REVIEW ON MURRAYA KOENIGII: VERSATILE ROLE IN MANAGEMENT OF HUMAN HEALTH

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ABSTRACT

*Murraya Koenigii* (L) Spreng (*Rutaceae*), is a medicinally important herb of Indian origin native to Asia and is found throughout the Indian subcontinent has been used for centuries in the Ayurvedic system of medicine. *Murraya Koenigii* (Curry leaf tree) has been used in several ancient systems of medicine including Siddha and Unani as a multi-potential medicinal plant. The whole plant is a rich source of carbazole alkaloids and these alkaloids have been reported for their various pharmacological activities such as antiemetic, antidiarrhoeal, blood purifier and febrifuge. It is also been reported as antidiabetic, antioxidant, antihypertensive, antibacterial, cytotoxic and also in the treatment of various respiratory tract disorders. The whole plant is used as a tonic and stomachic. The leaves are also been used externally to treat burns, bruises and skin eruption. It is also been used in preventing premature graying of hair. Apart from these medicinal properties the curry leaves are also been used from centuries as a species as natural flavoring agent. The extracted oil from the leaves is used in soap industry. Apart from all these activities, the plant is also reported to possess a wide spectrum of biological activities and has a potential as a valuable herb for the treatment of various disease as well as for the management of human health. The present review incorporates the description of *Murraya Koenigii*, and its phytochemical constituents, pharmacognostic evaluation and also throws light on its therapeutic potential for the treatment of various diseases.

KEYWORDS: Murraya koenigii, carbazole alkaloid, phytochemistry, pharmacognostic, pharmacological.

INTRODUCTION
Leaves of *Murraya Koenigii*(L) Spreng (*Rutaceae*) is commonly known as curry leaves or Mittha neem which is widely being used as flavoring agent in curries, and other foodstuffs since ancient times. The Rutaceae family represents more than 150 genera and 1600 species. Among 14 global species belongs to the genus of Murraya, only *Murraya Koenigii* Spreng and *Murraya Paniculata* (Linn) jack is available in India.[1] Of the two, the former is more popular due to its versatile medicinal properties of leaves, and high acceptance rate it is used from ancient time as a natural flavoring agent in various curries and food items.[2,3] The curry leaves is called by different name by different racial such as.

**Vernacular name/s of Murraya Koenigii Spreng in various Languages**

**Indian languages**

Botanical - *Murraya koenigii*

Synonyms - *Bergia koenigii, Chalcas koenigii*

Bengali - Barsunga

Gujarathi - Mitho Limdo

Hindi - Meetha neem, Kari patta, Kathnim, Bursunga

Kannada - Karibevu

Malayalam - Kariveppilei, Kareapela

Marathi - Karipat, Karhi patta, Karhinimb, Jhirang

Oriya - Bansago

Sanskrit - Girinimba, Suravi

Tamil - Karivempu, Karuveppilei, Karivepila

Telugu - Karepaku, Karuvespaku

**Foreign languages**

Burmese - Pindosine, Pyim daw thein

Danish - Karry bald

Dutch - Kerriebladeren

English - Curry leaves

French - Feuilles de cari, Feuilles de cury, Caloupile (Réunion), Carripoulé (Ile Maurice)

German - Curryblätter

Hungarian - Curry levelek
This review gathers data regarding the phyto-pharmacological research had been done on curry leaves and provides a better perception of its therapeutic and nontherapeutic properties.

**Taxonomic Classification**[^4]

Kingdom-Plantae  
Subkingdom- Tracheobionta  
Superdivision- Spermatophyta  
Division- Magnoliophyta  
Class- Magnoliopsida  
Subclass - Rosidae  
Family- Rutaceae  
Genus- *Murraya J. Koenig* ex L.  
Species- *Murraya Koenigii*(L.)Spreng.

**Plant description**

A small spreading shrub, about 2.5 metres height; the main stem, dark green to brownish, with numerous dots on it; its bark can be peeled off longitudinally, exposing the white wood underneath; the girth of the main stem is 16 cm. Leaves, exstipulate, bipinnately compound, 30 cm long, each bearing 24 leaflets, having reticulate venation; leaflets, lanceolate, 4.9 cm long, 1.8 cm broad, having 0.5-cm-long petiole.[^5]
Habit and Habitate
The plant *M. koenigii* is an aromatic and more or less deciduous shrub or a small tree found in almost all parts of India up to an altitude of 1500m commonly in forests often as gregarious undergrowths. The species is belongs to India and It is commonly occurs in the foothills of Himalaya, Assam, Sikkim, Kerala, Tamilnadu, Andhra Pradesh and Maharashtra.\[6\] It is also found in evergreen and deciduous forests peninsular India, often as underwood.\[7\]

Agronomy\[8,9,10,11,12\]

Soil and climate
*Murraya Koenigii* is found all over India, Sri Lanka and Andaman islands and commonly grown in every climatic condition. The tree is hardy and flourishes upto 600 m in Sri Lanka and upto 1500 m in the Himalayas. It grows well in almost any type of soil if there is a good drainage.

Propagation
Propagation is usually done by seeds but it also can be done by root suckers or air- layers. Which are best germinated in partial shades in nurseries. The seedlings are transplanted when 1 year old. They are planted in the field at 3-5 meters spacing between them.

Fertilizer
Two year old curry leaf bushes require 150g N/plant/year for optimum production of leaves with a basal dressing of 25g each of P and K. it has been found in an experiment that three year old plants at 5m spacing gives a highest annual yield, when treated with 200g N + 100g P₂O₅ + 100g K₂O per plant. But the pruning levels have no significant effect on the leaf yield.
Harvesting

The first harvesting of the leaves can be taken out about 6 months after sowing and altogether two pickings are possible during the first year, while in the subsequent years, three normal pickings can be done. In harvesting, leaves are plucked individually, or the terminal cluster of foliage complete with the silky, purplish new shoots are clipped off. Care should be taken not to allow plucking so as to expose the branches and trunk to sunburn.

Morphological characteristics

Leaves

Leaves have a green colour and a characteristic odour and taste. Exstipulate, bipinnately compound, 30 cm long, each bearing 24 leaflets having reticulate venation; leaflets lanceolate, 4.9 cm long, 1.8 cm broad, having 0.5 cm long petiole.[13]

Stem

An aromatic and more or less deciduous shrub or a small tree up to 6 m in height 15 to 40 cm in diameter.[14] The main stem is dark green to brownish with numerous dots on it. Its bark can be peeled off longitudinally, exposing the white wood underneath.

Flowers

Round to oblong, 1.4 to 1.6 cm long, 1 to 1.2 cm in diameter; weight 880 mg; volume 895 μL.

Fruits

Fully ripe fruits, black with a very shining surface; pulp, wistaria blue; the number of fruits per cluster varying from 32 to 80.

Seed

One in each fruit, 11 mm long, 8 mm in diameter, with spinach green colour.
Phytochemistry

The matured curry leaves consist 63.2% of moisture, protein which is of about 1.15% of nitrogen, carbohydrate 14.6% which is of total sugars and total ash 13.06%. The bioactive components in curry leaves are oxalic acid, resin, carbazole alkaloids and the major bioactive compounds such as the koenigin, bicyclomahanimbicine, cyclomahanimbine, murrayastine, coumarine, koenidine and pypayafolinecarbazole has significant pharmacological activities and the major portion of volatile oil consist of bicyclomahanimbicine, mahanimbicine.[15]

The mature leaves also contain 6.15% fat, 18.92% total sugars, 14.6% starch and 6.8% crude fiber. Out of the 13.06% total ash, the leaves shows acid insoluble ash 1.35%, cold water (20°C) extractive 27.33% and a maximum of hot water soluble extractive 33.45% and alcohol soluble extractive 1.82%.[16]

The whole plant of the *Murraya Koenigii* consists of various phytoconstituents in the various parts of the whole plant. The chemical constituents present in the different parts of the plant can be enlisted such as below:

Leaves

The leaves of *Murraya Koenigii* consist of abundant chemical constituents in it. The constituent depends on the state of the leaves either the leaves are fresh or dry. The leaves also consist of the volatile oil, carotenoids and carbazole alkaloids as the major constituent in it. All the constituents can be enlisted in brief such as below:

Volatile oil

The leaves consist of volatile compound in form of essential oil. The essential oil from the leaves can be obtained by conventional distillation method or by modern methods. The oil composition shows phenotypic and genetic variability and the chemical composition of oil varies with the various argclimatic and geographical variations.[18-25]

The composition of volatile compounds found in the essential oil of *Murraya Koenigii* leaves are Linalol (0.56%), trans-Sabinene hydrate (0.53%), trans-2-Cyclohexen-1-ol (0.48%), cis-2-Cyclohexen-1-ol (0.54%), para-Cymen-8-ol (10.31%), β-Terpinol (2.52%), trans-Piperitol (0.40%), Chrysanthenyl acetate (0.39%), Lavandulyl acetate (1.67%), Bornyl acetate (1.68%), α-Copaene (0.82%), β-Elemene (0.35%), (Z)-Jasnone (0.11%), β-Caryophyllene (19.50%), Aromadendrene (0.72%), α-Humulene (15.24%), Butanedioic acid (2.18%), β-
Selinene (3.81%), Naphthalene (1.90%), \( \alpha \)-Selinene (6.10%), \( \delta \)-Cadinene (2.03%), Nerolidol (2.64%), \textit{trans}-Nerolidol (1.32%), Cycloheptane (0.13%), Spathulenol (1.98%), Caryophyllene oxide (2.14%), Viridiflorol (1.51%), 2-Naphthalenemethanol (0.66%), Trivertal (0.35%), Juniper camphor (1.57%), Cubenol (0.57%), \( \beta \)-Cadena-1(6),4-diene (0.50%), Selina-6-en-4-ol (4.78%), Phytol (10.07%).[26]

**Carotenoids**
Leaves contain 9744 ng of lutein, 212 ng of \( \alpha \)-tocopherol and 183 ng of carotene/g of fresh weight.31 21.4 mg/100 g of total carotene, 7.1 mg/100 g of \( \beta \)-carotene, 14570-\( \mu \)g/100g of total carotenoids is reported in leaves as measured by HPLC. Out of total carotenoids, lutein content was 5252 and \( \beta \)-carotene content was 9328 \( \mu \)g/g.17

**Carbazole alkaloids**
Leaf of Murrayakoenigii consist of koenimbine, O-methyl murrayamine, O- methyl mahanine, isomahanine, bismahanine and bispyrayafoline, koenigine, koenine, koenidine, mahanimbine, isomahanimbine, koenimbidine and murrayacine, isomahanimbicine, Euchrestine B, bismurrayafoline E, mahanimbicine, bicyclomahanimbicine, cyclomahanimbine, bicyclomahanimbine, mahanimbidine, mukonicine, 8,8”-bis koenigine which consist monomer of koenigine and minor alkaloid; mahanine. The dried leave consist of glycozoline, 1-formyl-3 methoxy-6-methyl carbazole and 6, 7- dimethoxy-1- hydroxy-3 methyl carbazole. The leaves of Murraya Koenigii also consist of protein, carbohydrates, fibre, minerals, carotene, vitamin C, Nicotinicacid.[27,28]

**Stem**
The alcoholic extract of the stem bark gives the isolation of koenigine quinone A and koenigine quinone B.29 A probable biogenetic intermediate of pyrano carbazole alkaloid named as Mukonal was isolated from the stem bark.53 From the stem bark a minor carbazole alkaloid known as Murrayazolinol31 and various other alkaloids such as mahanimbinol32, murrayazolidine33,34, murrayacinine35, mukonicine36, murrayazolinine37, murrayane, girinimbine and mahanimbine38, girinimbolin and mahanimbilol39 was isolated and identified.

**Roots**
The roots of Murraya Koenigii consist bioactive compounds which is named as murrayanol, murrayagetin, marmesin-1”-O-rutinoside. In addition to that three monomeric and five binary
carbazole alkaloids namely mukoenine-A, B and C and murrastifoline-F.bis-2- hydroxy-3-methyl carbazole, bismahanine, bi koeniquinone-A and bismurrayaquinone-A were also extracted from the bark. The benzene extract of roots consist of mukoline, mukolidine. The root was also found to have girinimbine and the root bark consist of koenoline which synonym to 1-methoxy-3-hydroxy methyl carbazole.[28]

**Fruits**
Petroleum ether extract of the fruits of *Murraya Koenigii* gives mahanimbine and koenimbine. The other constituents were also been isolated with mahanimbine and koenimbine which are isomahanine, murrayanol, murrayazolidine, girinimbine and mahanime.[27,28]

**Seeds**
Seed of *Murraya Koenigii* consist of 3 bio active carbazole alkaloids which iskurryam, koenimbine and koenine. Furthermore, the seed also contain mahanimbine, girinimbine, koenimbine, mahanine and isomahanine. An indicolactone, anisoalctone and 2”,3”epoxyindicolactone which is a furocoumarin lactone were extracted from the seeds and this would be the first furocoumarin with a mono terpenoid lactone chain found in the genus of the Murraya and minor furocoumarins were also found in the seeds of *Murraya Koenigii* such as xanthotoxin, isobyaknagelicol, byakangelicol and isogosferol. isoheraclenin, isoimperatonin, oxypeucedanin, isopimpinellin and bergaptan were also found in the seeds of *Murraya Koenigii*. [27,28]

**Pharmacognostic features**
The leaf of *Murraya Koenigii* shows various characteristic pharmacognostic features such as:

- **Shape:** Obliquely ovate or fairly rhomboid.
- **Apex:** Acuminate obtuse or acute.
- **Petiole:** 20-30 cm in length.
- **Venation:** Reticulate.
- **Margin:** Dentate.
- **Base:** Asymmetrical.
- **Stomata:** Anomocytic.
- **Trichomes:** Uniseriate multicellular.
The transverse section of the leaf also shows various pharmacognostic features such as below:

The epidermis layer of the leaf is composed of rectangular cells which serve as the outer covering for both upper and lower layer. The upper epidermis is covered with cuticle, while the midrib portion is composed of 1-4 layers of collenchymatous hypodermis and 2-5 layers of chlorenchymatous cells filled with the chlorophyll contents. The stomata are distributed only in the abaxial portion; hence the adaxial portion does not contain any stomata. The parenchymatous cells which forms the ground tissues are of oval to polygonal in shape and is slanted with vascular bundle. The vascular bundle consists of xylem and phloem. Calcium oxalate crystals are also found in this region which is sandy and prismatic crystals\footnote{40}

**Ethnobotanical uses**

The leaves of *Murraya Koenigii* is generally used as fresh or dry leaf powder for flavoring soups, curries, fish and meat dishes, egg dishes, traditional curry powder blend etc. The essential oil of the leaves is used by aromatherapy industry in making of soaps and cosmetics.\footnote{41} The leaves are boiled with the coconut oil and the blanked residue obtained is being used as a natural hair tonic which helps to promote the hair growth and prevent the premature graying of hair. It is also used as blood purifier, febrifuge, and anti-inflammatory, body ache for kidney pain, as an antihelmetics and in vomiting.\footnote{42-46} It is also been proved to be effective against diabetis mellitus.\footnote{47,48} The paste of fresh leaves is applied for burns, bruises and skin eruptions.\footnote{49} The leaves and roots are used as analgesic, cure inflammation and itching, treats leucoderma and other various blood disorders like piles. The infusion of toasted leaves can be used to stop vomiting.\footnote{50} The paste of fresh leaves is applied locally to remove poison of the animal bite from the body.\footnote{51}

**Pharmacological activities**

The *Murraya Koenigii* possess various pharmacological activities and is known as a multi-potential medicinal plant and very commonly used spices and as a home remedy since ancient times as a folk medicine. The pharmacological uses of *Murraya Koenigii* can be described in brief such as below.

**Antimicrobial activity**

The roots of *Murraya Koenigii* possess antimicrobial activity. The hexane, methanol and chloroform extract of the roots show antibacterial and antifungal activity. These extracts were
tested among various types of bacterial species such as Bacillus Subtilis, Staphylococcus aureus, Escherichia coli and Salmonella typhi. These extracts are also being tested on various fungal species such as Aspergillus niger, Candida albicans and Trichophyton rubrum. Among all the extracts the methanolic extract shows more significant antibacterial activity whereas the aqueous extract is ineffective on all the species. Among all the selected species of microbes the Staphylococcus aureus is more susceptible to all the above extracts.\(^{[52]}\)

The essential oil obtained from the leaves of *Murraya Koenigii* also shows antifungal activity against various species such as Candida albicans, C.tropicalis, Aspergillus niger, A. fumigates and Microsporum gypseum. It is very potent as it is effective against Candida albicans even at the dilution of 1:500. The ethanolic extract of the leaves shows the activity against Colletotrichum falcatus and Rhizoctonia solani.\(^{[53]}\)

**Antipyretic activity**
The rats were fevered by parentral administration of Brewer’s yeast at the dose of 10mg/kg. All the extracts of the *Murraya Koenigii* leaves are being tested but the ethanolic extract show more activity as compared to petroleum ether and chloroform extract. Paracetamol at the dose of 150mg/kg was taken as a standard drug.\(^{[54]}\)

**Hypoglycemic effect**
The aqueous and methanolic extract of the *Murraya Koenigii* leaves shows decrease in plasma glucose level in alloxan induced rats.\(^{[55]}\) The leaf extract possess the property to decrease blood cholesterol and blood glucose level in diabetic mice and reduces the body weight after the treatment.\(^{[56]}\)

**Hepatoprotective activity**
The methanolic extract of *Murraya Koenigii* leaves helps to decrease the levels of elevated various hepatic marker enzymes such as Aspartate transaminase, Alanine transaminase, Serum bilirubin and alkaline phosphate at the dose of 200mg/kg, 300mg/kg and 500mg/kg. The maximum dose of 500mg/kg was compared to standard drug Silymarin, which is used clinically in the treatment of liver disease.\(^{[57]}\)

**Anti- inflammatory**
The leaves of *Murraya Koenigii* were extracted with three different solvents such as petroleum ether, chloroform and ethanol. Among all these extracts the ethanolic extract
shows significant reduction in carrageenan induced paw edema in Albino rats of the Wistar rat.\[58\]

**Cytotoxic activity**
The extract of Murrya Koenigii roots consists of Girinimbine is a carbazole alkaloid which possess cell death via apoptosis in a dose dependent manner in A549 cells. It can also be via classical mitochondrial pathway with cytochrome C release and caspase dependent apoptosis.\[59\]

**Anti obese activity**
The ethanolic extract of the *Murraya Koenigii* leaves was administered orally to male wistar rats for 30 days. The results show reduction in body weight, cholesterol, and triglyceride as well as controls glycemic levels.\[60\]

**Chemoprotective activity**
The methanolic extract of the *Murraya Koenigii* leaves was administered intraperitontial in swiss albino mice. The extract was administered at the dose of 100mg/kg before the administration of cyclophosphamide at the dose of 50mg/kg shows significant reduction in cyclophosphamide induced chromosomal damage and enhances the bone marrow protection.\[61\]

**Antihelmintic effect**
The ethanolic and aqueous extract of the *Murraya Koenigii* leaves showed antihelmintic activity when compared with the standard drug Piperazine. It is believed that the tannins present in the leaves which are a polyphenolic compound which is responsible for the antihelmintic activity. The methanolic extract also possess antihelmintic activity against Indian earthworm in a dose dependent manner such as it may cause paralysis in Indian earth worm 18 minutes and cause lethal and cause lethal effect in 45 minutes.\[62\]

**Inotropic activity**
The ethanolic extract of fresh leaves of *Murraya Koenigii* shows positive inotropic effect on isolated frog heart in a dose dependent manner. It was achieved due to increase in availability of calcium from the extracellular sites.\[63\]
Nephroprotective
The aqueous extract of *Murraya Koenigii* leaves was administered orally for 30 days and this shows significant reduction in serum creatinine level and promotes regeneration of tissue in kidney in streptozotocine induced diabetic male rat.[64]

Larvicidal activity
The petroleum ether and acetone extract of *Murraya Koenigii* leaves possess larvicidal activity at the concentration of 250ppm to 900ppm.[65]

Alzheimer’s disease
The total alkaloidal extract of *Murraya Koenigii* was administered in three different doses of 10, 20 and 30mg/kg for 15 days in different groups of young and aged mice shows significant improvement in memory scores and reversed the amnesia induced by scopolamine (0.4 mg/kg, i.p) and diazepam (1mg/kg,i.p). It also reduces the brain cholinesterase activity significantly.[66]

Haematological and histological studies
The whole curry leaf and mustard fed to rats at doses equal to normal human intake did not cause any adverse effect on food efficiency ratio (FER), red blood cell count (RBC), white blood cells (WBC), total count, differential counts or on the levels of blood constituents, like serum electrolytes, blood urea, haemoglobin, total serum protein, albumin-globulin ratio, fibrin level, glycosylated haemoglobin and the activity of glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) and alkaline phosphatase in serum. No histopathological changes were observed in the liver of rats administered curry leaf and mustard.[67]

DISCUSSION
The extracts obtained from the *Murraya Koenigii* leaves have various therapeutic activities. Each extracts possess different potency of the activity. The whole plant is used as a remedy since ancient times. The leaves are used as a spice and also as a flavouring agent in curries, soup and other food stuffs. The essential oil obtained by the steam distillation of the fresh leaves is used in aromatherapy and also in the soap and cosmetic industries. The leaves consist of carbazole alkaloids which are widely useful in various diseases.
CONCLUSION
The curry leaves are being used as a folk medicine since ancient times as a spice and for flavouring agent for curries, soup and other food stuffs. The leaves and their extracts possess various therapeutic activities and also to treat the various ailments affecting humans. The antimicrobial activity of the plant extract also helps to prevent the microbial infection and also possess mosquitocidal activity. The curry leaves are very important herb being used since ancient times and also till today.

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