



International Journal of Herbal Medicine

Available online at www.florajournal.com

I
J
H
M

International
Journal
of
Herbal
Medicine

E-ISSN: 2321-2187
P-ISSN: 2394-0514
IJHM 2015; 2 (6): 24-30
Received: 15-12-2014
Accepted: 26-01-2015

Mariyam Roqaiya
Dept. of Ilmul Qabalat wa
Amraze Niswan National
Institute of Unani Medicine,
Bangalore, Karnataka (India)

Wajeeha Begum
Dept. of Ilmul Qabalat wa
Amraze Niswan National
Institute of Unani Medicine,
Bangalore, Karnataka (India)

Danish Jahan
Dept. of Ilmul Qabalat wa
Amraze Niswan National
Institute of Unani Medicine,
Bangalore, Karnataka (India)

A review on pharmacological property of *Mimusops elengi* Linn.

Mariyam Roqaiya, Wajeeha Begum, Danish Jahan

Abstract

Mimusops elengi is a potent medicinal plant with several therapeutic uses mentioned in traditional medicine. The various extracts of the plant (bark, fruit, leaves, seed, and flowers) have been reported to be cardiotonic, alexipharmac and stomachic, hypotensive, antibacterial, anthelmintic, anti-gastric ulcers, teeth cleaner and renewable sources of energy. The aim of this review was to compile the information about pharmacological properties of *Mimusops elengi*. Literature was searched on computerized databases as well as medicinal plants texts. This review shows that *Mimusops elengi* has various pharmacological properties proved by experimental studies. More studies are needed before the pharmacological properties of *Mimusops elengi* can be utilized in therapy.

Keywords: *Mimusops elengi*, pharmacological, antibacterial, antifungal

1. Introduction

The practices of traditional medicine are based on hundreds of years of belief and observations and analysis, which help in the development of modern medicine. Today, there is widespread interest in herbal drugs [1]. Plants have been used in a number of systems of medicines in our country as well as in other countries. India is well known as the 'Emporium of Medicinal Plants' [2].

Mimusops elengi Linn (family Sapotaceae) commonly known as Bakul and is found all over the different parts of India, Pakistan, Bangladesh. The tree is of great significance to the Hindus and the dried twigs of the tree are used for various yajnas and religious rituals. Reports suggest that in the ancient Indian civilization, the fruits were a staple diet of the sages, hermits and people [3]. It has a long history of being used in Indian traditional medicine [4]. The bark is used as a gargle for odontopathy, ulitis and ulemorrhagia [5]. The bark and fruit of this plant are used in the treatment of diarrhea and dysentery. The pounded seeds pasted with oil are used for the treatment of obstinate constipation. Pillow stuffing made from the dried flowers induces nasal discharge and relieves headache [6]. Fruits are used as astringent, coolant and anthelmintic. The tender stems are used as tooth brushes, and in cystorrhea, diarrhea and dysentery [5]. Flowers are brain tonic and are useful as snuff to relieve cephalalgia [7]. Several triterpenoids, steroids, steroidol glycosides, flavonoids, and alkaloids have been reported from this species [6]. The various extracts of the plant (bark, fruit, leaves, seed, and flowers) have been reported to be cardiotonic, alexipharmac and stomachic, hypotensive, antibacterial, anthelmintic, anti-gastric ulcers, teeth cleaner and renewable sources of energy [8]. The aim of this review is to compile the information about pharmacological properties of *Mimusops elengi* so that researchers will get in detail about pharmacological properties for their further research.

2. Material and Methods

Literature was searched on databases such as Google Scholar, Medline, Pubmed, and Science direct with keywords; bakul, mulsari, pharmacological activity, scientific reports and traditional medicine. Medicinal plants texts were also reviewed like Pharmacographia Indica, Wealth of India, Medicinal properties of Plants, Indian Materia medica, Indian Plants and Drugs, A Handbook of Medicinal plants, Agro's Dictionary of Medicinal Plants and Medicinal Plants of India.

Correspondence:
Mariyam Roqaiya
Dept. of Ilmul Qabalat wa Amraze
Niswan National Institute of Unani
Medicine, Bangalore, Karnataka
(India)

3. Results: The medicinal plants texts showed different pharmacological actions of *Mimusops elengi* such as cooling, anthelmintic [9, 10], febrifuge [9, 10, 11], astringent, tonic [10, 11, 12, 13, 14, 15], antipyretic [12].

Experimental studies

Several studies have been reported on anti-bacterial, antifungal, anti-HIV, anthelmintic, larvicidal, molluscicidal, antipyretic, analgesic, anti-inflammatory, diuretic, anti-convulsant, spasmolytic, antioxidant, cytotoxic, antityrosinase, hepatoprotective, hypotensive, antihyperlipidemic, cognitive enhancing, hypoglycemic, antifertility, anti-ulcer, wound healing activity, antiulithiatic, anti-atherosclerotic and anti-anxiety property.

Anti-bacterial activity

Different solvent extracts of the leaves of *Mimusops elengi* were prepared and screened for their antibacterial activity against six different bacterial strains including both gram negative strains such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus vulgaris* and gram positive strains such as *Streptococcus pneumoniae*, *Staphylococcus aureus* and *Staphylococcus epidermidis*. All the tested extracts exhibited significant antibacterial activity in a dose dependent manner. Among the various extracts of *Mimusops elengi* leaves, methanol extract exhibited high inhibitory zone followed by ethanol, chloroform and petroleum ether [1]. The acetone extract of bark of *Mimusops elengi* was screened for antimicrobial activity against salivary micro flora. The results were compared with chlorhexidine, a known chemical antimicrobial agent. The results confirmed the antimicrobial potential of the plant and indicated that the acetone extract can be used in the treatment of infectious diseases caused by salivary micro flora [16]. The ethanolic extracts prepared from bark of *Mimusops elengi* were tested against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. The result showed antimicrobial activity against all the three isolates [17]. In another study, different solvent extracts of bark, fruits (fleshy portion) and leaves of *Mimusops elengi* were screened for their antibacterial activity against some pathogenic bacteria and. The activities of the extracts were not significantly enough against most of the tested organisms. Fruit extracts were less potent against most of the tested organisms compared to those obtained from bark and leaves [5]. The aqueous and ethanol extract of ten medicinal plants including leaf of *Mimusops elengi* were tested against *P. aeruginosa*, *P. mirabilis*, *S. aureus*, *B. cereus*, *A. faecalis* and *S. typhimurium*. The ethanol extracts were found to be more potent than aqueous extracts of all the medicinal plants [18]. The hexane, ethyl acetate, ethanol and methanol extracts of four plants including *Mimusops elengi* were tested against the dental caries causing bacteria *Streptococcus mutans* from caries infected patients. All the four extracts showed antibacterial activity against *S. mutans* [19]. Petroleum ether, dichloromethane, ethyl acetate and ethanol extracts of seeds of *M. elengi* were tested for antibacterial efficacy against *Escherichia coli*, *Bacillus subtilis* and *Salmonella typhi*. The compounds showed strong inhibitory activity against Gram positive and Gram negative bacteria [20]. *In vitro* evaluation of antibacterial activity of aqueous and solvent extract of *Mimusops elengi* was investigated against five pathogenic bacteria viz., *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Vibrio cholerae* and *Streptococcus pneumoniae*. Among the five pathogen tested, *Streptococcus pneumoniae* and *E. coli* showed a maximum inhibition compared to standard antibiotics Gentamicin, Tetracycline and Streptomycin. In solvent extract methanol and ethanol recorded a maximum inhibition against *Streptococcus pneumoniae* and *E. coli* [21]. To check the antimicrobial activity

of *Azadirachta indica*, *Ocimum sanctum*, *Mimusops elengi*, *Tinospora cordifolia* and Chlorhexidine Gluconate on common endodontic pathogens like *Streptococcus mutans*, *Enterococcus faecalis* and *Staphylococcus aureus*. All the plants extracts showed considerable antimicrobial activity against selected endodontic pathogens. *O. sanctum* was the most effective against *S. mutans*, *M. elengi* showed highest zone of inhibition against *E. faecalis*, whereas Chlorhexidine Gluconate was the most effective agent against *S. aureus* [22].

Antifungal activity

The saponins present in the seeds of the plant demonstrated antifungal activity against some human pathogen [23]. The aqueous and different solvent extracts viz., petroleum ether, benzene, chloroform, methanol and ethanol extracts and isolated constituents of *Mimusops elengi* was screened *in vitro* for antifungal activity. The test organisms included *Alternaria alternata*, two species of *Drechslera*, eight species of *Fusarium*, ten species of *Aspergillus* and three species of *Penicillium*. Aqueous, methanol and ethanol extract recorded highly significant antifungal activity against all the tested fungi [24]. Aqueous extract of fifty-two plants from different families including *Mimusops elengi* were tested for their antifungal potential against eight important species of *Aspergillus* such as *A. candidus*, *A. columnaris*, *A. flavipes*, *A. flavus*, *A. fumigatus*, *A. niger*, *A. ochraceus*, and *A. tamarii* which isolated from sorghum, maize and paddy seed samples. Among fifty-two plants tested, aqueous extract of *Acacia nilotica*, *Achras zapota*, *Datura stramonium*, *Embllica officinalis*, *Eucalyptus globules*, *Lawsonia inermis*, *Mimusops elengi*, *Peltophorum pterocarpum*, *Polyalthia longifolia*, *Prosopis juliflora*, *Punica granatum* and *Syzygium cumini* have recorded significant antifungal activity against one or the other *Aspergillus* species tested [25]. Different solvent extracts of bark, fruits (fleshy portion) and leaves of *Mimusops elengi* were screened for their antifungal activity against some fungi. The bark extracts were found to be active against most of the tested fungal strains. The fungus such as *Aspergillus flavus* was resistant against all the crude extracts. Ethyl acetate extract did not show any inhibitory effect against *Helminthosporium sativum*. The inhibition diameters displayed by the bark extracts against the fungi *Penecillium* sp. and *Aspergillus niger* were more than two-thirds of the standard Fluconazole. All the extracts obtained from *Mimusops elengi* fruits displayed weak activity against most of the fungi [5]. The hexane, ethyl acetate, ethanol and methanol extracts of four plants including *Mimusops elengi* were tested against the dental caries causing fungus *Candida albicans* isolated from caries infected patients. Result revealed that all the *M. elengi* crude extracts was devoid of any activity against the isolated fungal pathogen [19]. Another study was done to investigate the effect of aqueous extract of leaf and bark extracts of *Mimusops elengi* on the radial growth and sclerotial development of *Sclerotinia sclerotiorum* (Lib.) De Bary, a Polyphagous fungus *in vitro*. The fungitoxic effect of unsterilized aqueous bark extract showed significantly higher inhibition of radial growth and number and size of sclerotia compared to the sterilized and unsterilized aqueous leaf extract [4].

Anti-HIV activity

The triterpene minusopic acid, isolated from seeds of the plant was found to exhibit anti-HIV reverse transcriptase activity [23]. The crude aqueous and methanol extracts of *M. elengi*

inhibited HIV type 1 protease (PR) by more than 70% at a concentration of 0.2 mg/ml [26].

Anthelmintic activity

Anthelmintic activity of successive extracts (petroleum ether chloroform, acetone and ethanol) of *Mimusops elengi* bark were evaluated separately on adult Indian earthworm (*Pheretima posthuma*) and compared with that of albendazole. It was found that the extracts exhibited respectively dose-dependent action and inhibition of spontaneous motility (paralysis) and death of earthworms. The results indicated that the alcoholic and chloroform extracts were more potent [27]. The methanolic bark extract of *Mimusops elengi* was screened for *in vitro* anthelmintic activity against earthworms (*Pheretima posthuma*). The extract showed anthelmintic activity at all the concentrations of 25 mg/ml, 50 mg/ml and 100 mg/ml. But the potent anthelmintic activity was observed at the concentration of 100 mg/ml. At this concentration, the time required for paralysis and death of earthworms was about 22 and 34 minutes respectively whereas time taken for paralysis and death by the standard drug Pyrantel pamoate at 10 mg/ml was about 26 and 38 minutes respectively [28].

Molluscicidal activity

The molluscicidal activity of *Bauhinia variegata* leaf and *Mimusops elengi* bark was studied against vector snail *Lymnaea acuminata*. The toxicity of both plants was time and concentration-dependent. Among organic extracts, ethanol extracts of both plants were more toxic. Toxicity of *B. variegata* leaf ethanolic extract (96h LC₅₀- 14.4 mg/L) was more pronounced than *M. elengi* bark ethanolic extract (96 h LC₅₀-15.0 mg/L) [29].

Larvicidal activity

Ethyl acetate extract (EA) its four fractions, i.e. 100% hexane (EA1), hexane: ethyl acetate (9:1, EA2), hexane: ethyl acetate (8:2, EA3) and Cubebin which was isolated from the crude mass (HEX) of bark of *Mimusops elengi* were evaluated for its larvicidal activity against *Aedes aegypti* and *Culex quinquefasciatus*. Potency of these extracts can be graded as cubebin>hexane> EA1> EA2> EA3>EA. *Aedes aegypti* larvae were found to be more susceptible than *Cx. quinquefasciatus* since LC₅₀ values of all the samples tested were lower [30].

Analgesic and Antipyretic activity

Crude methanolic extract of *Mimusops elengi* leaf was investigated for possible analgesic activity. The analgesic activity of the sample was studied using acetic acid induced writhing of white albino mice and hot plate test. The extract produced 45.61% and 63.85% (P<0.001) writhing inhibition at the doses of 250 mg/kg and 500 mg/kg body weight respectively which is comparable to the standard drug diclofenac sodium was found to be 76.69% at a dose of 25 mg/kg body weight. In hot plate test the extract exerted significant (P<0.001) prolongation in the response of latency time to the heat stimulus [31]. Another study was done to investigate the antipyretic and analgesic activity of methanolic extract of leaves of *Mimusops elengi*. Antipyretic and analgesic activity was carried out on yeast induced pyrexia in rats and tail immersion model 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 and

significant effect was observed at 200 mg/kg dose [32].

Anti-inflammatory activity

Methanolic and Aqueous extracts of Leaves of *Mimusops elengi* was evaluated for their *In-vitro* and *In-vivo* antiinflammatory activity. *In-vitro* anti-inflammatory activity was evaluated by using membrane stabilization assay, proteinase inhibitory activity and immunomodulatory activity using macrophages. Methanolic and Aqueous extracts of *Mimusops elengi* leaves showed significant results in *In-vitro* and *In-vivo* anti-inflammatory models. The results of *In-vitro* and *In-vivo* models showed that *Mimusops elengi* has potential anti-inflammatory activity and acts through multiple mechanisms [3]. Another study was done to assess *in vitro* anti-inflammatory activity of the alcoholic extract of *Mimusops elengi* leaves. Inhibition of protein denaturation and human red blood cell membrane stabilization method was evaluated for anti-inflammatory activity. The maximum membrane stabilization of *Mimusops elengi* was found at (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 anti-inflammatory activity [33].

Anti-oxidant activity

Crude methanolic extract of *Mimusops elengi* leaf was investigated for possible antioxidant activity. The extract exhibited statistically significant antioxidant activity in DPPH free radical scavenging and nitric oxide scavenging test [31]. The various parts (bark, fruit, flower and leaves) of *Mimusops elengi* were studied for their antioxidant potential in various solvents. The antioxidant potential of the herb was investigated by 2, 2-diphenyl 1picryl hydrazyl radical (DPPH) scavenging and ferric reducing power assay. The methanolic extract of flowers (96.57%) and fruits (97.15%) possessed the highest and almost similar inhibition of DPPH radical when compared to other parts studied. The ferric reducing ability of methanolic extract of *M. elengi* leaves was maximum when compared to all other parts [34]. Petroleum ether, chloroform and alcohol extracts of *Mimusops elengi* bark were evaluated for antioxidant activity in male albino Wistar rats. *In vivo* antioxidant parameters such as lipid peroxidation, glutathione, superoxide dismutase and catalase were monitored. Alcoholic extract of *M. elengi* produced significant decrease in peroxidation and increase in glutathione, superoxide dismutase and catalase [35]. Another study was to assess the *in vitro* potential of chloroform extract of *Mimusops elengi* bark. The IC values of chloroform extract in 50 DPPH radical, nitric oxide, ABTS radical and hydroxyl radical were obtained to be 2.43 µg/ml, 152.76 µg/ml, 14.12 µg/ml and 6.31 µg/ml respectively. However, the IC values for the standard ascorbic acid were noted to be 0.66 µg/ml, 200 µg/ml, 0.7 µg/ml and 1 µg/ml 50 respectively. This study clearly indicates that *M. elengi* has a significant potential to use as a natural anti-oxidant agent [6]. The methanol and acetone: water extract of *Mimusops elengi* bark and seed were evaluated for antioxidant activity. Antioxidant activity of the extracts and partitioned fractions of bark was evaluated in terms of radical scavenging potential (DPPH), inhibition of lipid peroxidation and total antioxidant activity. The stem bark extract partitioned with ethyl acetate exhibited highest amount of total phenols (98.0 mg GAE/g dry weight), among all other extracts, with 92.0% DPPH radical scavenging activity at concentration of 0.5 mg/ml, while methanol extract (stem bark) had maximum inhibition of lipid peroxidation (62.0%) and total antioxidant

activity (771.0 mg/g GAE/g) [36]. The antioxidant capacities of the phenolic compounds extracted from immature green, mature green and orange 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 of the crude extract from immature fruit (GAE = 318.5 ± 12.3 mg/g extract) was higher than that of either the mature (GAE = 234.1 ± 9.2 mg/g extract) or the ripe fruit (GAE = 111.9 ± 4.9 mg/g extract) [37]. Crude methanolic extract of *Mimusops elengi* leaf was investigated for possible antioxidant activity. The extract exhibited statistically significant antioxidant activity in DPPH free radical scavenging and Nitric oxide scavenging test [31].

Antityrosinase activity

The various parts (bark, fruit, flower and leaves) of *Mimusops elengi* were studied for their antityrosinase activity in various solvents. Among the parts studied, the methanolic extract of *M. elengi* flowers showed the highest inhibition of tyrosinase with an IC₅₀ value of 401 µg which was followed by methanolic extract of leaves [34].

Cytotoxic activity

The cytotoxic effects of ethanolic extract of bark of *M. elengi* were investigated on meristematic 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. The results of the 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 [38]. Crude methanolic extract of *Mimusops elengi* leaf was investigated for possible cytotoxic activity. The cytotoxic activity of the extract was assessed by brine shrimp lethality bioassay as an indicator of toxicity in which LC₅₀ = 80 µg/ml and LC₉₀ = 320 µg/ml for sample. *Mimusops elengi* leaf extract showed cytotoxic activity. LC₅₀ = 80 µg/ml and LC₉₀ = 320 µg/ml which is comparable to chloramphenicol LC₅₀ = 40 µg/ml and LC₉₀ = 160 µg/ml [31]. Another study was done to investigate cytotoxic potential of methanolic leaf and bark extracts against human cervical cancer cell line (SiHa) by MTT (3-(4,5-dimethylthiazol-2-yl)-2; 5-diphenyltetrazolium bromide) assay, the apoptotic cells were quantified further by flow cytometry by FACS fluorescence activated cell sorting. The extract of *M. elengi* bark and leaf was effective towards tested cell line, with IC₅₀ values of 35.08 ± 2.92 µg/ml and 67.46 ± 4.21 µg/ml respectively. Further there is an increase in apoptotic bodies from 0.24% to 60% and 69% after treatment with extracts. These extracts exhibit significant cytotoxic effect by inducing apoptosis [39].

Antiurolithiatic activity

Petroleum ether, chloroform and alcohol extracts of *Mimusops elengi* bark were evaluated for antioxidant activity in male albino Wistar rats. Ethylene glycol (0.75%) in drinking water was fed to all the groups except normal control for 28 days to induce urolithiasis for curative and preventive regimen. Oxalate, calcium and phosphate were monitored in the urine and kidney. 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 of *M. elengi* [35].

Antihyperglycemic activity

One study was done to evaluate the effect of aqueous bark extract of *Mimusops elengi* in alloxan induced diabetic rats. Diabetes was induced in rats by administering alloxan monohydrate (150 mg/ kg bw) intraperitoneally. The aqueous bark extract of *Mimusops elengi* at the dose level of 500 mg/kg bw, produced significant alteration in biochemical and enzymatic parameters studied [8]. Methanolic extracts of flower and leaves of *Mimusops elengi* were evaluated for hypoglycemic effect in normoglycaemic and alloxan-induced diabetic rats. Both extracts of *Mimusops elengi* were administered orally (100 mg/kg, body weight) to normal and alloxan-induced diabetic rats. The fasting blood glucose (FBG), oral glucose tolerance test (OGTT) and alloxan-induced diabetic models were performed for the hypoglycemic effects and compared with tolbutamide (100 mg/kg, body weight), a standard drug. Both the extracts (flower and leaves) showed marked decreased (P < 0.01) in blood glucose level in normotensive rats within 2h after oral administration. A significant (P < 0.001) decreased in elevated blood glucose level was observed in glucose loaded animals [40].

Male antifertility activity

One study was done to screen antifertility activity of seeds of *Mimusops elengi*. When the aqueous powdered drug (2gm/body weight) was administered to male albino rats has proved to be an effective male contraceptive drug. The activity was confirmed by significant decrease in sperm count, biochemical assays so also through histopathological investigations [41].

Anti-atherosclerotic activity

One study was done to see the combined effect of *Mimusops elengi* & *Moringa oleifera* in high fat diet induced atheroma in rats. In combined extract treated group there is a significant (p>0.001) decrease in the TC (total cholesterol), LDL (low density lipoprotein), TG(triglycerides) and increase in the HDL (high density lipoprotein) level when compared with the HFD (high fat diet) group in case of individual group less significant decrease in the TC, LDL, TG and increase in the HDL level was seen [42].

Anti-hyperlipidemic activity

Methanolic extracts of flower (MFE) and leaves (MLE) of *Mimusops elengi* were evaluated for hypoglycemic effect in normoglycaemic and alloxan-induced diabetic rats. In diabetic rats, MFE and MLE treatment at a dose of 100 mg/kg, body weight for 7 days significantly (P < 0.01) decreased triglycerides levels compared to the diabetic control group [40].

Spasmolytic activity

The saponins from *M. elengi* seeds had spasmolytic action on guinea pig ileum preparation against acetylcholine, histamine and barium chloride. It was most active against histamine [12].

Anti-anxiety activity

One study was done to evaluate the anti-anxiety activity of methanolic, aqueous and n-butanol extract of bark of *Mimusops elengi* using elevated plus maze in swiss albino mice. Different doses of test extract were evaluated in animals. Methanol extract at 50,100 and 200 mg/kg, aqueous extract at 100 and 200 while n-butanol extract at 200 mg/kg in mice were active but methanolic extract at 200 mg/kg was found to have more significant anxiolytic activity as compared to

aqueous and n-butanol extract [7].

Anticonvulsant activity

The aqueous extract (AE) of fruits of *Mimusops elengi* at a dose of 200 mg/kg b.w and 400 mg/kg b.w by oral route were tested for their anticonvulsant property against Maximum Electric Shock (MES) induced convulsion model in Adult male Wistar rats (200–250 g). A significant ($p < 0.05$) anticonvulsant activity had been observed in the AE (200 mg/kg b.w and 400 mg/kg b.w) when compared with control group [60].

Hepatoprotective activity

Methanolic extract of bark of *Mimusops elengi* was used to evaluate the *In-vivo* hepatoprotective activity in carbon tetrachloride induced hepatotoxicity at different doses in Wistar rats of either sex rats weighing between 130 to 145 gm. The hepatoprotective activity was evaluated biochemically and histopathologically. The results of hepatoprotective activities of crude methanol extracts of *M. elengi* at a dose of 100, 200 and 400 mg/kg on rats intoxicated with carbon tetrachloride were exhibited dose dependent activity in restoring elevated levels of biochemical parameters. Serum SGPT, SGOT and cholesterol levels were normalized by the treatment [$p < 0.05$] but dose of 400 mg/kg showed highest restoration of elevated enzymatic parameters [44].

Diuretic activity

The ethyl acetate, ethanol and water extract of *Mimusops elengi* was evaluated for diuretic activity. This study was carried out in rodents 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. Na^+/K^+ ratio was higher in aqueous extract and followed by ethanol and ethyl acetate extracts. The aqueous extracts showed a significant diuretic activity when compared with other extracts [45].

Cognitive enhancing activity

The alcoholic extracts of *Mimusops elengi* flowers was used for the evaluation of cognitive enhancing activity using elevated plus maza and passive avoidance task method with Mentat as standard by using parameters of step down and transfer latency. Induction was carried out by MES and scopolamine for 7 days. On the 7th day the brain was isolated for evaluation of acetylcholinesterase enzyme activity. The alcoholic extracts (200 mg/kg BW) showed significant effect when compare to control. There was significant in step down latency and decrease in the of transfer latency and also decrease in acetylcholinesterase enzyme activity but was not as effective as that of standard drug [46].

Wound healing activity

Methanolic extract from bark of *M. elengi* was investigated for 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 wound models compared to standard drug betadine ointment in terms of wound contracting ability, wound closure time, tensile strength and dry granuloma weight [47]. The methanolic extract ointment of *Mimusops elengi* effectively stimulated wound contraction; increase tensile strength of incision & dead space wounds as compared to control group [48].

Antiulcer activity

The effect of bark of *Mimusops elengi* was evaluated in serotonin induced ulceration in albino rats. Antiulcer activity was evaluated by measuring ulcer index and percentage of ulcer healing. The alcoholic extract (200 mg/kg) and petroleum ether extract (200 mg/kg) of bark of *Mimusops elengi* showed significant antiulcer activity [49]. The 50% alcoholic extract of *Mimusops elengi* and its different fractions namely ethyl acetate, n-butanol, methanol and aqueous were studied against ethanol-induced gastric damage. Ethyl acetate extract was also studied in ethanol-induced, pylorus-ligated and water-immersion plus stress-induced gastric ulcer models. Ranitidine HCl was used as a reference standard. In ethanol-induced gastric ulcer model, pantoprazole was also used as a reference standard. Alcoholic extract at the doses of 50, 100, 300 and 500 mg/kg and its different fractions showed reduction in gastric ulceration ($P < 0.05$). Ethyl acetate extract at the doses of 10, 50 and 100 mg/kg showed dose-dependent inhibition of gastric lesions against ethanol-induced gastric damage. In 19 h pylorus-ligated animals, Ethyl acetate extract at 50 and 100 mg/kg 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 [50].

Hypotensive effect

The methanolic extract of *Mimusops elengi* caused 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, however, including nifedipine (0.9 mg/kg) and verapamil (3.9 mg/kg), caused corresponding reductions of 81 and 64% in extract-induced hypotension. These data imply *M. elengi* might possess calcium-blocking activity which would explain its hypotensive effect [51].

Immunostimulatory effect

The methanolic extract of bark of *Mimusops elengi* (MEMEL) was used to investigate the immunostimulatory activity in mice. The MEMEL was administered orally at the dose of 10, 20, 40 mg/kg/day body weight in mice. The immunostimulatory activities on specific and non-specific immunity were studied by carbon clearance test (CCT), haemagglutination antibody (HA) and delayed type hypersensitivity, using sheep red blood cells (SRBC) as the antigen. Distilled water served as a control in all the tests and vitamin E 150 mg/kg was used as standard. Oral administration of MEMEL showed a dose-dependent increased immunostimulatory response. Phagocytic index was found to be increased significantly ($P < 0.01$) in CCT. The production of circulatory antibody titre (humoral antibody response) was increased significantly ($P < 0.01$) and delayed type hypersensitivity reaction was found to be augmented less significantly ($P < 0.05$) by increasing the mean footpad thickness at 48 hr in response to SRBC as an antigen [52].

Nutritional value

15 wild edible fruits consumed in deciduous forest zone of India were evaluated for their nutritive value in order to

prioritize edible wild fruits suitable for domestication. The work identified superior/identical nutritional status in terms of carbohydrate, sugar and protein and mineral contents in non cultivated indigenous forest species, i.e., *Eugenia rothii*, *Mimusops elengi*, *Ziziphus oenoplia*, *Ziziphus rugosa*, *Bridelia tomentosa* and *Carissa spinarum* comparable to the cultivated fruits like mango, pomegranate, sapota, grapes, guava, cherry, banana and lemon etc [53].

Clinical trial

One clinical trial was done to evaluate the efficacy and safety of Complete Care Herbal Toothpaste in controlling dental plaque, gingival bleeding and periodontal diseases. Complete Care Herbal Toothpaste Contains Extracts of *Punica granatum*, *Zanthoxylum alatum*, *Acacia Arabica*, *Triphala*, *Embelia ribes*, *Vitex negundo*, *Salvadora persica*, *Acacia farnesiana*, *Acacia catechu*, *Mimusops elengi*, *Trachyspermum ammi* and *Azadirachta indica*. A significant symptomatic relief was seen after treatment for 6 weeks with Complete Care Herbal Toothpaste. No clinically significant adverse reactions were reported or observed, during the entire study period [54].

4. Conclusion

In the present comprehensive review, we referred primary and secondary data to compile the information about the pharmacological properties. This review shows that *Mimusops elengi* has various pharmacological properties proved by experimental studies. Based on the different studies on different parts of *Mimusops elengi*, there is a grim need to isolate and identify new compounds from different parts of the tree and also more studies are needed before the pharmacological properties of *Mimusops elengi* can be utilized in therapy.

5. References

- Padhi M, Mahapatra S. Evaluation of Antibacterial Potential of Leaf extracts of *Mimusops elengi*. Int Res J Biological Sci 2013; 2(7):46-49.
- Padhi M, Mahapatra S, Panda J, Sahoo BM. Phytochemical and pharmacological review of *Mimusops elengi* Linn. American Journal of Pharm Tech Research 2012; 2(6):213-230.
- Khatri DK, Manjulakonka, Juvekar AR. Evaluation of Anti-inflammatory activity of *Mimusops elengi* extracts in Different *In-vitro* and *In-vivo* models. Int J Phar Bio Sci 2014; 5(1):259-268.
- Niranjan K, Singh RK, Adaji MN, Singh RB. Effect of aqueous leaf and bark extracts of *Mimusops elengi* (Linn.) on radial growth and sclerotial formation of Sclerotinia sclerotiorum (Lib.) De Bary, a Polyphagous fungus. PAT 2009; 5(2):288-300.
- Ali MA, Mojid MA, Yeasmin S, Khan AM, Sayeed MA. An Evaluation of Antimicrobial Activities of *Mimusops elengi* Linn. Research Journal of Agriculture and Biological Sciences 2008; 4(6):871-874.
- Rao KS, Manjuluri PR, Keshar NK. *In vitro* Antioxidant Activity and Total Phenolic Content of *Mimusops elengi* Bark. Ind J Pharm Edu Res 2011; 45(1):317-323.
- Ganu G, Garud A, Agarwal V, Suralkar U, Jadhav S, Kshirsagar A. Anti-anxiety activity of *Mimusops elengi* barks extract in experimental animals. RJPBCS 2011; 2(3):405-410.
- Jerline M, Jyothi G, Brindha P. Effect of *Mimusops elengi* Linn. Bark extract on Alloxan induced hyperglycemia in albino rats. Journal of Tissue Research 2009; 9(3):1985-1988.
- Prajapati ND, Purohit SS, Sharma AK, Kumar T. A Handbook of Medicinal Plants. Agrobios, Joudhpur, 2009, 345.
- Prajapati ND, Kumar U. Agro's Dictionary of Medicinal Plants. Agrobios (India), Jodhpur, 2003, 214.
- Nadkarni KM. Indian Plants and Drugs with their Medical properties and Uses. New Srishti Book Distributors, Delhi, 2005, 234.
- Anonymous. Medicinal plants of India. Indian Council of Medical Research, New Delhi, 1987; II:257-259.
- Nadkarni KM, Nadkarni AK. Indian Materia Medica. 3rd revised and enlarged edition. Popular Prakashan Private Limited, Mumbai, 2009; I:800-801.
- Bhattacharjee SK. Handbook of Medicinal Plants. 4thed. Pointer publishers, Jaipur, 2004, 224- 225.
- Dymock W, Warden CJH, Hooper D. Pharmacographia Indica- A History of the principal drugs. Srishti Book Distributors, New Delhi, 2005; II:362-363.
- Deshpande RR, Ruikar A, Panvalkar PS, Kulkarni AA, Khatiwora E, Adasul V et al. Comparative evaluation of different concentration of *Mimusops elengi* (L) extract as an antimicrobial agent against salivary micro flora. J Biomed Sci and Res 2010; 2(3):151-154.
- Rangama BNLD, Abayasekara CL, Panagoda GJ, Senanayake MRDM. Antimicrobial activity of *Tephrosia purpurea* (Linn.) Pers. And *Mimusops elengi* (Linn.) against some clinical bacterial isolates. J Natn Sci Foundation Sri Lanka 2009; 37(2):139-145.
- Nair R, Chanda SV. Antibacterial activities of some medicinal plants of western region of India. Turk J Biol 2007; 31:231-236.
- Jebashree HS, Kingsley SJ, Sathish ES, Devapriya D. Antimicrobial activity of few medicinal plants against clinically isolated Human Cariogenic Pathogens- An *In vitro* Study. ISRN Dentistry 2011; 6.
- Hazra KM, Roy RN, Sen SK, Laskar S. Isolation of antibacterial pentahydroxy flavones from the seeds of *Mimusops elengi* Linn. Afr J Biotechnol 2007; 6(12):1446-1449.
- Lalitha V, Kiran B, Raveesha KA. *In vitro* Evaluation of *Mimusops elengi* L. Plant Extract for Antibacterial activity and Phytochemical analysis. Pharmacophore 2011; 2(1):78-85.
- Mistry KS, Sanghvi Z, Parmar G, Shah S. The antimicrobial activity of *Azadirachta indica*, *Mimusops elengi*, *Tinospora cordifolia*, *Ocimum sanctum* and 2% chlorhexidine gluconate on common endodontic pathogens: An *in vitro* study. Eur J Dent [serial online] 2014; 8(2):172-177.
- Ray AB, Sarma BK, Singh UP. Medicinal Properties of Plants: Antifungal, Antibacterial & Antiviral Activities Edn 1, IBDC India, 2004, 374.
- Satish S, Raghvendra MP, Mohana DC, Raveesha KA. Antifungal activity of a known medicinal plant *Mimusops elengi* L. against grain moulds. Journal of Agricultural Technology 2008; 4(1):151-165.
- Satish S, Mohana DC, Raghavendra MP, Raveesha KA. Antifungal activity of some plant extracts against important seed borne pathogens of *Aspergillus* sp. Journal of Agricultural Technology 2007; 3(1):109-119.
- Gupta PC. *Mimusops elengi* Linn. (Bakul)-A Potential Medicinal Plant: A Review. Int. J. Pharm.

- Phytopharmacol. Res. 2013; 2(5):332-339.
27. Dabadi P, Koti BC, Vishwanath swamy AHM, Chandrakala. *In vitro* Anthelmintic Activity of *Mimusops elengi* Bark. Indian Journal of Novel Drug delivery 2011; 3(4):307-310.
 28. Nasrin M, Dash PR, Saha MR, *In vitro* anthelmintic and cytotoxic activities of methanolic bark extract of *Mimusops elengi* Linn. Stamford J Pharmaceut Sci 2010; 3(2):20-24.
 29. Singh KL, Singh DK, Singh VK. Characterization of the Molluscicidal activity of *Bauhinia variegata* and *Mimusops elengi* plant extracts against the Fasciola vector *Lymnaea acuminata*. Rev Inst Med Trop Sao Paula 2012; 54(3):135-140.
 30. Ruikar AD, Pawar PV, Sen A, Phalgune UD, Puranik VG, Deshpande NR, Larvical potential of *Mimusops elengi* against *Aedes aegypti* (L) and *Culex quinquefasciatus* (Say) J Vector Borne Dis 2012; 49:111-113.
 31. Karmakar UK, Sultana R, Biswas NN. Antioxidant, analgesic and cytotoxic activities of *Mimusops elengi* Linn. Leaves. IJPSR 2011; 2(11):2791-2797.
 32. Sehgal S, Gupta V, Gupta R, Saraf SA. Analgesic and Antipyretic activity of *Mimusops elengi* L. (Bakul) leaves. Pharmacologyonline 2011; 3:1-6.
 33. Kar B, Kumar RBS, Karmakar I, Dolai N, Bala A, Mazumder UK, et al. Antioxidant and *in vitro* anti-inflammatory activities of *Mimusops elengi* leaves. Asian Pacific Journal of Tropical Biomedicine, 2012, 976-980.
 34. Narayanaswamy N, Rohini S, Duraisamy A, Balakrishnan KP. Antityrosinase and antioxidant activities of various parts of *Mimusops elengi*: a comparative study. International Journal of Research in Cosmetic Science 2011; 1(1):17-22.
 35. Ashok P, Koti BC, Vishwanathswamy AHM. Antiulithiatic and antioxidant activity of *Mimusops elengi* on ethylene glycol-induced urolithiasis in rats. Indian Journal of Pharmacology 2010; 42(6):380-383.
 36. Shahwar D, Raza MA. Antioxidant potential of phenolic extracts of *Mimusops elengi*. Asian Pac J Trop Biomed 2012; 2(7):547-550.
 37. Boonyuen C, Wangkarn S, Suntornwat O, Chaisuksant R. Antioxidant Capacity and Phenolic Content of *Mimusops elengi* Fruit Extract. Kasetart J. (Nat. Sci.) 2009; 43:21-27.
 38. Bhujpal SS, Deshmukh RP, Bidkar JS, Thatte VA, Awasare SS, Garg PP. Evaluation of cytotoxic activity of barks of *Mimusops elengi*. Eurasia J Biosci 2011; 5:73-79.
 39. Ganesh G, Abhishek T, Saurabh M, Sarada NC. Cytotoxic and apoptosis induction potential of *Mimusops elengi* L. in human cervical cancer (SiHa) cell line. Journal of King Saud University-Science 2014; 26:333-337.
 40. Zahid H, Rizwani GH, Shareef H, Mahmud S, Ali T. Hypoglycemic and hypolipidemic effects of *Mimusops elengi* Linn, extracts on normoglycaemic and alloxan-induced diabetic rats. International Journal of Pharmaceutical and Biological Archives 2012; 3(1):56-62.
 41. Gopalkrishnan B, Ringmichon CL, Shimpi SN. Seeds of *Mimusops elengi* Linn- An Antifertility Drug. IJABPT 2013; 4(3):111-116.
 42. Satishchandra A and Sumithra M, Synergistic effect of *Mimusops elengi* and *Moringa oleifera* on high fat diet induced atheroma in rats. Int J Adv Pharmaceut Res 2011; 2(6):293-300.
 43. Bhramaramba R, Kumar KV, Surekha ML, Tejaswi J, Shailaja K, Hepsyflorance M. Pharmacognostical and pharmacological studies on fruits of *Mimusops elengi* Linn. International Journal of Pharmacy and Pharmaceutical Science Research 2014; 4(4):71-75.
 44. Ganu G, Deshmukh TA, Middha A. Potential Hepatoprotective Activity from Extracts of *Mimusops elengi* Linn. International Journal of Medicine and Pharmaceutical Research 2013; 1(4):342-347.
 45. Katedeshmukh RG, Shete RV, Otari KV, Bagade MY, Pattewar A. Acute Toxicity and Diuretic activity of *Mimusops elengi* extracts. International Journal of Pharma and Bio Sciences 2010; 1(3):1-6.
 46. Hadaginhal RV, Tikare VP, Patil KS, Bhanushali MD, Desai NS, Karigar A. Evaluation of cognitive enhancing activity of *Mimusops elengi* Linn in albino rats. IJRAP 2010; 1(2):484-492.
 47. Gupta N, Jain UK, Investigation of wound healing activity of methanolic extract of stem bark of *Mimusops elengi* Linn. Afr J Tradit Complement Altern Med 2011; 8(2):98-103.
 48. Kumarasamyraja D, Jeganathan N S, Manavalan R. A Review on Medicinal Plants with Potential Wound Healing Activity. International Journal of Pharma Sciences 2012; 2(4):105-111.
 49. Prakash D, Koti BC, Vijay T, Chandrakala, Katagi MS, Antiulcer activity of *Mimusops elengi* bark extracts against serotonin induced ulcer in rats. Int Res J Pharm 2011; 2 (8):173-176.
 50. Shah PJ, Gandhi MS, Goswami SS, Santani D, Study of *Mimusops elengi* bark in experimental gastric ulcers. J Ethanopharmacol 2003; 89(2-3):305-311.
 51. Behbahanian DS, Malik A, Jahan N, Hypotensive effect of the methanolic extract of *Mimusops elengi* in normotensive rats. Phytomedicine 1999; 6(5):373-378.
 52. Shivatare RS, Kadam PV, Bhusnar HU, Bhilwade SK, Patil MJ. Immunostimulatory effect of *Mimusops elengi* Linn stem bark in mice. International Journal of Green Pharmacy 2014; 8(3):170.
 53. Mahapatra AK, Mishra S, Basak UC, Panda PC. Nutrient Analysis of Some Selected Wild Edible Fruits of Deciduous Forests of India: an Explorative Study towards Non Conventional Bio-Nutrition. Adv. J. F. Sci. Technol. 2012; 4(1):15-21.
 54. Patkip PS, Mazumdar M, Majumdar S, Chatterjee A. Evaluation of the Safety and Efficacy of Complete Care Herbal Toothpaste in Controlling Dental Plaque, Gingival Bleeding and Periodontal Diseases. J Homeop Ayurv Med, 2013, 2(2).