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### *Mimusops elengi*: A Review on Ethnobotany, Phytochemical and Pharmacological Profile

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The present review is an attempt to highlight the various ethno botanical and traditional uses as well as phytochemical and pharmacological reports on *Mimusops elengi* to which commonly known as Bakul and Spanish cherry, belonging to Sapotaceae family. It is a large ornamental evergreen tree cultivated in India and generally reared in gardens for the sake of its fragrant flowers. In the traditional Indian system of medicine, the ayurveda and in various folk system of medicine, the bark, fruit and seeds of *Mimusops elengi* possess several medicinal properties such as astringent, tonic, and febrifuge. Chemical studies have shown that, Bark contain tannin, some caoutchouc, wax, starch and ash and Flower contain volatile oil as well as Seeds contain fixed fatty oil. Preclinical studies have shown that *Mimusops elengi* or some part of its phytochemicals possess Analgesic, Antibiotic, Antihyperlipidemic, Anti-inflammatory, Antimicrobial, Antioxidant, Antipyretic, Cytotoxic, Congestive enhancing, Gingival bleeding, Gastric ulcer, Hypotensive activity.

**Keyword:** *Mimusops elengi*, Ethnobotany, Phytochemistry, Triterpenoids, Saponins

#### 1. Introduction

Natural products are known to play an important role in Pharmaceutical biology. Plants have been an important source of medicine for thousands of years. Even today, the World Health Organization estimates that up to 80 percent of people still rely mainly on traditional medicines.

In fact, many of the current drugs either mimic naturally occurring molecules or have structures that are fully or in part derived from natural motifs<sup>[1]</sup>. *Mimusops elengi* is considered as a sacred plant among Hindus and has obtained important place in religious texts as well as in ancient Sanskrit literature. Its fragrant flowers are celebrated in the Puranas and even placed amongst the flowers of the Hindu paradise. Krishna is said to have fascinated the milkmaids

of Brindaban on the banks of Yamuna by playing on his flute beneath a *Mimusops elengi* tree. Kalidasa has also included in his classical Sanskrit literature *Mimusops elengi* flowers as symbol of love and beauty<sup>[2]</sup>. A small to large evergreen tree found in the Deccan Peninsula and Andaman Islands, and frequently cultivated in gardens for ornament; it is grown also as an avenue or shade tree throughout the greater parts of India<sup>[3]</sup>. It has made important contribution to the field of science from ancient times as also to modern research due to its large number of medicinal properties<sup>[4, 5, 6]</sup>.

#### 1.1 Taxonomical Classification

Kingdom: Plantae

Order : Ericales

Family : Sapotaceae  
Genus : *Mimusops*  
Species : *M. elengi* L<sup>[6]</sup>.

### 1.2 Vernacular names

English: bullet wood, spanish cherry; Hindi: mulsari, sinha kasaraka Sanskrit: bakula, kesara, madhugandha Udumbara; assamese: Gokui; marathi: owalli; bengali: Bakul; Telugu: bogada, bogada-manu; Singhali: minn-mall, muhulla, muhuna; Tamil: vagulam, magadam, muhunain; Oriya: kira kauli, baula<sup>[4,7]</sup>.

### 1.3 Part used

Stem bark, leaves, flowers, fruit and seed<sup>[7]</sup>.

### 2. Distribution

*Mimusops elengi* tree is the native of western peninsula. The tree is found in south India in dry evergreen forests from the Krishna southwards and in ravines in the hills up to 20 meter along western coast and lower Ghats in moist evergreen forests. It is distributed in Andaman, Martaban, Tenasserim, Burma and the western in Ghats; in the Eastern Ghats it is found in dry areas, often on laterite and in comparatively small in size. It is mostly found in Northwestern Himalayas, Eastern Ghats, Western Ghats, Central Deccan Plateau, East Coast, West Coast, Indo-gangetic Plain, and Outlying Islands<sup>[3,8]</sup>.

### 3. Traditional medicinal uses

The bark is used for cooling, a cardio tonic, alexipharmic, stomachic, anthelmintic, tonic, astringent which cures biliousness, diseases of the gums and teeth. The flower is cooling, astringent to the bowels are used to cures the disease of blood, cure biliousness, liver complaints, diseases of the nose, headache, their smoke is good in asthma. The fruit is astringent to the bowel, good for the teeth, causes flatulence. The seed fix loose teeth and used as a cure troubles in the head. The root is aphrodisiac, diuretic, astringent to the bowel, good for gonorrhoea and used as a gargle which cures relaxation of the gums. The flowers, which appear twice a year, are somewhat fragrant and powerfully aromatic. The native distil an odoriferous water is collected from them. The

fruit is edible. The seeds yield an abundance of oil, in request for painters. If the leaves are put in the flame of a candle, they will make a smart crackling noise<sup>[8,9,10]</sup>.

### 4. Botanical description

A small to large evergreen tree, grows up to 15 m high. Generally characterized by a short, dark and very rough trunk and wide spreading, the ends of which tend to rise and forms a thick globular head to the tree<sup>[3,5]</sup> (Fig.1). The bark is dark grey, 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 thin and occurs in quills<sup>[11,12]</sup>. Berry is ovoid, 2.5 cm long with. It turns yellow and it tastes astringent and sweet. Fruition occurs in rainy season, when ripe containing 1, rarely 2 seeds. Seeds are grayish brown, solitary, ovoid, compressed, shining<sup>[12,13]</sup>. The leaves are glossy and are dark green 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 oblanceolate, short or long acuminate, margin undulate, closely but faintly veined. Petioles 1.2 - 2.5 cm long<sup>[14]</sup> (Fig. 2).

### 5. Phytochemical constituents

#### 5.1 Stem bark

Taraxerone, taraxerol, betulinic acid and spinasterol, sodium salt of betulinic acid and ursolic acid, Fatty acid esters of alpha-spinasterol was isolated from the bark<sup>[15]</sup>. A new farnane-type pentacyclic triterpene, farnan-2-one-3 beta-ol (mimusopfarnanol), was isolated along with the known triterpenoids, farnan-3-one, and olean-18-en-2-one-3-ol and lup-20(29)-en-3 beta-ol<sup>[16]</sup>. A new triterpene 3 $\beta$ -hydroxy-lup-20(29)-ene-23, 28-dioic acid, beta amyryl, lupeol<sup>[17]</sup> also obtained from bark. Steam distillation of bark sample yielded 0.18% of volatile organic matter. The major constituents were alpha cadinol, tau muurolol, hexadecanoic acid, diisobutyl phthalate, octadecadienoic acid<sup>[18]</sup>. New gallic acid esters, characterized as phenyl propyl gallate<sup>[19]</sup>.

Figure 1: Whole plant of *Mimusops elengi*Figure 2: Bark, Leaves, and Fruits of *Mimusops elengi* Linn

### 5.2 Fruit and seed

Fruit and seed of bakula showed presence of Quercitol, ursolic acid, dihydro quercetin, quercetin,  $\beta$ -D-glycosides of  $\beta$ -sitosterol, alpha-spinasterol after Saponification [20]. Two new Pentacyclic triterpene acids were isolated as mimusops acid and mimusopsic acid, possessing the novel migrated oleanane skeleton, mimusopane [21] along with mimusops gene and mimugenone, [22]. Pentacyclic triterpenes 3 $\beta$ ,6 $\beta$ ,19 $\alpha$ ,23-tetrahydroxy-urs-12-ene and 1 $\beta$ -hydroxy-3 $\beta$ -hexanoyllup-20 (29)-ene-23, 28-dioic acid have been isolated [23]. Two novel triterpenoid saponins, mimusops in and mimusops in were isolated from the seeds of *Mimusops elengi* [24] and minor triterpenoid saponin mimus in was isolated along with two known triterpenoid saponins, Mi-saponin A and 16 $\alpha$ -hydroxy Mi-saponin A [25]. In addition taxifolin, alpha-spinasterol glucoside, Mi-glycoside 1, two new triterpenoid saponins mimusopside A and B were also isolated [26]. Six New saponins were isolated from the seed kernel [27]. Bakul fruit are reported to contain moisture (79.27 %), protein (1.29%), fat (2.76 K Cal), reducing sugar (8.9%), Non reducing sugar (6.3%), Total sugar (15.2%), Fiber (1.13%),

Vitamin C (3.27 mg / 100 gm), Mineral content (0.32%), Iron (0.59 mg / 100 gm), Sodium (5.16 mg / 100 gm), Potassium (98.54 mg / 100 gm) [28].

### 5.3 Leaves, heartwood and roots

Hentriacontane, carotene and lupeol from the leaves, heartwood and roots were isolated. A new steroidal saponin, 5 $\alpha$ -stigmast-9(11)en-3 $\alpha$ -O-beta-D-glucopyranosyl (1-5)-O-beta-D-xylofuranoside was isolated from the roots of *mimusops elengi* [29, 30].

## 6. Pharmacology

### 6.1 Anthelmintic activity

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 the leaves exhibited significant anthelmintic activity with respect to standard and control. Albendazole was included as standard reference and distilled water as control [31].

### 6.2 Anti-anxiety activity

The study evaluates the anti-anxiety activity of methanolic, aqueous and n-butanol extract of bark using elevated plus maze in swiss albino mice model by different doses. Methanolic extract at 200 mg/kg showed more significant anxiolytic activity as compared to aqueous and n-butanol extract [32].

### 6.3 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 [33].

### 6.4 Antiulcer activity

The effect of bark alcoholic and petroleum ether extracts of *Mimusops elengi* was evaluated in rats. The alcoholic extract has significant antiulcer activity compare to petroleum ether

extracts of bark [34]. The alcoholic extract of bark *Mimusops elengi* and its different fractions namely ethyl acetate, *N*-butanol, and methanol and aqueous against different ulcer models, and concluded that Ethyl acetate fraction possesses anti-ulcer activity against experimental gastric ulcers [35].

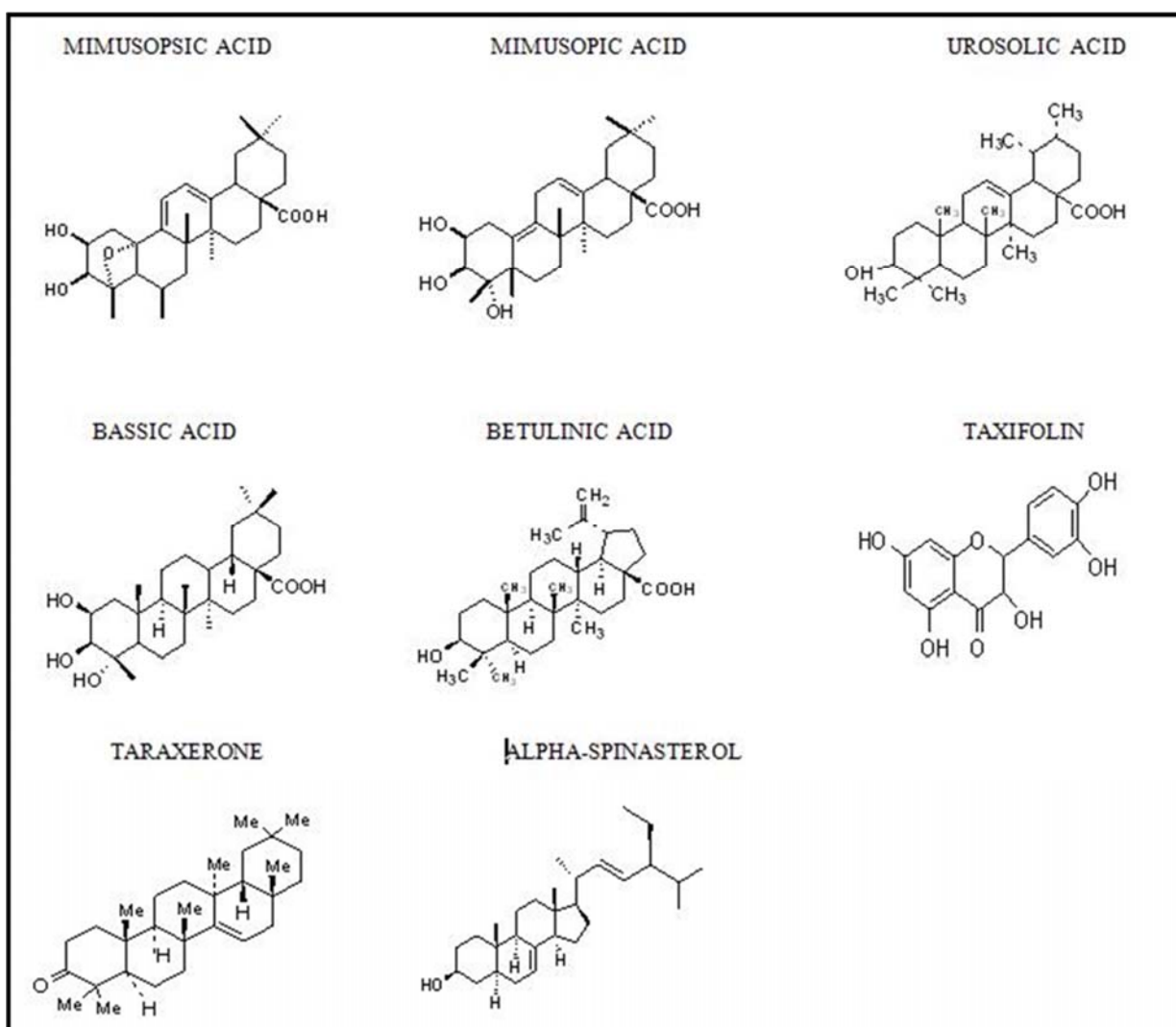
### 6.5 Anticonvulsant activity

The anticonvulsant activity of methanolic, aqueous, and *n*-butanolic extract of bark were evaluated using Maximal electroshock test (MES) in rats and Isoniazid (INH) induced convulsions in mice and concluded that methanolic, aqueous,

and *n*-butanolic extract possess significant anti-convulsion activity [36].

### 6.6 Anti-inflammatory, analgesic and antipyretic activities

Methanolic extract of leaf was investigated for analgesic activity using acetic acid induced writhing of white albino mice and hot plate test. In hot plate test the extract exerted significant prolongation in the response of latency time to the heat stimulus [37]. The ethanol extract of Bark was assessed for anti-inflammatory, analgesic and antipyretic activities in animals. The ethanol



extract of bark significantly inhibited the carrageenan-induced paw oedema at 3rd and 4th

h and in cotton pellet model it reduced the transudative weight and little extent of granuloma

weight. In analgesic models also the ethanol extract decreases the acetic acid-induced writhing and it also reduces the rectal temperature in Brewer's yeast induced pyrexia. However, there was no increase the latency time in the hot plate test. These results showed that ethanol extract of bark has an anti-inflammatory, analgesic and antipyretic activity [38]. The isolated fraction  $\beta$ -amyrincaprylate and ethanolic extract of bark was used for the evaluation of anti-inflammatory activity by using carrageenan induced paw oedema and cotton pellets. The effect was compared with Indomethacin used as standard drug. The results indicated that ethanolic extract and  $\beta$  amyrincaprylate contributes to the anti-inflammatory action of *Mimusops elengi* bark [9].

### 6.7 Antioxidant activity

The chloroform extract of bark was assessed by using DPPH (1,1-diphenyl-2-picrylhydrazyl) radical, nitric oxide, ABTS radical and hydroxyl radical respectively. The result obtained in this study clearly indicates that *M. elengi* has a significant potential to use as a natural antioxidant agent [39]. Crude methanolic extract of leaf exhibited statistically significant antioxidant activity in DPPH free radical scavenging and Nitric oxide scavenging test [38]. Protective effect of leaf extract on Lipid Peroxidation and activities of both Enzymatic and Non-Enzymatic Antioxidants in Plasma and tissues were studied. The oxidative stress was measured by plasma and tissue Lipid Peroxidative markers levels, Non Enzymatic antioxidants and enzymatic antioxidants. 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 [40].

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). It produced significant decreased in MDA and increased in GSH, SOD and CAT. The alcohol extract shows more potent antioxidant activity than petroleum ether and chloroform extract [41].

*In vitro* antioxidant activity of Methanolic extract was evaluated using reducing power assay, DPPH and hydroxyl radical scavenging assay. It offered significant *in vitro* reducing power capacity and radical scavenging activity [42]. The phenolic compounds extracted from immature green, mature green and orange ripe fruits of *Mimusops 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). 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 was higher than that of either the mature or the ripe fruit [43]. The methanol extract of the leaves was evaluated by using 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 [44].

### 6.8 Antiuro lithiatic effect

Petroleum ether, chloroform, and alcohol extracts of bark were evaluated for antiuro lithiatic 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 [41].

### 6.9 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 [45].

### 6.10 Antimicrobial effect

Hexane, ethyl acetate, ethanol and methanol extracts were tested against the dental caries causing bacteria *Streptococcus mutans* isolated from caries infected patients. The all extracts



showed antibacterial activity against *Streptococcus mutans* [46]. 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 [47]. The Acetone extract of bark was screened for antimicrobial activity against salivary micro flora collected from children of 6-12 years of age by 'paper disc diffusion' method and the acetone extract can showed antimicrobial activity [48].

The ethanolic extracts of bark tested for its antimicrobial activity were tested using the well method. The active extracts were subjected to the Minimum Inhibitory Concentration (MIC) agar dilution method, to determine the minimum inhibitory concentration of the extract. The extract showed activity against three *Staphylococcus* isolates including *Staphylococcus aureus* [49]. 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]. The Two chemical compounds were extracted by ethyl acetate and tested for antimicrobial activity by agar diffusion method. Two compounds showed good antimicrobial activity [51].

### 6.11 Antibacterial effect

The 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 [52]. The bark extracts in aqueous and acetone solvents were 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 [53]. The dichloromethane, chloroform, ethyl acetate, acetone methanol-chloroform methanol, ethanol, acetone-water, methanol-water and ethanol-water extracts of bark, fruit and seed were evaluated for antibacterial activity by using spectrophotometric method against gram positive and gram negative strains. The fruit and seed extracts were found inactive, while stem bark extracts showed antibacterial activity against all 6 bacterium [54].

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 ethanolic bark extract shows significant activity against three *Staphylococcus* isolates including *Staphylococcus aureus* [55]. 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 [56]. 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 [57].

### 6.12 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* [46]. The aqueous extract of leaf and bark extracts were evaluated for the radial growth and sclerotial development of *Sclerotinia sclerotiorum* *in vitro* using Potato Dextrose Agar (PDA) medium amended with both aqueous extracts before or after sterilization inhibited radial growth, number and size of sclerotia of *Sclerotinia sclerotiorum* (Lib.) de Bary *in vitro*. The unsterilized aqueous extracts in both cases of leaf and bark showed significantly higher reduction in radial growth and sclerotial developments show that the antifungal compound against *S. sclerotiorum* tested is heat liable [58]. 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 [50].

### 6.13 Cognitive enhancing activity

The effect of alcoholic extract of flower was evaluated for congestive enhancing activity using elevated plus maze and passive avoidance task method with mentat as standard by using parameter of step down and transfer latency. The alcoholic extract shows the significant effect [59].

### 6.14 Cytotoxic activity

The methanolic bark extract was screened for cytotoxic activity by brine shrimp lethality bioassay. The extract exhibited good cytotoxic activity with LC<sub>50</sub> value of 40 µg/ml whereas LC<sub>50</sub> of vincristine sulphate was 0.078 µg/ml [60]. 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 [37].

The cytotoxic effects of ethanolic extract of barks were investigated on meristematic cells of root tips of *Allium cepa* using different concentrations (2.5, 5, 10 mg/mL) of standard cytotoxic drug cyclophosphamide and ethanolic extract. The photomicrographs had shown the chromosomal abnormalities, stickiness, etc. with increasing concentration of ethanolic extract. The results of the presented study revealed that there is a significant decrease in percent mitotic index and root length of *Allium cepa* with respective time and with increasing concentration [61]. Cytotoxic activity of the 95% ethanol extracts of flower against the cancerous cell lines compared with normal cell line were assessed using MTT assay. 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 [62].

### 6.15 Antidiabetic effect

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]. 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 [42]. The aqueous bark extract of 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 which indicates effect [64].

### 6.16 Diuretic effect

The diuretic and electrolyte excretion activity in alcoholic extract were evaluated. After dosing of extracts and standards urine was collected and volume was recorded at 5 hours. The highest diuretic activity was presented by the alcoholic extract [65]. The ethyl acetate, ethanol and water extract was evaluated for diuretic activity. Diuretic study was carried out in rodents by measuring the urine volume at 1, 2, 4, 6 and 24 hrs. The aqueous extracts showed a significant diuretic activity when compared with other extracts [66].

### 6.17 Hypotensive effect

The methanolic extract caused hypotensive activities in anaesthetized rats were evaluated. 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. These data imply *M. elengi* might possess calcium-blocking activity which would explain its hypotensive effect [67].

### 6.18 Wound healing effect

The Wound healing activity of methanolic extract of bark parts of *Mimusops elengi* 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].

## 7. Conclusion and further scope

As the pharmacologists are looking forward to develop new drugs from natural sources, development of modern drugs from *Mimusops elengi* linn can be emphasized for the control of

various diseases. The betulinic acids isolated from the bark are proved to be Anti-HIV constituent so that the research work on the bark for anti-HIV effect will be possible. It is quite evident from this review that *Mimusops elengi* linn is an important medicinal herb and extensively all types of medicinal systems. It contains a number of phyto constituents, which are the key factors in the medicinal value of this plant. 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 all aspects of herb and throws the attention to set the mind of the researchers to carry out the work for developing the new formulations which can ultimately beneficial for the human being.

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