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REVIEW ARTICLE

MURRAYA KOENIGI-A BOON IN DIFFERENT PATHOLOGICAL CONDITIONS

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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 therapeutic applications 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 phytochemical constituents 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 crown[1]. 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 characterized[2]. 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 wood underneath. Flowers are small, white fragrant ebracteate, calyx deeply five cleft, pubescent[3]. 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 color[4]. 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 and externally to cure eruptions and bites of poisonous animals[5]. 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 vomiting[6]. Leaves and roots are also used traditionally as bitter, anthelmintic, analgesic, curing piles, inflammation, itching and are useful in leucoderma and blood disorders[7].

Table 1: Botany of plant.

Kingdom	Plantae
Sub-kingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliospida
Subclass	Rosidae
Order	Sapindales
Family	Rutaceae
Species	*Murraya koenigii* L. Spreng

Flowers are white, ebracteate, scented and small in size. Calyx deeply 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.

(a). Whole plant (b). Leaves

Figure 1: *M. koenigii.*

Origin and Distribution

M. koenigii is basically found in tropical Asia like the foothills of Himalayas of India, Sri Lanka, Myanmar, Indonesia, Southern China and Hainan. It reproduces the means of seeds which germinate freely under partial shade. It is also available in other part of Asian region like in moist forests of 500-1600m height in Guangdong, S Hainan, S Yunnan (Xishuang banna), 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 influence[8].

PHYTOCHEMISTRY

M. koenigii is a rich source of different organic compounds with diverse chemical composition.

Leaves

Fresh young leaves contains yellow colored volatile oil rich in vitamin A, calcium, girinimbin, iso-mahanimbin, koenine, koenigine, koenidine and koenimbine Leaves 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% total sugars, 14.6% starch, 6.8% crude fiber, ash 13.06%, acid insoluble ash 1.35%, alcohol soluble 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 oil[9].

Bark

Bark mainly contains the carbazole alkaloids as murrayacine, murrayazolidine, murrayazoline, mahanimbine, girinimbine, koenioline, xynthyletin. The alcoholic extract of stem bark shows the presence of koenigine-quinone A and koenigine quinone B[9].

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-hydroxylmethyl carbazole). Roots were also found to contain girinimbine[11].

Seeds

Mahanimbine, girinimbine, koenimbine, isomahanine and mahanine were isolated form seeds of *M. koenigii*[12].

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 different solvents. They were evaluated on the basis of oil stability index together with their radical scavenging ability against 1-1-diphenyl-2-picrylhydrazyl. The methylene chloride extract and the ethyl acetate soluble fraction of the 70 % acetone extract was prolonged[13,14].

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 system[15]. 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 significant loss in mitochondrial membrane potential. The results obtained suggested it, s cytotoxic activity potential[16].

3. Hypoglycemic activity

Leaves feeding produce hypoglycemia by increasing the hepatic glycogenesis as evident by increased activity of glycogen synthetase[17]. 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 sugar and 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 potential[18].

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 possess antibacterial 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 effect[19].

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- inflammatory action 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 reaction induced by ovalbumin. The extract also potentiated the production of circulating antibody titre significantly in response to ovalbumin[21].

7. Alzheimer disease therapy

In a study administration ethanolic extract of *M. koenigii* Leaves for 15 days produces significant dose-dependent improvement of memory. The results also indicated 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 *M. 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 was given orally (30 mg/kg/day) significantly lowered the body weight gain. These findings demonstrate the excellent pharmacological potential of mahanimbine to prevent obesity[23].

9. Anti-amnesic 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 marked reduction in wound area in comparison with the control group from 4th day onwards in albino rats by excision wound model[24].

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 of plasma 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 extract[25].

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 paracetamol[26].

12. Anti-ulcer activity

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

The extract dose of *M. koenigii* 200-400 mg/kg produced significant inhibition of gastric secretion. The results obtained suggested that the extract possesses significant antiulcer activity[27].

13. Anti-trichomonal activity

In earlier 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 of girinimbilol and mahanimbilol improved their activities to 0.60 and 1.08 mg/Ml[28].

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 significant anthelmintic activity than petroleum ether extract[29].

Table 2: Pharmacological activity shown by extract of different parts of *M. koenigii.*

S. N.	Plant Part	Pharmacological Activity	Extract
1.	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
2.	Bark, leaf	Anti-bacterial	Petroleum ether, alcohol
3.	Stem bark	Anti-cancer	Petroleum ether
4.	Seeds	Antidiarrhoeal	n-hexane
5.	Roots, stem	Cytotoxicity	Aqueous
6.	Leaf, fruit	Anti-diabetic	Aqueous, methanol

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 protection[30,31].

16. Anti-diarrhoeal activity

In a study bioactive alkaloids like, kurryam and koenimbine obtained from fractionated 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 progression[32]

17. Anti-cancer Activity

Intraperitoneal inoculation of Dalton's Ascitic Lymphoma cells in the mice produced an enormous increase in the cancer cell count which indicated that there is progression of cancer in the animals[33]. The decrease in the cancer cell number observed in the ether extract of *M. koenigii* the treated mice indicates that the test drug is having significant inhibitory effect on the tumour cell proliferation. The increase in tumour weight 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 *M. koenigii* reduced the tumour weight and hence increased the life span[34].

CONCLUSIONS

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 beneficial constituents in plants has always motivated 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 *M. 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.

AUTHOR'S CONTRIBUTION

Chibueze IJ: writing original draft, methodology, investigation, formal analysis, conceptualization. **Emenike IV:** writing, review and editing, methodology, formal analysis, conceptualization. All authors read and approved the manuscript.

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CONFLICT OF INTEREST

No conflict of interest associated with this work.

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