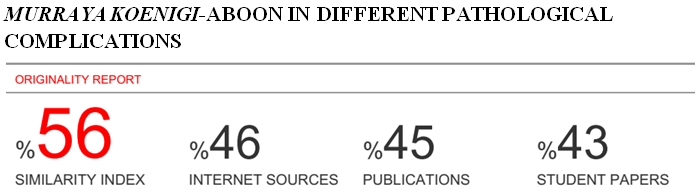
**Reviewer’s Comments**

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***MURRAYA KOENIGI*-ABOON IN DIFFERENT PATHOLOGICAL COMPLICATIONS**

**ABSTRACT-**

Since very long period of time medicinal plants or their bioactive compounds have been utilized by majority of world population particularly in developing countries for primary and traditional healthcare system. At present scenario, people are more interested to use herbal drugs because they are considered as safe and inexpensive having no adverse effects. Different parts of the plants like roots, leaves, stem, bark, fruits and seeds have been used in treatment of different diseases and strengthening the immune system. *Murraya koenigii*, is a herb from mainly Asian origin, it has therapeuticapplications such as in bronchial disorders, piles, vomiting, skin diseases, night blindness, dysentery, diarrhoea, bites of poisonous animals, bruises and eruption etc.

The present review is an attempt for description of *M. koenigii*, its phytochemicalconstituents and various pharmacological activities.

**Keywords:** Murraya koenigii, phytochemistry, pharmacological activities.

**INTRODUCTION**

Murraya koenigii (family *Rutaceae*) is a herb having characteristic aroma and different potential medicinal values. It is deciduous shrub or tree up to 6 m in height and 15-40 cm in diameter with short trunk, thin smooth grey or brown bark and dense shady crown1.

The most important chemical constitutents responsible for its intense characteristic aroma are P-gurjunene, P-caryophyllene, P-elemene and O-phellandrene. The plant is rich source of carbazole alkaloids. Phytocompounds like koenimbine, koenine, mahanimbine,murrayazolidine, murrayazoline, murrayacine, girinimbine, mukoeic acid, etc. have also been isolated and characterized2.

The stem of *M. koenigii* is an aromatic and more or less deciduous shrub or small tree upto 6 meters in height and 15 to 40 cm in diameter. The main stem is dark green to brownish. The bark of the stem can be peeled off longitudinally which exposes the white woodunderneath. Flowers are small, white fragrant ebracteate, calyx deeply five cleft, pubescent3. Petals five, free, whitish, glabrous and with dotted glands. Fruits occur in close clusters, small ovoid or sub-globose, glandular, thin pericarp enclosing one or two seeds having spinach green color4.

Fresh leaves, dried leaf powder, and essential oil are widely used for flavouring soups, curries, fish and meat dishes, eggs dishes, traditional curry powder blends, seasoning and ready to use other food preparations. Bark and roots are used as stimulant andexternally to cure eruptions and bites of poisonous animals5.

It is traditionally used as a whole or in parts as anti-emetics, anti-diarrheal, febrifuge, blood purifier, antifungal, depressant, anti-inflammatory, body aches, for kidney pain and vomiting.

Green leaves are eaten raw for cure of dysentery, diarrhoea and for checking vomiting6.

Leaves and roots are also used traditionally asbitter, anthelmintic, analgesic, curing piles, inflammation, itching and are useful in leucoderma and blood disorders7.

Flowers are white, ebracteate, scented and small in size. Calyxdeeply five cleft, pubescent. Petals five, free, whitish, glabrous and with dotted glands. It bears fruits in close clusters/ bunches, small, ovoid or sub-glucose, glandular, thin pericarp enclosing one or two seeds having spinach green color.

**Botany of Plant**

|  |  |
| --- | --- |
| Kingdom | Plantae |
| Sub-kingdom | Tracheobionta |
| Superdivision | Spermatophyta |
| Division | Magnoliophyta |
| Class | Magnoliospida |
| Subclass | Rosidae |
| Order | Sapindales |
| Family | Rutaceae |
| Species | *Murraya Koenigii* L. Spreng |

**Origin and Distribution**

*Murraya koenigii* is basically found in tropical Asia like the foothills of Himalayas of India, Sri Lanka, Myanmar, Indonesia, Southern China and Hainan. It reproducesthe means of seeds which germinate freely under partial shade. It is also available in other part of Asian region like in moist forests of 500-1600 m height in Guangdong, S Hainan, S Yunnan (Xishuangbanna), Bhutan, Laos, Nepal, Pakistan, Sri Lanka, Thailand, Vietnam. Together with South Indian immigrants, curry leaves reached Malaysia, South Africa and Réunion Island. They are hardly found outside the Indian sphere of influence8.



Whole Plant Leaves

**Fig 1- *Murraya koenigii***

**PHYTOCHEMISTRY:**

*Murraya koenigii* is a rich source of different organic compoundswith diverse chemical composition.

**Leaves**

Fresh young leaves contains yellow colored volatile oil rich in vitamin A, calcium, girinimbin, iso-mahanimbin, koenine, koenigine, koenidine and koenimbineLeaves are aromatic and contain proteins, carbohydrates, fiber, minerals, carotene, nicotinic acid and vitamin C. Mature leaves contains 63.2 % moisture, 1.15 % total nitrogen, 6.15 % fat, 18.92 % totalsugars, 14.6 % starch, 6.8 % crude fiber, ash 13.06 %, acid insoluble ash 1.35 %, alcoholsoluble extractive 1.82%. The leaves contain high amount of oxalic acid, leaves also contains crystalline glycosides, carbazole alkaloids, koenigin, resin, fresh leaves contain yellow color 2.5 % volatile oil9.

**Bark**

Bark mainly contains the carbazole alkaloids as murrayacine, murrayazolidine, murrayazoline, mahanimbine, girinimbine, koenioline, xynthyletin. The alcoholic extract ofstem bark shows the presence of koenigine- quinone A and koenigine quinone B9.

**Fruits**

The pulp of fruits contains 64.9% moisture, 13.35% of vitamin C, 9.76% total sugar, 0.17% non-reducing sugar), trace amount of minerals (1.97% phosphorus, 0.082% potassium, 0.811% calcium, 0.166% magnesium and 0.007% iron)10.

**Roots:**

**Roots contains** murrayanol, mukoenine- A, -B and C and murrastifoline –F. bis – 2- hydroxy- 3- methyl carbazole, bismahanine, bi koeniquinone- A and bismurrayaquinone A, Koenoline (1- methoxy-3- hydroxy methyl carbazole)**.** Roots were also found to contain girinimbine11.

**Seeds:**

Mahanimbine, girinimbine, koenimbine, isomahanine and mahanine were isolated form seeds of *M. koenigii12 .*

**PHARMACOLOGICAL ACTIVITY PROFILE OF *M. KOENIGII*:**

**1. Antioxidant and free radical-scavenging activity:**

Antioxidant activity has been reported by a number of workers. In a study antioxidative properties of the extract of *M.koenigii* leaves were done using differentsolvents. They were evaluated on the basis of oil stability index together with theirradical scavenging ability against 1-1-diphenyl-2-picrylhydrazyl. The methylene chloride extract and the ethyl acetate soluble fraction of the 70 % acetone extract was prolonged13, 14.

**2. Cytotoxic Activity-** In a study the alkaloid koenoline isolated from the root bark of M. koenigii is found to exhibit cytotoxic activity against KB cell culture system15. Carbazole alkaloids isolated from the stems are found to have significant effects in the growth of the human leukaemia cell line HL-60. Mahanine, pyrafoline-D and murrafoline-I (Carbazole alkaloids) showed significant cytotoxicity against HL-60 cells and cause a significantloss in mitochondrial membrane potential. The results obtained suggested it, s cytotoxic activity potential16.

**3. Hypoglycemic activity:**

Leaves feeding produce hypoglycemia by increasing the hepatic glycogenesis as evident by increased activity of glycogen synthetase17. In a study a decrease in glycogenolysis and gluconeogenesis is reported and was evident form decreased activity of glycogen phosphorylase and gluconeogenic enzymes. A significant reduction in fasting blood sugarand postprandial blood sugar was observed by feeding (12 gm) leaves powder to non insulin dependent diabetes mellitus patients. The results obtained suggested it, s hypoglycemic activity potential18.

**4.** **Antimicrobial and anti-fungal activity:**

In a study Murrayanine, girinimbine and mahanimbine isolated form stem bark showed anti fungal activity against human pathogenic fungi. 1- formyl-3 methoxy-6- methyl carbazole and 6,7-dimethoxy-1- hydroxy-3- methyl carbazole were reported to possessantibacterial and anti fungal property. Extract containing murrayanol and or isomahanine is used as microbicide in variety of industries due to high safety, strong activity, little odor and without coloring effect19.

**5. Anti-inflammatory activity**

In a study stem bark of alcoholic extract in a dose of 1 gm/ kg body weight showed protective effect against carrageenan-induced inflammation. Crude root extract also showed anti-inflammatory activity in rat model. The mast cell stabilization and antihistaminic effects of EEMK were suggested to be the probable mechanisms for its anti- inflammatoryaction and thus attains its therapeutic value. Study concludes anti-inflammatory potential of M. koenigii*20.*

**6.** **Immunomodulatory activity**

In a study methanolic extract of M. koenigii showed significant increase in phagocytic index by rapid removal of carbon particles from blood stream. The extract also increased the antibody titre against ovalbumin and protection towards cyclophosphamide-induced myelosuppression in albino mice. Oral administration of the aqueous extract of leaves at doses of 250 and 500 mg/kg significantly enhanced the delayed-type hypersensitivity reactioninduced by ovalbumin. The extract also potentiated the production of circulating antibody titre significantly in response to ovalbumin21.

**7.** **Alzheimer disease therapy**

In a studyadministration ethanolic extract of M. Koenigii Leaves for 15 days produces significant dose-dependent improvement of memory. The results alsoindicated to reduce the brain cholinesterase activity and total cholesterol level. Diet rich in *M. koenigii* leaves produced significant dose-dependent improvement in the memory scores of young and aged mice and significantly reduced the amnesia induced by scopolamine (0.4 mg/kg, intraperitoneally) and diazepam (1 mg/kg, intraperitoneally)22.

**8. Anti-obesity and anti-hyperlipidemic activities**

In a study the dichloromethane and ethyl acetate extracts of Murraya koenigii leaves significantly reduced the body weight gain, plasma total cholesterol and triglyceride levels significantly. The observed anti-obesity and antihyperlipidemic activities of these extract are correlated with the carbazole alkaloids, Mahanimbine. When it wasgiven orally (30 mg/kg/day) significantly lowered the body weight gain. These findings demonstrate the excellent pharmacological potential of mahanimbine to prevent obesity23.

**9.** **Antiamnesic and wound-healing activity-**

In a study aqueous extract of M. koenigii accelerates the wound-healing process by decreasing the surface area of the wound. Aqueous extract of leaves showed markedreduction in wound area in comparison with the control group from 4th day onwards in albino rats by excision wound model24.

**10.** **Kidney protective activity**

In a study aqueous extract of leaves produced a significant dose- dependent decrease in serum urea and creatinine levels (P<0.001), and a marked increase in the levels ofplasma antioxidant capacity (P<0.01) in diabetic rats, compared with the control (non-diabetic) subjects. Histological studies of the kidneys of these animals showed comparable tissue regeneration by the aqueous extract25.

**11.** **Antipyretic activity**

In a study ethanolic extract of leaves of M. koenigii was investigated for antipyretic activity in rats using yeast-induced pyrexia model. Ethanolic extract at a single dose of 300 mg/kg produced significant antipyretic activity (P<0.01) in albino rats as compared with the standard drug paracetamol26.

**12. Anti ulcer activity-**

Antiulcer activity of aqueous and solvent ether extracts of *Murraya koenigii* was studied in reserpine induced gastric ulcer model in albino rats. Aqueous and solvent ether extracts of *Murraya koenigii* effective in gastric ulceration and suggested as protective as ranitidine.

The extract dose of murraya koenigii 200-400 mg/kg produced significant inhibition of gastric secretion. The results obtained suggested that the extract possessessignificant antiulcer activity27.

**13. Antitrichomonal activity**

In a study carbazole alkaloids and their derivatives from M. koenigii leaves showed antitrichomonal activity against Trichomonas gallinae. Girinimbine and girinimbilol with IC50 values of 1.08 and 1.20 mg/mL were the most active. Acetylation ofgirinimbilol and mahanimbilol improved their activities to 0.60 and 1.08 mg/Ml28.

**14. Anthelmintic activity**

Ethanolic and aqueous extracts from *M. koenigii* leaves were investigated for their anthelmintic activity against *Pheretima posthuma*. Both the extracts exhibited significant anthelmintic activity at concentration of 100 mg/mL. The alcoholic extract produced more significantanthelmintic activity than petroleum ether extract29.

**15. Cosmetic use-**

Hyaluronidase inhibitors are extracted from M. koenigii and are formulated in a cream base. *M. koenigii* extract is included in a skin-lightening cosmetic for its moisturizing, antioxidant and hyaluronidase inhibitory activity. Herbal composition containing *M. koenigii* stem extract as one of the ingredient showed skin lightening and rough skin improving effect. *M. koenigii* was studied for sun protection30, 31.

**16. Anti-diarrhoeal activity**

In a study bioactive alkaloids like, kurryam and koenimbine obtained fromfractionated n-hexane extract of the seeds of M. koenigii were showed inhibitory action in reference to castor oil-induced diarrhoea and prostaglandin E2-induced enter pooling in strain of Wistar rats in charcoal meal test in Wister rats, these compounds were found to exhibit significant reduction in gastrointestinal motility and play mandate role in studying the modulatory role in disease progression32.

**17. Anticancer Activity**

Intraperitoneal inoculation of Dalton’s Ascitic Lymphoma cells in themice produced an enormous increase in the cancer cell count which indicated that there is progression of cancer in the animals33. The decrease in the cancer cell number observed in the ether extract of *Murraya koenigii* the treated mice of G4 indicates that the test drug is having significant inhibitory effect on the tumour cell proliferation. The increase in tumour weight of G2 may be due to accumulation of peritoneal fluid as an abnormal enlargement of peritoneal cavity was observed in tumour-induced mice. Treatment with extract of *Murraya koenigii* reduced the tumour weight and hence increased the life span34.

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| --- | --- | --- | --- |
| **S. N.** | **Plant Part** | **Pharmacological Activity** | **Extract** |
|  | **Leaf** | Anti-inflammatory | Ethanol, petroleum ether, chloroform, methanol |
| Anti-amnesic, memory enhancer, anti-tumor | Petroleum ether |
| Hypocholesterolemic, wound healing activity, anti-helminthic | Ethanol |
| Anti-fungal | Petroleum ether, alcohol and acetone |
| Analgesic and antinociceptive, radioprotective and chemoprotective, anti-oxidant, phagocytic activity, anti-lipid peroxidative | Methanol |
| Anti-ulcer, cardiovascular | Aqueous |
|  | **Bark, leaf** | Anti-bacterial | Petroleum ether, alcohol |
|  | **Stem bark** | Anti-cancer | Petroleum ether |
|  | **Seeds** | Antidiarrhoeal | n-hexane |
|  | **Roots, stem** | Cytotoxicity | Aqueous |
|  | **Leaf, fruit** | Anti-diabetic | Aqueous, methanol |

**CONCLUSION**

At present scenario, people are moving towards the use of herbal medicine for any kind of treatment as it seems to be economical and more beneficial without any adverse effects. According to WHO (World Health Organization), 80% of the population of developing countries still rely on plant-based medicines. The presence of various beneficialconstituents in plants has always motivate scientists to carry out research for investigations for finding new therapeutic agents for treatment of different diseases. Based on tremendous pharmacological activities and plenty of literature available, *M. koenigii* may be utilized to alleviate the symptoms of variety of diseases. Almost each and every part of the plant has numerous therapeutic values. Various parts of it have numerous medical applications; modern drugs can be developed after extensive investigation of its bioactivity, mechanism of action, pharmaco-therapeutics, toxicity and after proper standardization and clinical trials. Wide spread availability of *M. koenigii* makes it suitable candidate for further pre-clinical and clinical research. From the available literature it can be stated that *Murraya koenigii* is a versatile medicinal plant having rich source of biologically active compounds. Thus, it can be consider being a most suitable candidate for new drug discovery evaluated by means of scientific experimental animal models and clinical trials.

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