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## *Murraya koenigii* (L.) Spreng: an ethnobotanical, phytochemical and pharmacological review

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**Abstract**

Medicinal plants have been used in traditional healthcare system throughout human history and are considered as a source of healthy human life. Different parts of the plants like roots, leaves, stem, bark, fruits and seeds have been used in combating infection and strengthening the immune system. *Murraya koenigii* is a potential medicinal plant highly valued for its characteristic aroma and bioactive compounds. It belongs to family Rutaceae which represent more than 150 genera and 1600 species. *Murraya koenigii* has diverse role in traditional medicine and is known for its stomachic properties. The leaves and roots in different forms have great therapeutic potential and is used for the treatment of night blindness, dysentery, diarrhoea, vomiting, bites of poisonous animals, bruises and eruption. Leaves are often used in curries for flavouring and seasoning due to their aromatic nature. They are generally called by the name "curry leaves" and are an important export commodity from India and fetches good foreign revenue. The plant is a rich source of carbazole alkaloids. Phytocompounds like koenimbine, koenine, mahanimbine, murrayazolidine, murrayazoline, murrayacine, girinimbine, mukoeic acid, etc. have also been isolated and characterized. These bioactive compounds possess antioxidant, antimicrobial, anthelmintic, analgesic, anti-inflammatory, antidiarrheal, hepatoprotective and antitumor properties. The present review incorporates the description of *M. koenigii*, its ethnobotany, phytochemical constituents and various pharmacological activities of crude extracts, fractions and isolated compounds which could lead to development of viable drugs for the treatment of variety of ailments.

**Keywords:** Ethnobotany, *Murraya koenigii*, pharmacology, phytochemistry, Rutaceae.

**1. Introduction**

Plants have been used as medicines for thousands of years all over the world. According to WHO (World Health Organization), 80% of the population, mostly in developing countries still rely on plant-based medicines for their primary health care. In India, the different systems of medicinal usage like Ayurveda, Siddha, Unani, Amchi and local health traditions, focuses on the use of plant products for the treatment of human and animal diseases. Medicinal plants contain numerous biologically active compounds which are helpful in the treatment of various diseases and improving human life. In addition to being a good source of anti-infective agents, they are also cost-effective and have fewer side effects<sup>[1, 2]</sup>. The presence of various life sustaining constituents in plants has always encouraged scientists to carry out investigations for finding new therapeutic agents for the various fields of biomedicine. Some of the outstanding medicinal drugs developed from the plants include vinblastine and vincristine (*Catharanthus roseus*), reserpine (*Rauwolfia serpentina*), aspirin (*Salix purpurea*), and quinine (*Cinchona pubescens*) used for treating cancer, hypertension, (inflammation pain and thrombosis) and malaria, respectively.

India has rich plant diversity and houses about 47,000 plant species, out of these 7,500 have medicinal value; but only 800 plant species are used in the preparation of herbal drugs. A large number of plants still remain unexplored with regard to their medicinal properties and they can be sources of potential bioactive compounds for the development of new "leads" to combat various diseases. The present review is on *Murraya koenigii* which is commonly called as "curry leaf" in English and meetha neem in Hindi. It is an important medicinal plant of our country and is grown in almost every house for its aromatic leaves. Systematic scientific studies have been conducted regarding the efficacy of different plant parts in the treatment of various diseases. There is a need to review the information available in literature on *Murraya koenigii* to answer the gaps between ethnobotanical uses and phytochemical studies, so that it would aid future research by phytochemists, pharmacologists, clinicians,

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scientists, researchers and toxicologists. The information collected has been compiled and made available at one place in the interest of the scientific community.

## 2. Botany of Plant

### 2.1. Origin and Distribution

*Murraya koenigii* is a native of India, Sri Lanka and other south Asian countries. *Murraya koenigii* is distributed throughout India and is abundantly found from Sikkim to Garhwal, Bengal, Assam, Western Ghats and Kerala. It reached to Malaysia, South Africa and Reunion Island from India along with South Indian immigrants. The taxonomic status and vernacular names used in India and different parts of the world are given below:

### 2.2. Taxonomic status

Kingdom	:	Plantae
Subkingdom	:	Tracheobionta
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Subclass	:	Rosidae
Order	:	Sapindales
Family	:	Rutaceae
Genus	:	<i>Murraya</i>
Species	:	<i>koenigii</i>

### 2.3. Vernacular names in Indian languages

Bengali	:	Barsunga
Gujarati	:	Mitho limdo
Hindi	:	Meetha neem, Karipatta, Kathnim, Bursunga
Kannada	:	Karibevu
Malayalam	:	Kariveppilei, Kareapela
Marathi	:	Karipat, Karhi patta, Karhinimb, Jhirang
Oriya	:	Bansago

Sanskrit	:	Girinimba, Suravi
Tamil	:	Karivempu, Kariveppilei, Karivepila
Telugu	:	Karepaku, Karuvepaku

### 2.4. Vernacular names in other languages

Burmese	:	Pindosine, Pyim daw thein
Danish	:	Karry bald
Dutch	:	Kerriebladeren
English	:	Curry leaves
French	:	Feuilles de cari, Feuilles de cury
German	:	Curryblatter
Indonesian	:	Daun kari
Italian	:	Fogli de Cari
Spanish	:	Hoja

### 2.5. Plant Description

*Murraya koenigii* is more or less deciduous shrub or small tree reaching up to 6 m in height. The plant has a short trunk with 15-40 cm diameter, smooth, greyish or brown bark and has dense shady crown [4]. The main stem is dark green to brownish in colour. The leaves are bipinnately compound, 15-30 cm long, each bearing 11-25 leaflets alternate on rachis, 2.5-3.5 cm long ovate lanceolate with an oblique base. The leaf margins are irregularly serrate and petiole is 2-3 mm long. Inflorescence is terminal cymes; each bearing 60-90 flowers. Each flower is bisexual, white, funnel shaped sweetly scented, stalked, complete, ebracteate and regular with average diameter of fully opened flower being 1.12 cm. The calyx is deeply lobed with five cleft and pubescent. Petals are five with free, whitish, glabrous dotted glands. Fruits occur in close clusters. They are small ovoid or subglobose, glandular, with thin pericarp enclosing one or two seeds which are spinach green in colour [6]. Fruits are 2.5 cm long and 0.3 cm in diameter wrinkled with glands and turns purplish black after ripening; are edible and yields 0.76% of a yellow volatile oil. The individual seed is 11 mm long, 8 mm in diameter and weights up to 445 mg [5].



**Fig 1:** Morphology of *Murraya koenigii* (A-Whole plant, B-leaves, C-seeds).

**3. Ethnobotanical Uses**

*Murraya koenigii* is one of the plant species with potential medicinal properties. The whole plant and different parts of

the plant are used to cure many human ailments. The ethnobotanical profile is given in Table 1.

**Table 1:** Ethnobotanical profile of *Murraya koenigii*

S.no.	Plant part used	Ethnobotanical uses	References
1.	Whole plant	Used as Stimulant Hair tonic Bloodpurifier Antidepressant Antidysenteric Antidiarrheal Antifungal Anti-inflammatory Antiemetic  To cure Diabetes mellitus Leucoderma Body aches Kidney pain Vomiting	[13-25]  [7] [7] [12]  [9] [9] [10] [9] [9]
2.	Stem	Used as Datum for cleaning, strengthen gums and teeth	[11]
3.	Bark	Used as Hair tonic, Stomachic and Carminative	[10]
4.	Leaves	Used as Stomachic Purgative Febrifuge Anti-anemic Anti-helminthic Analgesic Anti-ulcer Antinociceptive Antiamnesic Anti Inflammation, cooling and itching Hair tonic Stimulant of hair growth  To cure Bruises and Eruption Night blindness, Vomiting Bites of poisonous animals Hypercholesterolemia lightening  For Flavoring and Seasoning Memory enhancing Maintaining the natural skin Pigmentation and showed skin lighting and rough skin improving effect Losing weight Hypoglycemic activity	[7-10,89] [87, 88] [89] [3]  [7-10] [7-10]    [7-10]  [3] [13] [3] [3,93]  [94-100]

		To Enhance Appetite and digestion	
5.	Fruits	Used as Astringent	[10]
6.	Roots	Used as Anti helminthic Analgesic Cooling agent	[9]
		Reduces Inflammation, itching	[9]
		To cure Kidney pain Leucoderma Blood disorders	[10] [9] [9]

#### 4. Phytochemistry

*Murraya koenigii* is a rich source of organic compounds with diverse chemical composition. The presence of alkaloids, flavonoids, and sterol in plant extracts prepared in solvents such as petroleum ether, ethyl acetate, chloroform, ethanol and water has been reported by various workers [27-30].

##### 4.1. Roots

Srivastava *et al.* (1993) isolated murrayanol, murrayagetin and marmesin-1''-O-rutinoside [54]. Chihiro *et al.* (1993) isolated three monomeric and five binary carbazole alkaloids named mukoenine-A, B, C and murrastifoline-F. Bis-2-hydroxy-3-methyl carbazole, bismahanine, bi koeniquinone-A and bismurrayaquinone a form root and stem bark [55]. From the benzene extract of roots mukolidine (fig. 7) and mukoline (fig. 8) were detected [54]. Roots were also found to contain girinimbine, koenoline (1- methoxy-3- hydroxy methyl carbazole) (Fig.6) [56-57].

##### 4.2. Stem

The bark of the stem contains the carbazole alkaloids such as murrayacine, murrayazolidine, murrayazoline, mahanimbine (fig.2), girinimbine (fig.10), koenioline and xynthyletin [36, 82]. The alcoholic extract of stem bark shows the presence of koenigine- quinone A and koenigine quinone B. Chemical structures of these compounds were established as 7-methoxy-3 methyl carbazole-1,4-quinone and 6,7-dimethoxy-3-methyl carbazole-1,4- quinone respectively [37]. Chakraborty *et al.* (1997) isolated 9-carbethoxy-3-methyl carbazole and 9-formyl -3- methyl carbazole [38]. Bhattacharya *et al.* (1994) isolated Me- 2- methoxy carbazole -3- carboxylate, 1- hydroxy -3- methyl carbazole, Mukonal (fig.9), a probable biogenetic intermediate of pyrano carbazole alkaloid and murrayazolinol (a minor carbazole alkaloid) [39-41]. Compounds mahanimbine (fig. 3), girinimbine, mahanimbine, girinimbine and mahanimbilol (possible biogenetic precursors of girinimbine and mahanimbine) have also been isolated from the stem bark of *M. Koenigii* [48, 49]. Presence of coumarin galactoside marmesin- 1'-O-β-D-galactopyranoside, osthol and umbelliferone has been shown in the ethanolic extract of stem bark was also detected [64]. Petroleum ether extract has shown the presence of 3- (1, 1- dimethyl allyl xanthyletin) [65]. The presence of mukeic acid (1- methoxy carbazole- 3- carboxylic acid) and mukoeic acid has also been reported

from the stem [66, 67].

##### 4.3. Leaves

The leaves contain proteins, carbohydrates, fibre, minerals, carotene, nicotinic acid, vitamin C, oxalic acid, crystalline glycosides and carbazole alkaloids. Fresh young leaves contains yellow colored volatile oil rich in vitamin A, calcium, girinimbine, iso-mahanimbine, koenine, koenigine, koenidine and koenimbine [30-31]. Fresh leaves were analyzed by gas chromatography and mass spectrometry and thirty-four compounds were detected in the oil which are-alpha-pinene (51.7%), sabinene (10.5%), beta-pinene (9.8%), betacaryophyllene (5.5%), limonene (5.4%), bornyl acetate (1.8%), terpinen-4-ol (1.3%), gamma-terpinene (1.2%) and alpha-humulene (1.2%) were the major constituents identified [32]. Mature leaves contains 63.2 % moisture, 1.15 % total nitrogen, 6.15 % fat, 18.92 % total sugars, 14.6 % starch, 6.8 % crude fibre, 13.06 % ash, 1.35 % acid insoluble ash, 1.82% alcohol soluble, 27.33% cold water and 33.45% hot water soluble extractive [29]. A large number of secondary metabolites such as alkaloids (murrayastine, murrayaline, pypayafolinecarbazole) triterpenoid (cyclomahanimbine, tetrahydromahanimbine), coumarin (murrayone imperatoxin) and other compounds (mahanimbicine, bicyclomahanimbicine, phebalosin) have been reported from the leaves of *M. Koenigii* [33-35].

##### 4.4. Fruits

The pulp of fruits generally contains 64.9% moisture, 9.76% total sugar (9.58% reducing sugar, 0.17% non-reducing sugar), 13.35% of vitamin C, trace amount of minerals (1.97% phosphorus, 0.082% potassium, 0.811% calcium, 0.166% magnesium and 0.007% iron) and negligible amount of tannin and acids [50]. The Petroleum ether extract of fruits has shown the presence of mahanimbine and koenimbine [51-52]. Reisch *et al.* (1992) isolated isomahanine (fig.5), murrayanol and carbazole alkaloids (mahanimbine, murrayazolidine, girinimbine, koenimbine and mahanine) [53].

##### 4.5. Seeds

Reisch *et al.* (1994) isolated mahanimbine, girinimbine, koenimbine, isomahanine and mahanine from the seeds of *M. koenigii* [58]. Petroleum ether extract of seeds has shown the presence of 2- methoxy-3- methyl carbazole [59]. Mandal *et al.* (2010) isolated three bioactive carbazole alkaloids-

kurryam, koenimbine and koenine with structural confirmation with 2D-NMR spectra [60]. Coumarin like indicolactone, anisoalctone and 2, 3 epoxy indicolactone (a furocoumarin lactone) were also isolated from the seeds [61]. Adebajo *et al.* (2000) has reported the presence of xanthotoxin, isobyaknagelicol, byakangelicol and isogoserol as minor furocoumarins in seeds of *M. Koenigii* [62]. Isoheraclenin, isoimperatonin, oxypeucedanin,

isopimpinellin and bergaptan were isolated from the seeds of

*M. Koenigii* [63]. 4.4% of the total lipids are found in seeds, of which 85.4 % are neutral lipids, 5.1 % are glycolipids and 9.5 % are phospho-lipids. Neutral lipids consisted of 73.9% triacylglycerol, 10.2% free fatty acids and small amounts of diacylglycerols, monoacylglycerols and sterols. Sterylglucoside and acylated sterylglucoside are major glycolipids identified from the seeds. Phospholipids mainly consist of phosphatidylethanolamine and lysophosphatidyl choline [68].

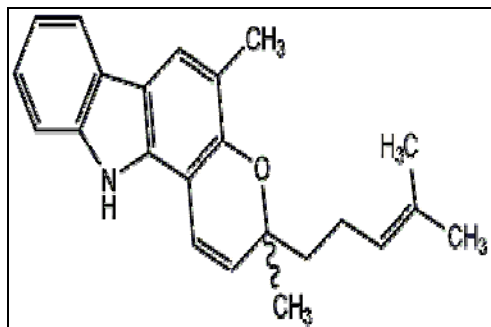


Fig 2: Mahanimbine

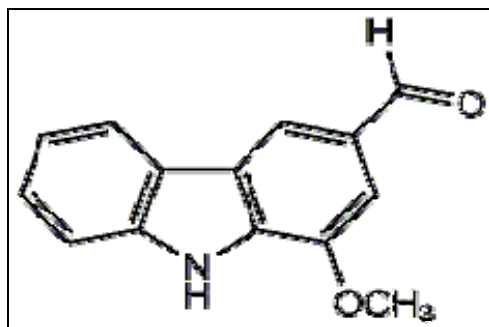


Fig 3: Murrayanine

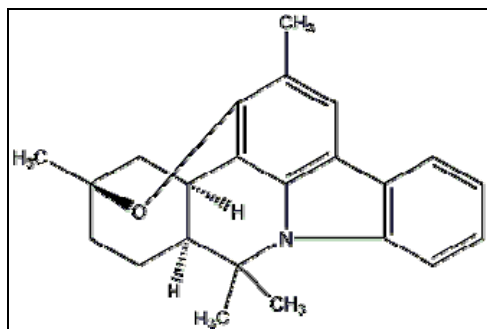


Fig 4: Murrayazoline

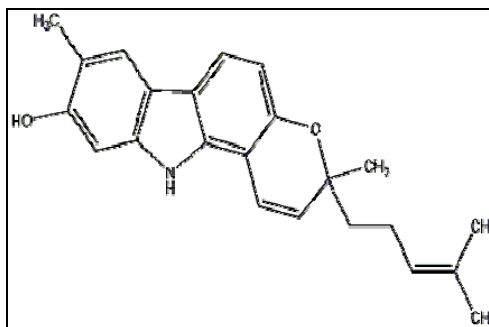


Fig 5: Isomahanine

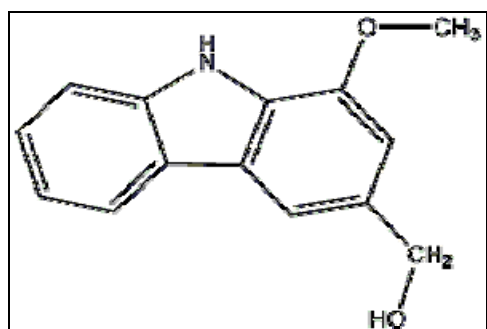


Fig 6: Koenoline

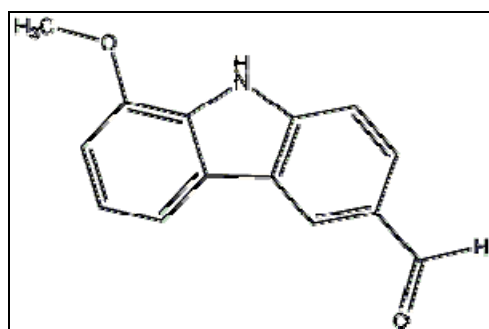


Fig 7: Mukolidine

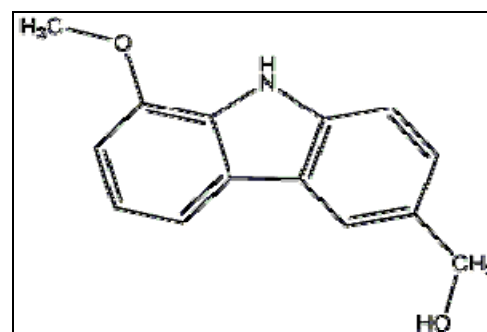


Fig 8: Mukoline

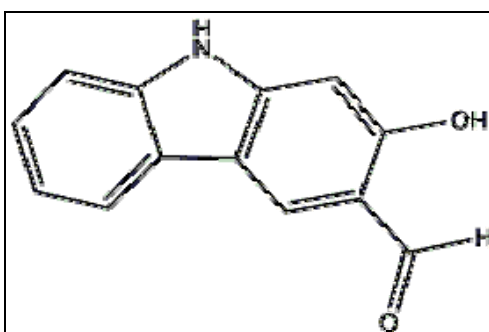


Fig 9: Mukonal

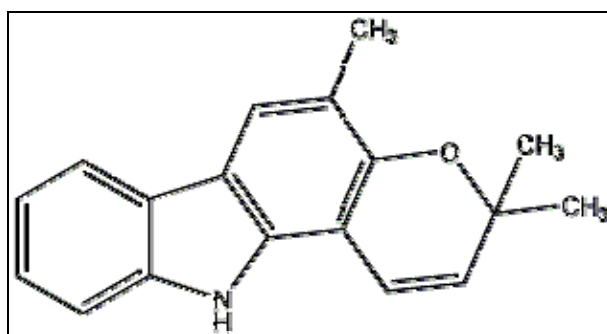


Fig 10: Girinimbine

### 5. Pharmacology

The presence of important phytochemicals makes *Murraya koenigii* useful for treating different ailments and potential

source of providing useful drugs. The different standards can be set for developing crude drugs by quantitative determination of pharmacognostic parameters (Table 2).

**Table 2:** Biological activities of different chemical constituents identified from different parts of *Murraya koenigii* are:

Plant parts	Chemical constituents	Biological activity	References
Stem bark	Girinimbine	Anti fungal and antibacterial Anti-cancer	[26] [86]
	Murrayanine	Anti fungal ,Antimicrobial	[26,48]
	Marmesin-1'-O-beta-D-galactopyranoside	Anti viral, Anti bacterial, Anti fungal	[26]
	Mahanine	Topoisomerase I and II inhibitory activity Antimicrobial	[76] [76]
	Murrayacine	Antimicrobial	[79]
	Girinimbine	Anti-tumor	[80]
	Mukoic acid	Anti-oxidant	[81]
	Murrayazolinine	Anti -leukemial	[47]
	Girinimbilol	Anti-trichomonal	[83]
	Mahanine, Pyrafoline-D Murrafoline-I	and Cytotoxic and induced the loss of mitochondrial membrane potential	[91]
Leaves	Koenimbine Koenine Koenigine	Antioxidant activity, Anti- diarrhea Anti-oxidant Anti-oxidant, radical-scavenging properties	[69] [70] [70]
	Mahanimbine	Anti-oxidant	[70,92]
	Murrayazolidine	Hepatoprotective	[71]
	Murrayazoline	Hepatoprotective	[71]

	Girinimbine	Hepatoprotective	[71]
	Tocopherol	Hepatoprotective	[71]
	Isomahanimbine	Hepatoprotective	[71]
	Mahanimbine	Hepatoprotective Anti microbial Topoisomerase I and II inhibitory activity Antioxidant activity	[71] [49] [49] [49]
	Gurjunene	Anti microbial	[72]
	Murrayanol	Mosquitocidal Anti-microbial	[73] [49]
	Mahanine	Hepatoprotective Anti caries Antioxidant activity	[71] [74] [75]
	Bismurrayafoline E	Antioxidant activity	[75]
	Euchrestine	Antioxidant activity	[75]
	Bismahanine	Antioxidant activity	[77]
	Bispyrafoline	Antioxidant activity	[77]
	Isomahanine	Antioxidant activity	[77]
	O-methyl murrayamine A	Antioxidant activity	[77]
	O- methyl mahanine	Antioxidant activity	[77]
	Lutein	Antioxidant activity	[69]
	Tocopherol	Antioxidant activity Hepatoprotective	[69] [71]
	Carotene	Antioxidant activity	[78]
Root	Mukoline	Cytotoxic activity	[84]
Seed	Koenoline	Cytotoxic activity	[84]
	Kurryam,	Anti diarrheal activity	[85]
	Koenine	Anti diarrheal activity	[85]
	Koenimbine	Anti diarrheal activity	[85]

## 6. Conclusions

It is evident from the available literature that leaves and root of *Murraya koenigii* are the most widely used parts of the plant. The plant is mainly used as stimulant, antidiarrheal, anti-periodic, antiemetics, antidiarrheal, blood purifier, tonic,

antifungal, depressant, anti-inflammatory. It can also be used to cure body aches, kidney pain, vomiting, stomachic, leucoderma, febrifuge, diabetes mellitus, besides promoting appetite and digestion. Carotenoids, carbazole alkaloids, coumarin, carbazole carboxylic acid, lipids and essential oil

are the dominant phytoconstituents of the plant. As the plant validates nearly all the traditional uses, clinical trials and formulation development could be taken as future directions along with the mechanistic approach for these studies. Factors such as geographical and seasonal variation play an important role in the authentication of the chemical constituents responsible for the bioactivity can be an area of interest. An extensive research and development work should be undertaken on the plant and its products for better economic and therapeutic utilization.

### 7. Authors Contribution

DKG have collected information from different sources, prepared, designed, analyzed and interpretate the data, SJ collected data on ethnobotanical uses and contributed in formatting and editing the manuscript, PD have been involved in drafting the manuscript critically for important intellectual content and have given final approval of the version to be published.

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