate inhibitory activity against HIV type-1 protease [37, 38] and non-significant activity against *Herpes simplex* virus type-1 [39]. The seed/bark of *M. elengi* and their active compound mimusopic acid exhibited anti HIV reverse transcriptase activity [40].

Free radicals are chemical species that cause oxidation and ultimately causing various diseases in the body. In many chronic diseases oxidative stress due to production of reactive oxygen (ROS) and nitrogen species (RNS) by aerobic animals. There are a number of damaging oxidants that we are exposed to daily. Some common are hydroxyl (OH), superoxide (O₂⁻), hydrogen peroxide (H₂O₂), ozone (O₃), Nitric oxide (NO) and peroxynitrite (ONOO⁻). Formation of free radicals sites are mitochondria, plasma membrane, Endoplasmic reticulum etc. About 1% of O₂ that we inhale ROS throughout year, we produce 1.75 Kg ROS through oxidation phosphorylation [41]. Plant product antioxidant mainly phenolic and flavonoids are safe and much attention for the last two decades. During these years several research papers have been published in the plant origin antioxidant activity. Phenolic extract of *M. elengi* fruit at different ripening stage were analyzed for their anti-oxidant capacities and total phenolic contents [42]. The chloroform extract of bark was assessed by using DPPH (2,2-diphenyl-1-pierylhydrazyl) radical, nitric oxide, ABTS radical (2,2-azinobis(3-ethylbenzothiazoline-sulphonic acid) and hydroxyl radical, respectively. The result clearly indicates that *M. elengi* bark has a significant potential to act as a natural antioxidant [43]. Crude methanolic extract of leaf has significant antioxidant activity in DPPH free radical scavenging and Nitric oxide scavenging test [22]. Protective effect of leaf extract on lipid peroxidation and activities of both enzymatic and non-enzymatic antioxidants in plasma and tissues were studied. It showed
promising antioxidant properties by significant quenching impact on the extent of lipid peroxidation, along with enhancement of antioxidant defense system in pancreas tissues [44]. Different organic solvent extract such as petroleum ether, chloroform, and alcohol extracts of bark were evaluated for in vivo antioxidant activity, which includes lipid peroxidation (MDA), glutathione (GSH), superoxide dismutase (SOD) and catalase (CAT). Result obtained significantly decreased in lipid peroxidation and increased in GSH, SOD and CAT. The alcohol extract shows more potent antioxidant activity than petroleum ether and chloroform extract [45]. In in vitro antioxidant activity of methanolic extract of M. elengi bark was evaluated using reducing power assay, DPPH and hydroxyl radical scavenging assay. It has reducing power capacity and radical scavenging activity [46]. The phenolic compounds extracted from immature green, mature green and orange ripe fruits of M. elengi were investigated for antioxidant activity. The compounds were first removed as crude extracts from the fruits using methanol-acetone and then further separated into three different fractions designated as free phenolic acids (F1), soluble phenolic esters (F2) and insoluble phenolic acid esters (F3) [47]. A result shows the antioxidant activity of the crude extract from immature fruit was higher than that of either the mature or the ripe fruit of M. elengi [46, 48, 49].

Katedeshmukh et al. [50] observed that the different organic extract such as ethyl acetate, ethanol and aqueous of M. elengi showed diuretic activity. The diuretic activity was carried out in rodents by measuring the urine volume at 1, 2, 4, 6 and 24 hours. Mimusops elengi extracts were administered orally at the dose of 250 mg/kg. Among all treatments (organic and aqueous) aqueous extracts showed a significant diuretic activity [50]. The diuretic and electrolyte excretion activity in alcoholic extract were noted. After treatments of extracts and standards was urine collected and volume was recorded at 5 hours. The maximum diuretic activity was found in alcoholic extracts [51]. Hot aqueous extracts of flowers at intravenous dose of 1.0 ml/kg to dogs showed diuretic activity [1]. The methanolic extract and its fractions were used for the bioassay by using adult Indian earthworms Pheretima posthuma. The results indicated that the methanolic extract and ethyl acetate fraction of leaves exhibited significant anthelmintic activity with respect to standard and control. Albendazole was taken as standard reference and distilled water as control [52]. Ethanolic and aqueous extracts of bark of M. elengi showed the anthelmintic activity against adult earthworm Eisenia fetida (redwarm) [5, 53]. Dharmija et al. [54] noted the ethanolic and aqueous extract of M. elengi prepared by hot and cold extraction, respectively. Effect of plant extract on Eisenia fetida noted down the paralysis time (Vermifuse) and death time (Vermicidal). It was found that both ethanolic and aqueous extract of bark of M. elengi have significant anthelmintic action against Eisenia fetida at the dose of 4 mg/ml, which may be due to presence of secondary metabolites of plants such as glycoside, tannins, saponins in the extract [53, 54].

Prakash et al. [55] was noted the effect of bark extracts of M. elengi in serotonin induced ulceration (20 mg/kg) in albino rat. The ulcerogenic effects of 5-hydroxytriptamine (5-HT) and its precursor (5HTP) 5-hydroxytryptophan have been reported [55]. High dose causes erosions and ulcers. The alcoholic extract (200 mg/kg) and petroleum ether (200 mg/kg) of bark of M. elengi have significant antiulcer activity in albino rat. The alcoholic extract has significant antiulcer activity compare to petroleum ether extracts of bark [56]. The alcoholic extract of bark M. elengi and its different fractions namely ethyl acetate, N-butanol and methanol against different ulcer models, and it was concluded that ethyl acetate fraction possesses antiulcer activity against experimental gastric ulcers [57]. Traditional use of higher plants with anti-inflammatory, analgesic and antipyretic is a common feature of indigenous cultural system worldwide. Karmakar et al. [58] observed methanolic extract of M. elengi leaf for analgesic activity using acetic acid induced writhing of albino mice and hot plate test. In this experiment the hot plate test exerted significant prolongation in the response of latency time against heat stimulus [58]. The Ethanolic extract of bark of M. elengi has anti-inflammatory, analgesic and antipyretic activities in animals [15]. The antipyretic and analgesic activities of M. elengi leaves were
noted in yeast induced pyrexia in rat after oral administered 100 mg/kg and 200 mg/kg. The extract was found to be dose dependent antipyretic activity. Antipyretic trigger the hypothalamus and in ethnobotany plant origin antipyretic properties are commonly refer to febrifuges [15]. The isolated fraction β-amyrin caprylate and ethanol extract of bark of M. elengi exhibited significant antiinflammatory activity by using carrageenan induced paw edema and cotton pellets. The effect was compared with indomethacin used as standard drug. The results indicated that ethanol extract of M. elengi bark and β-amyrincaprylate caused antiinflammatory activity [6]. The organic solvent extract such as petroleum ether, chloroform and alcohol extract of bark were evaluated for antiurolithiatic activity in male albino wistar rats. Oxalate, calcium, and phosphate were monitored in the urine and kidney. The alcohol extract bark significantly lowers the elevated levels of the oxalate, calcium, phosphate in urine and kidney as compared to petroleum ether and chloroform extract [45]. The methanolic bark extract of M. elengi was screened for cytotoxic activity by brine shrimp lethality bioassay. The extract exhibited good cytotoxic activity with LC50 value of 40 μg/ml whereas LC50 of vincristine sulphate was 0.078 μg/ml [59]. The methanolic extract of leaf was investigated for cytotoxic activity which was done by brine shrimp and lethality bioassay as an indicator of toxicity. The study clearly indicates that the methanolic extract possess cytotoxic substances [59]. Cytotoxic activity of the 95% ethanol extracts of flower against the cancerous cell lines compared with normal cell line were assessed using MTT assay 3-(4,5- dimethylthiazol-2-yl) -2,5-diphenyltetrazo- lium bromide. It exhibited promising activity against the cholangiocarcinoma CL-6 cell line with cell survival of less than 50% at the concentration of 50 μg/ml [60]. M. elengi leaves exhibited antitumor activity in Swiss mice, which may be due to its cytotoxic effect and antioxidant properties [61].

Jerline et al. [62] reported that the aqueous bark extract of M. elengi were evaluated for antidiabetic activity using alloxan induced hypoglycemic rats. Blood glucose, serum insulin, glycosylated haemoglobin and liver glycogen, glucokinase, glucose-6-phosphatase and glucose-6-phosphate dehydrogenase after 45 days of the treatment were analyzed. The bark extract produced significant alteration in biochemical and enzymatic parameters studied. The polar and nonpolar solvent extracts leaves were screened for antidiabetic activity using alloxan induced hypoglycemic rats on acute and prolonged treatment. Alcoholic and aqueous extracts showed significant antidiabetic results with both acute and prolonged treatment studies [63]. Methanolic extract of M. elengi significantly decreased serum glucose level in hyperglycemic animals [49]. The plant extract that are used for antidiabetic activity may contain one or more compound to decrease blood sugar level suggesting that the natural constituents could act separately or synergistically to produce hypoglycemic effect [64]. Traditional antidiabetic plants and plant extract which are being used for the treatment of diabetes are considered as a source for new oral hypoglycemic compounds that are not only effective in the management of diabetes but also having minimal or less side effects [65]. Aqueous alcoholic and ethanolic extracts of leaves of M. elengi showed antidiabetic activity on alloxan induced diabetic rats [65, 66]. Aqueous and methyl alcohol extract of the plant also decreased blood glucose levels in normal and alloxan diabetic rabbits [54]. The antihyperglycemic effect of methanolic extract of stem bark were evaluated by oral glucose tolerance test in diabetic and non-diabetic mice and the extract of barks of produced significant reduction in elevated glucose levels in glucose loaded non diabetic animals and also show reduction in elevated glucose levels [46]. The ethanolic extract of M. elengi leaf was used for its antihyperglycemic effects in Wister albino rats. Diabetes was induced in albino rats by administration of single doses of streptozotocin (STZ) 40mg/kg body weight [65]. The ethanolic extract M. elengi at optimum dose concentration of 100 mg/kg body weight was administered as a single dose/day to diabetes induced rats for a period of 30 days. The effect of leaf extract on blood glucose, insulin (in plasma), hemoglobin, glycosylated haemoglobin (HbA1c) and carbohydrate metabolic enzymes such as glucokinase, glucose-6-phosphate dehydrogenase and glycogen
content in liver and kidney, and gluconeogenic enzymes such as glucose-6-phosphatase, fructose 2,6 bis-phosphatase levels has also been studied. Leaf extract elicit significant (p<0.05) reduction of blood levels and lipid profile levels in liver and kidney of diabetic rats except HDL, and carbohydrate metabolic enzyme significantly (p<0.05) increased [66].

Gami et al. [1] noted the methanolic extract of M. elengi show the hypotensive activities on anaesthetized rats. On intravenous administration 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, however, including nifedipine (0.9 mg/kg) and verapamil (3.9 mg/kg), caused corresponding reductions of 81% and 64% in extract induced hypotension [19, 67]. The methanolic extract of M. elengi of bark showed wound healing activity 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 [68]. The traditional Indian medicine Ayurveda, describes various herbs, fats, oils and minerals with antiaging as well as wound healing properties. In Ayurveda, M. elengi has been reported to be used for arresting bleeding of gums and preparation of a lotion for sores and wounds. Pimpare et al. [69] studied M. elengi bark along with Yashad Bhasma for treatment of wound. Methanolic extract of bark of M. elengi has immunostimulatory activity in mice studied by carbon clearance test. Haemagglutination antibody titer and delayed type hypersensitivity using sheep red blood cells as antigen distilled water served as a control in all the tests and vitamin E 150 mg/kg was used as standard. The M. elengi extract showed a dose dependent increase immunostimulatory response [19].

Singh et al. [23, 72] reported that M. elengi leaf, bark and seed are potential source of botanical molluscicide against the fresh water snail Lymnaea acuminata and Indoplanorbis exustus. These snails are the intermediate host of liver fluke Fasciola hepatica and Fasciola gigantica, which causes 94% fasciolosis in the cattle population of northern part of India [70, 71]. The active molluscicidal component in M. elengi soluble in chloroform, acetone, ether and ethanol. Among all the organic solvent ethanol is more potent molluscicide. Usually toxicity of M. elengi bark powder against Lymnaea acuminata and Indoplanorbis exustus is higher than leaf and seed powder [23, 72]. Singh et al. [23] characterized that saponin are the main molluscicidal components of M. elengi. The toxicity of saponin was found to be higher than column and other organic extracts at 96h exposure period. LC50 of 96h exposure period of column purified fraction of M. elengi bark (7.20 mg/l) against L. acuminata is lower than the LC50 (96h) values of synthetic molluscicides and other plant molluscicides carbaryl (14.40 mg/l), phorate (15.0 mg/l), formothion (8.56 mg/l), and aldicarb (11.50 mg/l) [73]. The 96h LC50 of crude powder of common spices, Allium sativum bulb (271.06 mg/l), Zingiber officinale thizome (273.80 mg/l), Trachyspermum ammi (97.59 mg/l), Allium cepa bulb (253.27 mg/l), Cinnamomum tamala leaf (830.90 mg/l), Ferva asafoetida dried latex powder (82.71 mg/l) and Syzygium aromaticum flower bud (51.98 mg/l) [74-77], respectively. Recently, Singh et al. [78] noted that toxicity of binary combination of Mimusops elengi with other plant molluscicides Saraca asoca and Thuja orientalis was more toxic against fresh water snail Indoplanorbis exustus. Among all combinations of toxicity, Mimusops elengi leaf + Saraca asoca bark (24h LC50 = 208.49 mg/l and 96h LC50 = 103.16 mg/l) was more potent than other combinations of plant molluscicides. Ruikar et al. [79] studied the efficacy of M. elengi bark extracts against Aedes aegypti (L) and Culex quinqu fasciatus (Say) (Diptera: Culicidae). Early IV instar larvae were used for the experiments. The organic solvent of hexane and ethyl acetate of bark of M. elengi has time dependent larvicidal activity. The result suggests that the larvicidal activity may be the lignin compound cubebin [79]. Saponin fractions of M. elengi have been reported to have spermicidal activity at a dilution of 0.06% in human semen [1].
3. CONCLUSIONS

Information from extensive literature suggests that *M. elengi* has a broad spectrum of pharmacological effects. As the pharmacologists are looking forward to develop new drugs from natural sources, development of modern drugs from *M. elengi* can be emphasized for the control of various diseases. *M. elengi* plant extracts are very effective against various animal and plant bacteria, fungi and harmful viruses, harmful insects and vectors/pest. Antimicrobial, antiviral, antioxidant and hepatoprotective and cytotoxic activities of *M. elengi* are well accepted because of the wealth of scientific literature supporting these effects. Instead of several tests on rats, *M. elengi* is not yet widely used against man. More research should be undertaken to determine its efficacy against several diseases on human with respect to other natural products and modern drugs. Therefore, *M. elengi* has more attention by scientific community and public health specialists to explore its full range of benefits in the welfare of the society. Almost all parts of this plant such as leaf, fruit, seed, bark and flowers are used to cure a variety of diseases. It elicits on different aspects of plant origin and attention to the researchers to carry out the work for developing the new formulations which can ultimately boon for the human being.

AUTHORS’ CONTRIBUTION

All authors are involved in conception and design, drafting the review article, read and approved the final manuscript.

TRANSPARENCY DECLARATION

The authors declare no conflicts of interest.

REFERENCES


77. Kumar P, Singh DK. Molluscicidal activity of *Ferula asafoetida*, *Syzygium aromaticum* and *Carum carvi* and their active components against the snail *Lymnaea acuminata*. Chemosphere, 2006; 63: 1568-1574. [http://dx.doi.org/10.1016/j.chemosphere.2005.08.071](http://dx.doi.org/10.1016/j.chemosphere.2005.08.071)


