AMERICAN JOURNAL OF PHARMTECH RESEARCH

Journal home page: http://www.ajptr.com/

Phytochemical and pharmacological review of *Mimusops elengi* linn.

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ABSTRACT

In the last few decades there has been an exponential growth in the field of herbal medicine. Herbal medicines have been the basis of treatment and cure for various diseases and physiological conditions in traditional methods of practice such as Ayurveda, Unani and Siddha. Medicinal components from plants play an important role in conventional as well as western medicine. They were the sole source of active principles capable of curing man's ailments. Thus natural products have been a major source of drugs for centuries. *Mimusops elengi*, commonly called 'Bakul' is a medicinally important plant of family sapotaceae. All parts of the plant including stem, bark, leaves, fruit, root and seeds in all stages of their maturity have medicinal properties. Taking into consideration the medicinal importance of the plant, the present review has made to explore the phytochemical and pharmacological potential of *Mimusops elengi*.

Keywords: *Mimusops elengi*, bakul, phytochemical, pharmacological

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Received 14 November 2012, Accepted 26 November 2012

Please cite this article in press as Panda J *et al.*, Phytochemical and pharmacological review of *Mimusops elengi* linn. American Journal of PharmTech Research 2012.

INTRODUCTION

Medicinal plants are the richest bio-resource of drugs of traditional systems of medicine, modern medicines, neutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for the synthetic drugs. In recent years, there has been a surge of interest in herbal remedies for a number of ailments. Use of herbal drugs has been an inseparable part of human civilization as many food materials like ginger, garlic, turmeric etc. have long been used as medicines. The world health organization (WHO) estimates that about 80% of the population is still depends upon these herbal medicines for their treatment of diseases due to easy availability, economic and less side effects when compared to allopathic system of medicines. 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'. The use of plants to treat various diseases in India dates back to the times of Rig-Veda (3500 to 1800 B.C.). Later, the monumental Ayurvedic works like Charaksamhita and Sushrutasamhita followed by other Ayurveda and Siddha treatises have incorporated nearly 700 plant derived drugs entering into several medicinal preparations used in the health care system.[1] The main aim of this review is to give recent information along with the traditional uses of *Mimusops elengi* that might be an important plant due to its invaluable pharmacological properties by which students and researchers will get the overall information about its published phytochemical and pharmacological properties for their further research.

Figure 1: Habitat of *M. elengi*

Figure 2: Flowering top of *M. elengi*

Figure 3: Fruits of *M. elengi*

Figure 4: Ripe fruit of *M. elengi*

Morphology

Mimusops elengi, commonly called Bakul, is a medicinal plant belonging to the family Sapotaceae. It is a small to large glabrous evergreen tree with a compact leafy head and short erect trunk, bark smooth, scaly and gray. Leaves are 6-10cm long and 3-6cm broad pointed with serpentile ends, glabrous, base acute or rounded, petioles 1.3-2.5cm long. Flowers are white in colour with a sweet fragrance, nearly 2.5cm across solitary and buds ovoid, acute; pedicels 6.20 mm long. Calyx 1cm long, stamens 8, opposite to the inner circle of lobes. Ovary appressedly silky-pubescent. The fruit is a berry, containing usually one, rarely two seeds about 1.7-1.9cm in length and 1.2-1.5cm in breadth. It is compressed, obliquely ovoid and yellow when ripe. The seeds are light brown to blackish in colour. All parts of the tree have medicinal properties. [2] The different parts of the plant are given in the figure1-4.

Vernacular names

Taxonomy and nomenclature (common names) is as following[3]

Kingdom: Plantae,

Order: Ericales,

Family: Sapotaceae,

Genus: Mimusops,

Species: M. elengi L.,

Binomial name: Mimusops elengi (L).

The plant is also known as varieties of name as mention bellow:

Sanskrit:Anangaka, Bakula, Chirapushpa, Dhanvi, Gudhpushpa, Kantha, Karuka, Kesha, Mukula, Padyamoda, Sharadika, Sindhugandha, Simhakeshaa, Sthirmukhgandha, Surabhi, T ailanga, Varalahdha, Visharada

Gujarati: Babhuli, Bolsari, Varsoli, Vovoli

Hindi: Bakul, Bolsari, Maulsarau, Maulser, Maulsari

Marathi: Bakhor, Bakula, Barsoli, Ovalli, Owli, Vavoli, Wovali, Wowli

Malayalam: Bakulam, Elengi, Ilanni, Iranni, Makuram

Tamil: Alagu, Ilangi, Kesaram, Kosaram, Magil, Magilam, Vagulam

Punjabi: Maulsari, Maulsiri

Bengali: Bakal, Bakul, Bohl, Bukal

English: Bullet wood, Indian Medlar

Nepalese: Bakulapuspa

Sinhalese: Munemal

German: Affengesict

French: karanicum

Unani: Moolsari

Burmese: Kaya

Malaysian: Enengi

Telgu: Pogada.

General Properties of the plant and their traditional uses

The bark is acrid and sweet; cooling, cardiotonic, alexipharmic, stomachic, anthelmintic, astringent; cures biliousness and diseases of the gum and teeth.[4] The flowers are sweet, acrid, oleagenous; cooling, astringent to the bowels; good for the teeth, causes flatulence. They are used as expectorant; cures biliousness, liver complaints, diseases of the nose, headache and their smoke is good in asthma.[5] The seeds fix loose teeth; as an errhine cures nasal congestion and headache.[6] The root is sweet and sour; aphrodisiac, diuretic, cardiotonic, stomachic, astringent to the bowels; good for gonorrhoea; as a gargle, strengthens the gums.[2] The fruits are sweet and sour, aphrodisiac, diuretic, astringent to the bowels, good in gonorrhoea. The pulp of the ripe fruit is sweetish and astringent and has been successfully used in curing chronic dysentery.[2,7] The leaves are traditionally used in fever, postural eruptions of skin, ulcer, headache, dental diseases, bacterial diseases,[8] wound along with antioxidant, cytotoxic, analgesic and antipyretic activities.[5,9]

Chemical constituents

The important constituents of the bark are alkaloids, starch, tannin and sapponins. Among this taraxerol, taraxerone, ursolic acid, betulinic acid, V-spinosterol, W-sitosterol, lupeol,[10,11,12] isoretronecyl tiglate,[13] tau-muurolol, alpha-cadinol, penta-decanoic acid, di-isobutyl phthalate, hexa-decanoic acid, eicosane, oleic acid, octadecadienoic acid are major one.[6] The bark contains the amino acids such as Tryptophan, Lysine, Methionine, Proline, Glysine and Alanine.[14] The volatile oil constituents of the bark are Linalol, Copaene, Isosafrol, β-caryophyllin, Safrol, δ-cadinene, Phenol, 2,5-bis(1-methylethyl)-(Thymol), γ-cadinene.[15] The lipid concentration of the bark was ranging from 13.5 to 16.8 mg/gm. In summer (16.8 mg/gm) showed highest content over other season i.e. monsoon (13.5mg/gm) and winter (14.7 mg/gm). Dibutyl phthalate is the important secondary metabolite present in the bark of *Mimusops elengi*.[16]

The flower of *Mimusops elengi* contains volatile oil, querictol, teraxerol and lupeol. The most abundant volatile constituents of the flowers of *Mumusops elengi* are phenylethanol (29.8%), *(E)*-2-hexenal (11.8%), benzyl alcohol (10.4%), 3-Phenyl-2-propene-1-ol, 4-

Hydroxybenzenemethanol, Methyl-4-hydroxybenzoate, 2-Butyl phenol, Hexadecanoic acid, Long chain carboxylic acid, (Z)-9-Octadecanoic acid.[16,17] The major constituents of seeds of *Mimusops elengi* are Qurecitol, Dihydroqurecitin, Qurecitin, Ursolic acid.[8] Leaves of *Mimusops elengi* contains Qurecitol, Hentriacontane, β-carotene, D-mannitol, β-sitosterol, β-sitosterol-β-D glucoside and Qurecetin.[18] The lipid concentration of leaves was higher in summer (32.7 mg/gm) over that of monsoon (29.75 mg/gm) and winter (30.7 mg/gm). The alkaloids contents of leaves ranging from 0.8 to 2.0 mg/gm, higher amount of alkaloid observed at summer (2.6 mg/gm) over than monsoon (0.8 mg/gm) and winter (1.8 mg/gm) respectively. The bark contains lower amount of alkaloids than the leaves. The lipid and alkaloids content were in increasing order from wood< bark< leaves.[19]

Table 1: Fluorescence analysis of the Powder of the stem bark of *M. elengi* [20]

S. N.	Solvents Treatment	Visible light	Short UV(254 nm)	Long UV(366nm)
1	Drug + Distilled water	Light yellow	Dark brown	Dark Black
2	Drug + Petroleum Ether	Reddish brown	Blackish green	Blackish brown
3	Drug + Chloroform	Light brown	Dark brown	Dark Black
4	Drug + Methanol	Yellowish brown	Greenish black	Dark brown
5	Drug + Conc. HCl	Dark brown	Brownish black	Off white
6	Drug + Conc. HNO_3	Ceramic yellow	Black	Reddish brown
7	Drug + Conc. H_2SO_4	Greenish brown	Black	Violet black
8	Drug + Picric acid	Yellowish Brown	Greenish black	Ceramic yellow
9	Drug + Ammonia solution	Mud brown	Greenish black	Ceramic brown
10	Drug+10% NaCl	Dark brown	Ceramic green	Brownish Black
11	Drug + Ferric chloride	Greenish black	Yellowish brown	Blackish green

Table 2: Fluorescence analysis of the bark and seed powder of *M. elengi* under visible and UV light after treated with different chemicals[6]

Treatment	Visible Light		UV light(366nm)	
	Bark	Seed	Bark	Seed
Powder +1 N NaOH	Greenish black	White	Yellowish green	No florescence
Powder +Acetic acid	Creamy white	White	No florescence	No florescence
Powder +1N HCl	Dull white	White	No florescence	No florescence
Powder +1 N HNO_3	Dull white	White	No florescence	No florescence
Powder +HNO_3 + NH_3	Orange	White	No florescence	No florescence
Powder +5 % $FeCl_3$	Light brown	Yellow	Fluorescent green	Fluorescent green
Powder +5 % Iodine	Orange red	Yellow	Yellow	Fluorescent green
Powder +1 N NaOH in methanol	Yellowish brown	White	Yellowish green	No florescence
Powder +Methanol	Reddish brown	Off white	Violet	No florescence

Table 3: Colour analysis of the bark and seed powder of *M. elengi* after treated with different chemicals[6]

Treatment	Bark	Seed
HCl	Reddish brown	Light pink
H_2SO_4	Reddish brown	Dark reddish orange
HNO_3	Yellowish red	Yellow
Acetic acid	Reddish brown	White
Ammonia liq.	Brown	Creamy white
Ferric chloride	Black	Black
Iodine solution	Orange red	Yellow
10% NaOH	Brownish red	Creamy white

Table 4: Percentage of minerals in the bark of *M. elengi* [1]

Mineral	Percentage
Nitrogen	0.33
Phosphorous	0.33
Potassium	1.25
Calcium	0.39
Copper	0.0014
Iron	0.0409
Aluminium	0.007408
Manganese	0.005185
Zinc	0.0029

Table 5: Extractive value of the bark and seeds of *M. elengi* in different solvents[6]

Treatment	Parts	Percentage of extraction	Filtrate colour	Residual nature and colour
Water	Bark	71.73 ± 1.51	Reddish brown	Crystalline Reddish brown
	Seed	36.86 ± 0.70	Off white	Crystalline white
Methanol	Bark	66.73 ± 0.46	Reddish brown dark	Crystalline Reddish brown
	Seed	34.08 ± 0.52	Off white	Solid off white
Chloroform	Bark	51.10 ± 1.64	Reddish brown	Solid light orange
	Seed	19.76 ± 0.49	Light yellow	Sticky yellowish white

Table 6: Physicochemical parameters of powder of the bark[21]

S. N.	Parameter	Bark powder
1	Foreign organic matter (%w/w)	0.33 ± 0.28
2	Moisture content (%w/w)	3.86 ± 0.72
Ash values		
3	Total ash (% w/w)	5.16 ± 0.28
4	Acid insoluble ash (% w/w)	0.16 ± 0.28
5	Water soluble ash (% w/w)	2.46 ± 0.05
6	Sulphated ash (% w/w)	2.70 ± 0.34
Extractive values		
7	Water soluble extractive value (% w/w)	5.00 ± 0.50
8	Alcohol soluble extractive value (% w/w)	7.10 ± 0.76

Values are expressed as mean ± SEM

Table 7: Histochemical study of the seed[22]

Test	Observations
Test for Starch	+
Test for Lipids	+
Test for Proteins	+
Test for Tannins	+
Test for Alkaloids	-
Test for Saponins	+
Test for Glucosides	-
Test for Mucilage	+
Test for Calcium oxalate crystals	-

+ Present, - absent

Table 8: Physicochemical evaluation of the seed[22]

Ash values	Total ash	Not more than 0.5 %
	Acid insoluble ash	Not more than 0.40 %
	Water soluble ash	Not more than 0.30 %
Extractive values	Ethanol	Not more than 18.90 %
	Water	Not more than 12.88 %
	Chloroform	Not more than 11.16 %

Table 9: Preliminary phytochemical screening of different extracts of the seed[22]

Test for Phytoconstituents	Water extract	Chloroform extract	Ethanol extract
Test for Starch	+	+	+
Test for Terpenoids	+	+	+
Test for Proteins	+	+	+
Test for Amino acids	-	-	-
Test for Mucilage	+	+	+
Test for Alkaloids	-	-	-
Test for Anthraquinone glycoside	+	+	+
Test for Cardic glycoside	+	+	+
Test for Saponins	+	+	+
Test for Steroids	-	-	-
Test for Tannins	+	+	+
Test for Flavonoids	-	-	-

+ Present, - absent

Table 10: Proximate analysis of the fruits of *M. elengi*[23]

Factors	Amount
Moisture (%)	55.11 ± 3.19
Carbohydrate (%)	18.15 ± 0.80
Total Sugar (%)	15.9 ± 01
Protein (%)	0.61 ± 0.07
Ascorbic Acid (mg/100g)	25.22 ± 1.65
Reducing Sugar (%)	0.8 ± 0.04
Non-reducing Sugar (%)	15.1 ± 0.04
Phenol (%)	3.1 ± 0.14
Acid content (%)	0.27 ± 0.02
Carotenoid (mg/g)	88.52 ± 4.45

Table 11: Nutritive value of *M. elengi* fruit[24]

Factors	Amount
Moisture (%)	79.27
Protein (g/100gm)	1.29
Fat (%)	2.76
Reducing sugar (%)	8.9
Non reducing sugar (%)	6.3
Total sugar (%)	15.2
Fiber (%)	1.13
Mineral matter (%)	0.32
Vitamin C (mg/100gm)	3.27
Iron (mg/100gm)	0.59
Sodium (mg/100gm)	5.16
Potassium (mg/100gm)	98.54
Energy (K Cal)	90.8

Table 12: Micronutrient analysis of *M. elengi* fruit[22]

Name of the micronutrients	mg/100gm
Iron	4.71
Sodium	52.97
Potassium	808.02
Calcium	1975.16
Copper	0.51
Manganese	8
Zinc	2.1

Table 13: Qualitatitive phytochemical analysis of *M. elengi* flowers[25]

S. N.	Name of the test	Results
1	Alkaloids test	+
2	Flavonoids test	+
3	HCN test	*
4	Hot water test	*
5	Indoles test	-
6	Molish test	+
7	Phenol test	+
8	Saponins test	*
9	Steroids test	-
10	Tannins test	+

+ Positive; - Negative; * Not performed

PHARMACOLOGICAL ACTIVITIES

Antimicrobial activities:

The extracts of *Mimusops elengi* bark, fruit and seed were evaluated for antibacterial activity against gram positive and gram negative strains viz. *Nocardia asteroids* NRRL-174, *Micrococcus luteus* ATCC-10240, *Bacillus subtilis* PCSIRB-248, *Bacillus licheniformis* NCL-2024, *Proteus mirabilis* ATCC-29425 and *Salmonella typhimurium* ATCC-14028. The fruit and

seed extracts were found inactive, while stem bark extracts showed antibacterial activity against all the test organisms. The ethyl acetate extract exhibited the highest zone of inhibition against *B. subtilis* whereas the aqueous methanol (2:8) extract also showed significant results against *N. asteroids*. [26]

In vitro evaluation of antibacterial activity of aqueous and solvent extract (petroleum ether, toluene, chloroform, methanol and ethanol) of *Mimusops elengi* was investigated against five pathogenic bacteria viz., *Escherichia coli, Pseudomonas aeruginosa, Salmonella typhi, Vibrio cholera* and *Streptococcus pneumonia* at 10, 20, 30, 40 and 50µl concentration. Among the five pathogen tested, *Streptococcus pneumonia* and *E.coli* showed a maximum inhibition at 50µl concentration compared to standard antibiotics Gentamicin, Tetracycline and Streptomycin. In solvent extract at 10 to 50µl concentration, methanol and ethanol extract exhibited maximum zone of inhibition against *Streptococcus pneumonia* and *E.coli*.[27]

Ethonolic extracts of the bark of *Mimusops elengi* was tested for its antimicrobial activity against *Staphylococcus aureus*-NCTC 6571, *Pseudomonas aeruginosa*-NCTC 10662, *E. coli*-NCTC 10418, coliforms and one clinical isolate of *Candida* spp. The extract showed considerable inhibition against *S. aureus* and was inactive against coliforms and *Pseudomonas* spp.[28]

The bark extracts of *Mimusops elengi* in aqueous and acetone solvents were evaluated for antibacterial activity against salivary microflora. The salivary samples were collected from children of 6-12 years of age with moderate caries (DMFT=3-4). Antibacterial assay was carried out using paper disc diffusion method. The acetone extract has shown its antibacterial potential against the salivary microflora whereas the aqueous extracts of *M. elengi* did not show any significant zones of inhibition.[29]

Seed extracts of *M. elengi* were prepared from organic solvents (petroleum ether, dichloro methane, ethyl acetate and ethanol) and were tested for antimicrobial efficacy against *Escherichia coli*-ATCC 25922, *Bacillus subtilis*-ATCC 6633 and *Salmonella typhi*-ATCC 6539 in nutrient agar medium. Antimicrobial assay was done by agar diffusion method which showed strong inhibitory activity against the test organisms.[30]

The pre-ripened and ripened fruits extracts of *Mimusops elengi* was examined for antibacterial activity against various bacterial strains namely *Bacillus cereus, Bacillus subtilis, Micrococcus luteus, Staphylococcus epidermidis, Escherichia coli, Klebsiella pneumoniae, Salmonella paratyphi* and *Salmonella typhi*. Among the various extracts of *Mimusops elengi* fruit, methanol extract exhibited high inhibitory zone followed by acetone, water, ethyl acetate and diethyl ether. Diethyl ether extracts exhibited least activity against all the tested organisms. Among these

bacterial strains *Staphylococcus epidermidis* and *Salmonella paratyphi* were found to be highly resistant and exhibited no activity against the *Mimusops elengi* fruit extracts. Similarly, ethyl acetate extracts of *Mimusops elengi* fruit exhibited least activity against all selected bacterial strains, among which *Bacillus cereus* and *Micrococcus luteus* were the most resistant strains, while high inhibition was recorded against *Escherichia coli*. Acetone extract of the ripened fruit exhibited good activity against *Salmonella paratyphi* followed by *Staphylococcus epidermidis* and *Micrococcus luteus* while mature fruit exhibited activity against *Salmonella paratyphi*. Using the methanol extract, good activity was recorded against *Salmonella typhi* using the ripened and pre-ripened fruit extracts, besides *Escherichia coli* was found to be highly resistant when compared to that of other bacterial strains used.[31]

The aqueous leaf and bark extract of Mimusops elengi was investigated against the fungus *Sclerotinia sclerotiorum* in Potato Dextrose Agar medium. The antifungal effect of unsterilized aqueous bark extract showed significantly higher inhibition as compared to the sterilized and unsterilized aqueous leaf extract.[32]

The aqueous and acetone extract of *Mimusops elengi* bark was studied against oral microflora at different concentrations. The acetone extract was found to be more effective against the tested organism whereas the aqueous extract was found to be ineffective.[33]

Mimusops elengi extracts were prepared in four different solvents such as petroleum ether, acetone, methanol and water. Each extract was tested for their antibacterial activity against five dental infection microorganisms such as *Staphylococcus aureus, Streptococcus mutans, S. salivarius, S. sanguis, Lactobacillus acidophilus* and *Candida albicans* by well diffusion method. Methanolic and aqueous extracts showed greater activity as compare petroleum ether and acetone extracts.[34]

The Bark was identified as potential antimicrobial possessing part among all tested aerial part. In vitro developed callus from nodal portion also possessing similar phytochemical and biological activities and can be used as substitutes of the bark.[35]

Essential oil from leaves at the concentration of undiluted/disc, anti-fungal activity was against Keratinonyces ajelloi, Microsporum gyseum, Trichophyton equinum, Trichophyton mentagrophytes, Trichophyton terrestris, Trichophyton rubrum on the agar plates.[36]

The volatile constituents of the flowers of *Mumusops elengi* were isolated by hydrodistllation and identified by capillary GC and GC-MS. The most abundant components were 2-phenylethanol (29.8 %), *(E)*-2-hexenal (11.8 %) and benzyl alcohol (10.4 %). The flower

volatiles were tested for antibacterial activity using the micro-dilution antibacterial assay. The flower oil showed antibacterial activity against Gram-negative bacteria (78-156 µg/mL).[37]

Antioxidant Activities:

Antioxidant potential of the methanol extract of the leaves of *Mimusops elengi* was evaluated by using 1,1-diphenyl-2-picrylhydrazyl (DPPH) scavenging assay, reducing power and total antioxidant capacity. The extract showed significant activities in all antioxidant assays compared to the reference antioxidant ascorbic acid in a dose dependent manner.[38]

The antioxidant activity of various parts (bark, fruit, flower and leaves) of *Mimusops elengi* was studied in various solvents. The antioxidant potential of the herb was investigated by 2,2-diphenyl-1-picryl hydrazyl radical (DPPH) scavenging and ferric reducing power assay. The methanolic extract of flowers and fruits 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. The flowers of *M.elengi* have superior antioxidant activities.[39]

The antioxidant capacities of the phenolic compounds extracted from immature green, mature green and orange ripe fruits of *Mimusops elengi* were investigated. 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, soluble phenolic esters and insoluble phenolic acid esters. 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.[40]

Crude methanolic extract of *Mimusops elengi* leaf was investigated for its possible antioxidant activity. The extract exhibited statistically significant antioxidant activity in DPPH free radical scavenging and Nitric oxide scavenging test.[41]

In vitro antioxidant activity of methanolic extract of bark of *M. elengi* was evaluated using reducing power assay, DPPH and hydroxyl radical scavenging assay. The extract offered significant in vitro reducing power capacity and radical scavenging activity.[42]

The extract of stem bark and seeds of *Mimusops elengi* were prepared in methanol and acetone:water (7:3) to evaluate their antioxidant potential of the phenolic extracts. The acetone: water was further partitioned with ethyl acetate and n-butanol. Antioxidant activity of the extracts and partitioned fractions of *M. elengi* was evaluated in terms of radical scavenging potential (DPPH), inhibition of lipid peroxidation [ferric thiocyanate (FTC)] and total antioxidant activity (phosphomolybdate method). Total phenolics content were calculated using Folin-

Ciocalteu reagent. The stem bark extract partitioned with ethyl acetate exhibited highest amount of total phenols, 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 and total antioxidant activity.[43]

The in vitro antioxidant of methanolic extract of bark of *M. elengi* was evaluated using reducing power assay, DPPH and hydroxyl radical scavenging assay. The extract offered significant in vitro reducing power capacity and radical scavenging activity.[44]

Wound Healing activity:

Methanolic extract of bark parts of *Mimusops elengi* was studied 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 above said wound models as comparable to those of a standard drug Betadine ointment in terms of wound contracting ability, wound closure time, tensile strength and dry granuloma weight.[45]

Cytotoxic activity:

The ethanolic extract of the leaves and its different fractions: n-hexane, chloroform, ethyl acetate and n-butanol were evaluated for *in vivo* hepatoprotective activity against CCl_4 induced hepatic cell damage in rats and in vitro cytotoxicity against human liver cancer cell line (HEPG2). The n-hexane fraction showed promising cytotoxicity against HEPG2 where as ethyl acetate fraction showed significant hepatoprotection.[46]

The cytotoxic effects of ethanolic extract of barks of *M. elengi* was investigated on meristimatic cells of root tips of *Allium cepa* by using different concentrations 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.[47]

Crude methanolic extract of *Mimusops elengi* leaf was investigated for its possible cytotoxic activity. The cytotoxic activity of the extract was assessed by brine shrimp lethality bioassay. The extract exhibited statistically significant activity.[41]

Antihyperglycemic activity:

In vivo antihyperglycemic property of methanolic extract of bark of *M. elengi* was studied in alloxan induced diabetes in mice, the extract exhibited significant antihyperglycemic effect in diabetic as well as non diabetic glucose loaded mice.[42]

Methanolic extracts of flower and leaves of *Mimusops elengi* were evaluated for their hypoglycemic effect in normoglycaemic and alloxan-induced diabetic rats. Both the extracts of

Mimusops elengi were administered orally to normal and alloxan-induced diabetic rats. The fasting blood glucose, oral glucose tolerance test and alloxan-induced diabetic models were performed for the hypoglycemic effects and compared with tolbutamide, a standard drug. Both the extracts showed marked decreased in blood glucose level in normotensive rats within 2 h after oral administration. A significant decreased in elevated blood glucose level was observed in glucose loaded animals. The study demonstrated the potential hypoglycemic and hypolipidemic effects of flower and leaves of *Mimusops elengi* and support the traditional use of the plant as hypoglycemic and hypolipidemic agents.[48]

In vivo antihyperglycemic property of methanolic extract of bark of *M. elengi* was studied in alloxan induced diabetes. The antihyperglycemic effect of the extract was persistent up to 24th hr after drug administration. The extract demonstrated significant reduction in elevated glucose levels 2hr before glucose administration and 6 hr after glucose load in oral glucose tolerance test in diabetic animals which exhibited antihyperglycemic activity in diabetic as well as non diabetic glucose loaded mice.[44]

Molluscicidal activity:

The molluscicidal activity of *Mimusops elengi* bark was studied against vector snail *Lymnaea acuminata*. The toxicity of the plant was time and concentration-dependent. Among the organic extracts (ethanol, acetone, ether and chloroform), ethanol extract was more toxic. Saponin and quercetin were identified as active molluscicidal component of the bark.[49]

Analgesic activity:

The methanolic bark extract of *Mimusops elengi* was investigated for its possible analgesic activity on mice at the doses of 100mg/kg, 200mg/kg and 400mg/kg body weight. For the evaluation of analgesic activity, tail immersion and acetic acid induced writhing tests were used. In tail immersion test, the extract produced a significant increase of latent time to flick tail compared to control in a dose dependent manner. In acetic acid-induced writhing test, the extract also showed significant inhibition of writhing compared to the control while the reference drug Diclofenac sodium was found to be more potent than the test. The result suggested that the extract possesses analgesic activity.[50]

Crude methanolic extract of *Mimusops elengi* leaf was investigated for its 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 significantly inhibition of writhing at a dose dependent manner. In hot plate test the extract exerted significant prolongation in the response of latency time to the heat stimulus.[41]

Neuropharmacological activity:

The methanolic bark extract of *Mimusops elengi* was investigated for its possible neuropharmacological activities on mice. The neuropharmacological activity of the extract was screened using hole cross and open field tests to investigate the central nervous system depressant activity. In CNS depressant activity tests, the extract significantly decreased motor activity and exploratory behavior of mice in hole cross and open field tests respectively which suggest that the extract possesses CNS depressant activity.[50]

CONCLUSION

Herbal medicines are in great demand in developed and developing countries for their primary health care because of their wide range of biological activities, higher safety margins, easy availability and lesser costs. This review has presented the general properties, important chemical constituents, fluorescence analysis, colour analysis, histochemical study, extractive values of different parts of the plant in different solvents, nutritive values and traditional uses along with the wide range of pharmacological activities of *Mimusops elengi* which will be helpful to the researchers for further study about the plant.

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