Curry leaf (Murraya Koenigii): a spice with medicinal property

Abstract
The AYUSH department included the following system of medicines Ayurvedic, Yoga, Unani, Siddha and Homeopathy (AYUSH). These systems help us to eradicate or help in to overcome the problems related to the allopathic medicines such as side effect, drug resistance and adverse effect of the drug. Due to all these reasons the plant source for medicinal purpose are highly prefer. This review article describes the medicinal importance of the medicinal plant Murraya koenigii. The therapeutic value of Murraya koenigii extract for the various diseases with its other pharmacognostic features such as morphology, growth constraints, biochemical composition and biological activities. This review contains the description of Murraya koenigii with its pharmacological activities of isolated compounds and bioactivity of extract on different animal models in various laboratories. In addition to that, it highlights its potential to have a various type of pharmacological activity.

Keywords: medicinal plant, plant extract, phytochemistry, biological activity, research work

Introduction
India is frequently known by enormous biodiversity of medicinal plants. Among them Murraya koenigii have a lots of bioactive principles due to which plant has been proven as the medicinally important plant but least or no attention received by the scientist. Murraya koenigii is proven as the natural medicinal plant.1 There are different forms of Murraya koenigii due to which they are found as the useful plant such as extract, essential oil, or directly used due to the presence of following active constituent bismahanine, murrayanine, murrayafoiline-A, bi-koeniquinone-A, bismurrayquinone, mukoine-A, mukoine-B, mukoine-C, murrastifoline, Murrayazolinol, murrayacine, murrayazolidine, murrayazoline, mahanimbine, girinimbine, koeniline, xynthyletin, koenigne-Quinone A and koenigne-Quinone B for therapeutic purpose by folk people.2-5 Many medicines such as digitalis, vinblastine, aspirin and quinine has plant as a source of origin for example foxglove (Digitalis purpurea), willow bark (Salix spp.), quinine bark (Cinchona officinalis). For therapeutic or prophylactic purposes medicinal plant are used. For the therapeutic properties of medicinal plants presence of secondary metabolites plays a very important role such as alkaloids, flavonoids, terpinoids, vitamins, tannins etc., these all are the secondary metabolites of the plant as active constituent.6 These all secondary metabolites of plant physiologically affect the body at different stages of body development and make the body disease free. The plant Murraya koenigii belonging to the family Rutaceae is largely growing plant throughout the spring, summer and in rain fall season in every part of the tropical region up to the height of 1500 to 1655m from sea level.6,7 It is also known as Curry Leaf English, Mitha Neem in Hindi, and Karupeppilei in Tamilnadu and Surabhinimba in Sanskrit.8

Synonym

Synonym in Indian Language
Curry Leaf (English), Karepaku (Andhra Pradesh), Narasingha (Assam); Barsanga, Kartaphulli (Bengal); Gorenimb (Gujrat); Mitha Neem (Himachal Pradesh); Kathnim, Mitha Neem, Kurry Patta (Hindi); Karibeva (Karnataka); Kariveppilei (Kerala); Gandhela, Gandla, Gani (Kumaon); Mahanimb (Sanskrit); Karibeva (Karnataka); Kariveppilei (Kerala); Gandhela, Gani (Kumaon); Bhursanga (Orissa); Mahanimb (Sanskrit); Karivepumpu (Tamilnadu).

Synonym in other language
Burmes: Pindosine; Danish: Karry bald; Dutch: Kerrieblanderen; English: Curry leaves; French: Feuilles de cury; German: Curryblatter; Indonesian: Daun kari; Italian: Fogli de Cari; Spanish: Hoja.

Biological source
The species name commemorates the botanist Johann König. The genus Murray commemorates Swedish physician and botanist Johann Andreas Murray who died in 1791. Hence the botanical name of the curry leaves is Murraya koenigii.9

Taxonomic status
a. Kingdom - Plantae
b. Sub-kingdom - Tracheobionta
c. Superdivision - Spermatophyta
d. Division - Magnoliophyta
e. Class - Magnoliopsida
f. Subclass - Rosidae
g. Order - Sapindales
h. Family - Rutaceae
i. Genus - Murraya J. Koenig ex L
j. Species -Murraya koenigii L. Spreng.

History
The history of curry leaves are seen in early 1st to 4th century AD. In Tamil and Kannada literature it was updated as word ‘kari’ with

---

Sub-kingdom: Magnoliospida
Kingdom: Plantae
Subclass: Rosidae
Class: Magnoliopsida
Division: Magnoliophyta
Superdivision: Spermatophyta
Sub-kingdom: Tracheobionta
Kingdom: Plantae

---

Volume 2 Issue 3 - 2017
Manshu Jain,1,2 Ritu Gilhotra,1 Ravindra Pal Singh,1 Jitendra Mittal2
1School of Pharmacy, Suresh Gyan Vihar University, India
2Ayushraj Enterprises Pvt Ltd, India

Correspondence: Jitendra Mittal, Ayushraj Enterprises Pvt Ltd, Village Mansinghpura, Dehmi Begus Road, Ajmer Road Jaipur, India, Email Jitendraayti@gmail.com

Received: October 22, 2017 | Published: November 21, 2017

MOJ Biology and Medicine

MOJ Biol Med. 2017;2(3):236–256.

© 2017 Jain et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially.
its uses. The word now popularly used for the *Murraya koenigii* is curry leaf which is originated from Tamil word Kari which means as ‘spiced sauce’. In the early literatures of Tamil and Kannada the use of *Murraya koenigii* is described as the flavouring agent for the vegetables. Today *Murraya koenigii* are grown as the cultivated crop in India, Sri Lanka, Southeast Asia, Australia, Pacific Islands and Africa as flavouring agent for the food.

**Distribution**

*Murraya koenigii* originates from east and south part of India, Pakistan, Sri Lanka, China and Hainan but widely cultivated in South-East Asia and some parts of the United States and Australia. It grows throughout India up to the height of 1500 to 1655m from sea level and in the Andaman Islands. It is also available in other part of Asian region like in moist forests of 500-1600m height in Guangdong, Shainan, S Yunnan (Xishuangbanna), Bhutan, Laos, Nepal, Pakistan, Sri Lanka, Thailand, Vietnam. Together with South Indian immigrants, curry leaves reached Malaysia, Australia, South Africa and Reunion Island. Out of the 14 global species that belong to the genus Murraya, only two are known to be found in India, which is *Murraya koenigii* (Spreng) and *Murraya paniculata* (Jack). Can grow in full sun or light shade.*Murraya koenigii* is distributed from south and East Asia to Australia.

**Growing season**

Curry Leaf plant to have flowers and vibrant green leaves throughout the spring, summer and in rain fall. The leaves drop off during its’ resting period in the winter months. They like full sun, well-drained soil, which should be the dry side and they need fertilizer in the month of summer. The flowering season was observed to continue from the end of June to the end of August, and the July is considered as the peak fruiting season. In India, harvesting of leaves started from 15 months after planting out and collection of leaves repeated in every 2 to 3 months. In cold countries such as in Southern California, South Texas and South Florida, outdoors growth needs protection from freezing. Seeds are fragile so handle with care.

**Plant description**

**Tree**

*Murraya koenigii* is semi deciduous, unarmed aromatic small spreading shrub or tree with strong woody stem but slender with the stem which is dark green to brownish in colour the tree is 4–8.7m (13–31 feet) tall, with a trunk up to 81cm diameter. The diameter of main stem is about 16cm. The flowers of curry leaves is small, white fragrant and funnel-shaped, regular, pentamorous, stalked, complete, ebracteate, hypogynous, persistent, inferior, green, corolla, polypetalous, androecium, polyandrous, lanceolate, stigma, bright, sticky, style, short, ovary, inflorescence, a terminal cyme, the diameter of a flower is 1.12cm in the fully opened form, each cluster bear approximately 60 to 90 flowers at a time after flowering at once, 5-lobed calyx, with petals in having length 5 mm and the petals are 5 in number, with stamen in number 10 and in small in size approximate number 4 mm, dorsifixed, arranged into circles, with long superior gynoecium with 6 to 9mm. Curry tree flowers have a sweet fragrance, bisexual with self-pollinated for produce black berries in small size with shiny appearance containing a large visible seed with the number 1.

**Leaf**

Curry leaves are aromatic in nature having characteristic aroma, leaves of curry leaves are shiny and smooth with paler undersides. Leaves are pinnate, extipulate, having reticulate venation and having ovate lanceolate with an oblique base, with 11-21 leaflets whose size description is each leaflet is 0.79–1.57inch long and 0.39–0.79 inch broad. Leaflets are short stalked, alternate, gland dotted and having 0.5-cm-long petiole The leaf margins are irregularly serrate. The yield of a bush in approximately found about 480 g in three to four pickings.

**Stem and bark**

The stem of *Murraya koenigii* is brown to dark green in colour, with dots on the bark like small node on it, when the bark was peeled off longitudinally under the exposing the white wood underneath; the girth of the main stem is 16cm up to 6 meters in height and 15 to 40cm in diameter.

**Fruit**

Fruits of the *Murraya koenigii* occur in cluster form varies to 32 to 80 in number. The fruits are in the ovoid or subglobose and small in size in the spinach green colour seed in one or two number which are enclosing each other in thin pericarp. The fruits are 1 to 1.2cm in diameter with length 1.4 to 1.6cm, purple black after ripening and they are edible and yields 0.76% of a yellow volatile oil. Curry leaf fruit is 11mm long and weigh about 445mg Fruits. The plant produces small white flowers which can self-pollinate. The weight of pulp is 880mg and the volume is 895 microliters. The seeds of the *Murraya koenigii* are poisonous in nature and should not be consumed for any purpose.

**Microscopy**

The microscopically view of *Murraya koenigii* is as follow:

**Leaves:** The leaves have the obliquely ovate or fairly rhomboid with acuminate obtuse or acute apex. The petiole is about 20 to 30cm in length and the leaves have reticulate venation and dentate margin with an asymmetrical base. In the microscopic studies, it was elucidate that the stomata were distributed on adaxial surface and the axadial surface does not have stomata and the type of stomata that was found is anomocytic. The transverse section of the leaves has a layer of epidermis which is composed of rectangular cell. The upper epidermis was covered with cuticle and in the midrib the epidermis has 1 to 4 layers of collenchymatous hypodermis with 2-3 layers of chlorenchyma cells. The ground tissue is oval to polygonal parenchyma cell with vascular bundle. Calcium oxalate found in sandy and prismatic crystals. The curry leaf shows the presence of unicellular trichomes with obliterated lumen, parenchymatous pith in petiole, long pericyclic fibre in the midrib, large cruciferous stomata and prismatic calcium oxalate crystals. Fresh leaves on steam distillation under pressure yield 20.6% of volatile oil and without pressure less than 2%. The fibres measure 2000μι in length.

**Root:** The root shows tetrach to pentarchstele, pheloderm fibres are absent and concentric grains of parenchyma are present.

**Powder:** Green in colour with no distinct odour or taste, unicellular, bent or curved trichomes, two layered palisade, portion of secretory canals, well developed pericyclic fibres and a few prismatic crystals of calcium oxalate are the important identifying characters.
**Chemical constituent**

*Murraya koenigii* is very rich source of organic compounds with different chemical composition such as alkaloids, flavonoids carbohydrates, and sterol is present in the plant extract prepared in solvents such as petroleum ether, ethyl acetate, chloroform, ethanol and water. The major chemical constituents are explained for the confirmation of the phyto-constituents in the plant extract, various numbers of tests were performed:

i. The presence of alkaloids was confirmed by using Mayer’s reagent, which shows formation of white or cream colored precipitates in the extract of *Murraya koenigii*.

ii. Phenolic compounds were confirmed by formation of white precipitate by the addition of few drops of 5% lead acetate solution to alcoholic extracts of *Murraya koenigii*.

iii. The presence of flavonoids is detected by Yellow coloration of filter paper by dipping in ammoniated alcoholic upon the extract.

iv. Presence of Saponins is considered when the extract showed honey comb like frothing formation after giving a shake with sodium bicarbonate.

v. The presence of proteins and free amino acids is indicated by the conducting the following tests i.e., Millons, Biurets and Ninhydrins test.

vi. Presence of sterol and triterpenes are indicated by alcoholic extract which was shaken with chloroform and few drops of acetic anhydride along with few drops of concentrated sulphuric acid from the side of the tube form the blue to brick red coloration. The essential oil composition of *Murraya koenigii* was studied and then presence of D-Sabinene, D-α-Terpinol, di-α-phellendrene, D-α-pinene, Caryophyllene and dipentene and the property of *Murraya koenigii* oil is explained (Table 1).

Table 1 The essential oil property of *Murraya koenigii*

| Sl. No | Property                        | Value     |
|--------|---------------------------------|-----------|
| 1      | Specific Gravity (25°C)         | 0.9748    |
| 2      | Refractive Index (25°C)         | 1.5021    |
| 3      | Optical Rotation (25°C)         | + 4.8     |
| 4      | Saponification Value            | 5.2       |
| 5      | Saponification Value after Acetylation | 54.6 |
| 6      | Moisture                        | 66.3%     |
| 7      | Protein                         | 6.1%      |
| 8      | Fat (Ether Extract)             | 1.0%      |
| 9      | Carbohydrate                    | 18.7%     |
| 10     | Fibre                           | 6.4%      |
| 11     | Mineral Matter                  | 4.2%      |
| 12     | Calcium                         | 810Mg/100 G |
| 13     | Phosphorus                      | 600Mg/100 G |
| 14     | Iron Of Edible Portion          | 3.1Mg/100 G |
| 15     | Carotene (As Vitamin A)         | 12 600µ/100 G |

**Leaves**

The fresh leaves of *Murraya koenigii* contain 61.77-66.2% of moisture, 2.1-12.5% of protein, 14.6-18.97% of total sugar, 9.7-13.06% of total ash, 1.35-1.82% of acid insoluble ash, 1.35-1.82% of alcohol soluble extractive and water extractive value ranges between 27.33-33.45%. The nutritional value is explained. Solvents used in preparation of the extract are ethyl acetone, ethyl, petroleum ether, water and chloroform and compounds such as alkaloids, flavonoids and sterols have been extracted. In leaves by acetone extract Koenigine, koene, koenidine and (-) mahanine were isolated. Form the hexane mahanimbine, isomahanimbine, koenimbine and murrayacine where isolated. Isomahanimbicinc was isolated in the petroleum ether. (Table 2).

Table 2 Nutrients Value of *Murraya koenigii*

| S.no. | Nutrients value as per 100gram | Fresh curry leaf | Dry curry leaf |
|-------|--------------------------------|------------------|---------------|
| 1     | Protein                        | 6g               | 12g           |
| 2     | Fat                            | 1g               | 5.4g          |
| 3     | Carbohydrate                   | 18.7g            | 64.31g        |
| 4     | Calcium                        | 830mg            | 2040mg        |
| 5     | Iron                           | 0.93mg           | 12mg          |
| 6     | B-carotene                     | 0.0031mg         | 0.009mg       |

**Seed and fruits**

Seed of *Murraya koenigii* consist of furcocumarin lactone, carbazole alkaloids, glycolipids, Phospholipids and terpinene. It also contains 4.4% of total lipids in which 85.4% are neutral lipids, 5.1% are glycolipids and 9.5% are phospho-lipids. 73.9% triacylglycerol, 10.2% free fatty acids and small amounts of diacylglycerols, monoacylglycerols and sterols which are present in neutral lipids. The seeds of *Murraya koenigii* contain terpinene these are as follow terpinene, terpinen-4-ol, linolol, ocimene, limbele, limbolee and simbolee. The fruit contain pulp which is having 64.9% of moisture, 16.8% of total soluble solids, 9.76% of total sugar, 9.58% of reducing sugar, 0.17% of non-reducing sugar, 13.35% of vitamin C, 2.162% of total ash, 1.97% of protein, 0.082% of phosphorus, 0.811% of potassium (32.2), 0.166% of calcium, 0.216% of magnesium, 0.007% of iron and 0.00057% of tannin.

**Stem and bark**

The chemical constituent of matured stem and bark of *Murraya koenigii* are carbazole alkaloids, coumarin galactoside, Carbazole carboxylic acid, glycolipids, Phospholipids etc.

**Roots**

The roots of *Murraya koenigii* include many types of bioactive compounds. The extraction of root was done in benzene and petroleum ether (Table 3).
Table 3 Chemical Constituent of *Murraya koenigii*

| Chemical Composition | Structure | Nature        | Extracted From | Percentage | Reference |
|----------------------|-----------|---------------|----------------|------------|-----------|
| α-Copaene            | ![Structure](image1) | Sesquiterpenoid | Leaves         | 0.82       | 12        |
| α-Pinene             | ![Structure](image2) | Terpentine     | Leaves         | 42.676     | 19        |
| α-Humulene           | ![Structure](image3) | Sesquiterpene  | Leaves         | 2.770      | 19        |
| Aromadendrene        | ![Structure](image4) | Sesquiterpene  | Leaves         | 0.72-0.78  | 25        |
| α-Selinene           | ![Structure](image5) | Monoterpenoid  | Leaves, Stems  | 6.10       | 28        |
| β-Elemene            | ![Structure](image6) | Sesquiterpene  | Leaves, Stem   | 0.35-7.09  | 21        |
| Bismurrayafoline E   | ![Structure](image7) | Carbazole Alkaloid | Leaves, Stems | 0.76-1.23 | 40        |
| Bispyrafoline        | ![Structure](image8) | Carbazole Alkaloid | Leaves, Stems | 0.34-0.98 | 26        |
| Chemical Composition | Structure | Nature          | Extracted From         | Percentage | Reference |
|----------------------|-----------|-----------------|------------------------|------------|-----------|
| **β-Myrcene**        | ![Structure](image1.png) | Olefinic Natural Organic Hydrocarbon | Leaves, Stems | 1.103      | 38        |
| **Bornyl Acetate**   | ![Structure](image2.png) | Terpene | Leaves, Stems, Roots | 1.165-1.68 | 12        |
| **Bicyclomahanimbicine** | ![Structure](image3.png) | Terpenoid Alkaloids | Leaves, Stems | 1.43       | 23        |
| **β-Bisabolene**     | ![Structure](image4.png) | Sesquiterpene | Leaves | 2.3        | 28        |
| **β-Pinene**         | ![Structure](image5.png) | Terpene | Leaves | 8.347      | 19        |
| **β-Caryophyllene**  | ![Structure](image6.png) | Sesquiterpene | Leaves, Seeds | 7.3-19.50  | 28        |
| **β-Costol**         | ![Structure](image7.png) | Alcohols | Leaves | 0.9        | 51        |
| **β-Eduesmol**       | ![Structure](image8.png) | Alcohols | Leaves | 9.61       | 36        |
| **β-Phellandrene**   | ![Structure](image9.png) | Cyclic Monoterpenes | Leaves | 6.5        | 37        |
Table Continued...

| Chemical Composition                   | Structure                          | Nature            | Extracted From | Percentage | Reference |
|----------------------------------------|------------------------------------|-------------------|----------------|------------|-----------|
| Bikoeniquinone                          | ![Structure](image1)               | Indole Alkaloid   | Roots          | 0.001109   | 63        |
| Bicyclomahanimbine                      | ![Structure](image2)               | Alkaloids         | Leaves, Stems, Roots | 0.324      | 19        |
| Butanedioic Acid                        | ![Structure](image3)               | Dicarboxylic Acid | Leaves, Stems  | 2.18       | 19        |
| Butyl Myristate                         | ![Structure](image4)               | Esters            | Leaves, Stems  | 0.66       | 51        |
| β-Selinene                              | ![Structure](image5)               | Sesquiterpenes    | Leaves, Stems  | 3.81       | 36        |
| Bismahanine                             | ![Structure](image6)               | Indole Alkaloid   | Leaves, Stems  | 0.0208     | 37        |
| Bis-3-Hydroxy-3-Methyl Carbazole        | ![Structure](image7)               | Indole Alkaloid   | Roots          | 0.00136    | 44        |
| β-Terpineol                             | ![Structure](image8)               | Alcohols          | Leaves         | 2.52       | 38        |
| β-Cadina                                | ![Structure](image9)               | Oleoresin         | Leaves         | 6          | 32        |
Table Continued...

| Chemical Composition     | Structure   | Nature       | Extracted From | Percentage | Reference |
|--------------------------|-------------|--------------|----------------|------------|-----------|
| Carotene                 | Terpene     | Leaves       | 0.898          | 55         |           |
| Camphene                 | Bicyclic Monoterpene | Leaves | 2.16 | 54       |           |
| Cis-2-Cyclohexen-1-Ol    | Monoterpenoid Alcohol | Leaves | 0.54 | 46       |           |
| Chrysanthenyl Acetate    | Monoterpene       | Leaves, Stem | 0.39 | 25       |           |
| Cycloheptane             | Cycloalkane   | Leaves       | 0.13           | 39         |           |
| Citral                   | Monoterpenoidal Aldehyde | Leaves, Stems | 0.76 | 13       |           |
| 3-Carene                 | Bicyclic Monoterpene | Leaves, Stems | 0.543 | 24      |           |
| Cadinene                 | Sesquiterpene | Leaves       | 5.2            | 78         |           |
### Table Continued...

| Chemical Composition | Structure | Nature         | Extracted From | Percentage | Reference |
|----------------------|-----------|----------------|----------------|------------|-----------|
| Cyclomahanimbine     | ![Structure](image1.png) | Indole Alkaloid | Leaves         | 1.233      | 10        |
| Curryanine           | ![Structure](image2.png) | Indole Alkaloid | Stems          | 1.003      | 10        |
| Δ-Cadinene           | ![Structure](image3.png) | Sesquiterpene  | Leaves         | 2.30-5.20  | 48        |
| Cis-Caryophyllene    | ![Structure](image4.png) | Sesquiterpene  | Leaves         | 11.74      | 18        |
| Carvomenthone        | ![Structure](image5.png) | Ketone         | Leaves         | 2.3        | 73        |
| Cubenol              | ![Structure](image6.png) | Sesquiterpene  | Leaves, Stems  | 0.57       | 38        |
| 4-Diene              | ![Structure](image7.png) | Diolefin       | Leaves, Stems  | 0.50       | 71        |
| Dipentene            | ![Structure](image8.png) | Monoterpene    | Leaves         | 11.3-15.9  | 15        |

**Citation:** Jain M, Gilhotra R, Singh RP et al. Curry leaf (Murraya Koenigi): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256. DOI: 10.15406/mojbm.2017.02.00050
| Chemical Composition | Structure | Nature          | Extracted From                  | Percentage | Reference |
|----------------------|-----------|-----------------|---------------------------------|------------|-----------|
| 6,7-Dimethoxy 1-Hydroxy Carbazole | ![Structure](image1.png) | Carbazole Alkaloids | Leaves, Stems, Roots | 0.0004 | 76 |
| Dehydro Aromadendrene | ![Structure](image2.png) | Sesquiterpene | Leaves, Stems, Roots | 2.75 | 51 |
| Euchrestine | ![Structure](image3.png) | Protein | Leaves | 0.09 | 36 |
| Eustifoline-D | ![Structure](image4.png) | Indole Alkaloid | Roots | 0.0005 | 51 |
| Formlycarbazole | ![Structure](image5.png) | Indole Alkaloid | Roots | 0.00072 | 43 |
| Frnesol | ![Structure](image6.png) | Alcohols | Leaves | 1.56 | 37 |
| Girinimbine | ![Structure](image7.png) | Indole Alkaloid | Leaves, Stems, Roots, Fruits, Seeds | 0.015-0.1622 | 51 |
| Glycozoline | ![Structure](image8.png) | Carbazole Alkaloids | Stems | 0.034 | 21 |
| Gurjunene | ![Structure](image9.png) | Carbotricyclic Sesquiterpene | Leaves | 0.002 | 34 |
| Girinimbilol | ![Structure](image10.png) | Indole Alkaloid | Leaves, Stems, Roots | 0.15 | 48 |
| Chemical Composition       | Structure                  | Nature          | Extracted From | Percentage | Reference |
|---------------------------|----------------------------|-----------------|----------------|------------|-----------|
| Heraclenin                |                            | Coumarin        | Leaves         | 0.454      | 38        |
| 1-Hydroxy-3-Methyl        |                            | Indole Alkaloid | Stems          | 0.0022     | 76        |
| Carbazole                 |                            | Pyranoalkaloid  | Leaves         | 1.23       | 46        |
| Isomahanine               |                            | Pyranoalkaloid  | Leaves         | 1.23       | 46        |
| Isomurrayzoline           |                            | Alkaloid        | Leaves, Stems  | 2.34       | 39        |
| Isomurrayzolinine         |                            | Alkaloid        | Leaves, Stems  | 3.22       | 40        |
| Iso Caryophyllene         |                            | Sesquiterpene   | Leaves, Stems  | 6.72       | 16        |
| Isogirinimbine            |                            | Alkaloid        | Leaves, Stems  | 2.004      | 32        |
| Imperatorin               |                            | Furocoumarin    | Leaves         | 3.433      | 55        |
| Iso Menthone              |                            | Ketone          | Leaves, Stems, | 0.6        | 54        |
|                           |                            |                 | Roots          |            |           |

**Citation:** Jain M, Gilhotra R, Singh RP et al. Curry leaf (Murraya Koenigii): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256. DOI: 10.15406/mojbm.2017.02.00050
### Chemical Composition

| Chemical Composition | Structure | Nature          | Extracted From | Percentage | Reference |
|----------------------|-----------|-----------------|----------------|------------|-----------|
| Isomahanimbine (+)   | ![Image](image1.png) | Indole Alkaloid | Leaves, Fruit  | 1.9903     | 46        |
| Juniper Camphor      | ![Image](image2.png) | Terpenoid       | Leaves         | 1.57       | 20        |
| Junipene             | ![Image](image3.png) | Sesquiterpense  | Leaves         | 4.90       | 23        |
| Koenimbine           | ![Image](image4.png) | Indole Alkaloid | Leaves, Fruits | 02.33      | 77        |
| Koenoline            | ![Image](image5.png) | Carbazole Alkaloid | Leaves, Seeds | 20.34      | 78        |
| Kurryam              | ![Image](image6.png) | Carbazole Alkaloid | Leaves | 7.89      | 38        |
| Koenimbidine         | ![Image](image7.png) | Carbazole Alkaloid | Leaves, Stems | 13.5       | 22        |
| Koenigicine          | ![Image](image8.png) | Carbazole Alkaloid | Leaves, Stems | 3.89       | 19        |
| Koenigine            | ![Image](image9.png) | Indole Alkaloid | Leaves         | 3.893      | 21        |
| Koenine              | ![Image](image10.png) | Indole Alkaloid | Leaves         | 2.44       | 21        |
| Linalool             | ![Image](image11.png) | Terpene Alcohol | Leaves, Stems, Roots | 0.56 | 27        |

---

**Citation:** Jain M, Gilhotra R, Singh RP et al. Curry leaf (Murraya Koenigii): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256. DOI: 10.15406/mojbm.2017.02.00050
| Chemical Composition | Structure | Nature       | Extracted From | Percentage | Reference |
|----------------------|-----------|--------------|----------------|------------|-----------|
| Lutein               | ![Structure](https://example.com/structure1.png) | Xanthophyll   | Leaves         | 0.25-0.59  | 4         |
| Linalyl Acetate      | ![Structure](https://example.com/structure2.png) | Acetate Ester | Leaves, Stems  | 0.93       | 13        |
| Limonene             | ![Structure](https://example.com/structure3.png) | Cyclic Terpene| Leaves, Stems  | 5.374      | 19        |
| Lavandulyl Acetate   | ![Structure](https://example.com/structure4.png) | Acetate Ester | Leaves, Stems  | 1.67       | 37        |
| Mahanimbinine        | ![Structure](https://example.com/structure5.png) | Terpenoid     | Leaves, Stems  | 5.5464     | 73        |
| Murrayamine-J        | ![Structure](https://example.com/structure6.png) | Carbazole     | Leaves, Stems  | 2.45-2.90  | 46        |
| Marmesin-1'-O-Beta-D Galactopyranoside | ![Structure](https://example.com/structure7.png) | Coumarin      | Stems          | 1.114      | 50        |
| Murrayamine-M        | ![Structure](https://example.com/structure8.png) | Carbazole     | Leaves, Stems  | 1.34-1.99  | 46        |
| Murrayamine-G        | ![Structure](https://example.com/structure9.png) | Carbazole     | Leaves, Stems  | 1.32-2.09  | 38        |

**Citation:** Jain M, Gilhotra R, Singh RP et al. Curry leaf (Murraya Koenigii): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256. DOI: 10.15406/mojbm.2017.02.00050
| Chemical Composition | Structure | Nature | Extracted From | Percentage | Reference |
|----------------------|-----------|--------|----------------|------------|-----------|
| Murrayazolidine      | ![Structure](image1) | Pentacyclic Carbazole Alkaloid. | Leaves, Stems | 0.43-1.89 | 40        |
| Murrayacine          | ![Structure](image2) | Pyrano-Carbazole Alkaloid | Leaves, Stems | 1.00-1.90 | 3         |
| Murrayacinine        | ![Structure](image3) | Carbazole Alkaloid | Leaves, Stems | 1.32-2.43 | 79        |
| Mahanimboline        | ![Structure](image4) | Carbazole Alkaloid | Leaves, Stems | 1.32-2.98 | 43        |
| Mukoeic Acid         | ![Structure](image5) | Carbazole Carboxylic Acid | Leaves, Stems | 1.02-1.98 | 80        |
| Mukonine             | ![Structure](image6) | Carbazole Alkaloid | Leaves, Stems, Roots | 1.23-2.78 | 81        |
| 3-Methyl Carbazole   | ![Structure](image7) | Carbazole Alkaloids | Leaves, Stems, Roots | 0.23-2.34 | 76        |
| Mahanimbine          | ![Structure](image8) | Alkaloids | Leaves, Stems | 0.23-2.34 | 23        |
| Mukonidine           | ![Structure](image9) | Carbazole Alkaloids | Leaves, Stems | 0.29-2.89 | 40        |
| Murrayakoeninol      | ![Structure](image10) | Alkaloids | Leaves | 1.45-2.89 | 19        |
| Mahanimbine          | ![Structure](image11) | Indole Alkaloid | Roots, Leaves | 0.0113 | 22        |
### Chemical Composition

| Chemical Composition | Structure | Nature             | Extracted From               | Percentage | Reference |
|----------------------|-----------|--------------------|------------------------------|------------|-----------|
| Mukoline             | ![Structure](Image1) | Carbazole alkaloid | Roots                        | 1.89-2.99  | 67        |
| Murrayanol           | ![Structure](Image2) | Alkaloids          | Roots, Leaves, Stems         | 0.23-2.87  | 46        |
| Murrayazolinine      | ![Structure](Image3) | Carbazole Alkaloid | Leaves, Seeds                | 0.89-1.29  | 62        |
| Murrafoline-I        | ![Structure](Image4) | Biscarbazole Alkaloid | Leaves, Stems, Seeds | 0.34-2.43  | 65        |
| Mukonicine           | ![Structure](Image5) | Carbazole Alkaloid | Fruits, Seeds, Leaves        | 2.98-3.09  | 23        |
| Murrayacinine        | ![Structure](Image6) | Carbazole Alkaloid | Leaves, Stems                | 1.32-2.43  | 79        |
| Mukoenine A          | ![Structure](Image7) | Indole Alkaloid    | Leaves, Roots                | 0.0015     | 74        |
| 2-Methoxy-3-Methyl   | ![Structure](Image8) | Indole Alkaloid    | Leaves, Stems                | 0.0022     | 3         |
| O-Methyl Murrayanine | ![Structure](Image9) | Carbazole Alkaloids | Roots, Leaves, Stems | 2.45-2.99  | 37        |
| Mukolidine           | ![Structure](Image10) | Carbazole Alkaloid | Leaves                       | 0.23-1.98  | 18        |
| Mukonal              | ![Structure](Image11) | Carbazole Alkaloid | Leaves                       | 0.54-2.09  | 25        |

Table Continued....
Table Continued...

| Chemical Composition | Structure | Nature               | Extracted From | Percentage | Reference |
|----------------------|-----------|----------------------|----------------|------------|-----------|
| Murrayazolinol       | ![Murrayazolinol Structure](image1) | Carbazole Alkaloid   | Leaves         | 1.78-2.099 | 45        |
| Murrayazoline        | ![Murrayazoline Structure](image2) | Carbazole Alkaloid   | Leaves         | 2.90-3.58  | 39        |
| Mahanimbinol         | ![Mahanimbinol Structure](image3) | Indole Alkaloid      | Stems, Leaves, Roots | 0.29-2.86  | 39        |
| Mahanine             | ![Mahanine Structure](image4) | Indole Alkaloid      | Stems, Leaves, Roots | 0.00116   | 21        |
| Murrayanine          | ![Murrayanine Structure](image5) | Carbazole Alkaloid   | Stems, Leaves  | 0.05-1.78  | 72        |
| Menthol              | ![Menthol Structure](image6) | Alcohols             | Leaves         | 2.83       | 32        |
| Nicotinic Acid       | ![Nicotinic Acid Structure](image7) | Carboxylic Acid      | Stems, Leaves, Roots | 2.3       | 46        |
| 2-Naphthalenemethanol| ![2-Naphthalenemethanol Structure](image8) | Naphthalenes         | Stems, Leaves  | 0.66       | 39        |
| Steary Alcohol       | ![Steary Alcohol Structure](image9) | Alcohols             | Stems, Leaves, Roots | 1.01      | 39        |
| Stearaldehyde        | ![Stearaldehyde Structure](image10) | Aldehyde             | Stems          | 1.53       | 56        |
| Sabinene             | ![Sabinene Structure](image11) | Terpenes             | Stems, Leaves  | 0.10       | 48        |
Curry leaf (Murraya koenigii): a spice with medicinal property

\[ \text{Table Continued...} \]

| Chemical Composition | Structure | Nature | Extracted From | Percentage | Reference |
|----------------------|-----------|--------|----------------|------------|-----------|
| Tocopherol           | ![Tocopherol Structure](image) | Alcohol | Leaves         | 2.788      | 45        |
| \( \alpha \)-Terpinene| ![\( \alpha \)-Terpinene Structure](image) | Terpenoids | Leaves, Stems | 1.438      | 69        |

**Extraction methods for active chemical constituent**

Many methods are available for the preparation of the extract in which some methods are as follow:59–60

i. *Murraya koenigii* powder was extracted with 100ml of Ethanol and kept on rotary shaker at 190-220 rpm for 24 hours. The extract was collected and solvent was evaporated to make the final volume and stored at 40\(^{\circ}\)C in air tight bottles.61

ii. The essential oil was extracted by hydro-distillation method using Clevenger apparatus. The distilled oil was separated from water by a separating funnel and stored in refrigerator.62

iii. Extractions and separations on the isolates of hexane, chloroform and methanol of the plant samples (stem bark and roots) have led to the isolation and characterizations of carbazole alkaloids. Stem barks and roots of *Murraya koenigii* extracts was concentrated to yield a brown yellowish viscous syrup for crude hexane extract (22.5g and 33.0g) and dark brown viscous syrup for crude chloroform extract (14.0g and 24.0g). Each crude extracts was subjected to column vacuum chromatography over silica gel and eluted with mixture of hexane, hexane/ethyl acetate, ethyl acetate, ethyl acetate/methanol and methanol to give a total about 75 fractions each.63

iv. The crude powder of *Murraya koenigii* leaves was defatted with petroleum ether for about 24h. After defatation, the extraction was carried out using a Soxhlet apparatus in hydro-methanolic solution in the ratio 30:70.64

**Uses**

Biological activity of *Murraya koenigii* are reported which included the following these activities are studied on the following the crude extracts which are as follow in the *Murraya koenigii* has been mentioned in the traditional medicinal system in Ayurveda different studies were performed on the Bark, root, leaves, fruit and fruit pulp of *Murraya koenigii*65 (Table 4).

Table 4 Pharmacological use of *Murraya koenigii*

| S.No | Uses                  | Chemical constituent used                      | Pharmacological action on                  | Animal used   | Dose     | Reference |
|------|-----------------------|------------------------------------------------|-------------------------------------------|---------------|----------|-----------|
| 1    | Anti-Diabetic         | Koenimbidine, Murrayacine, Murraysazoline.     | Decreases Oxidative Stress By Acting On Paraoxonase 1 Activity | Rats          | 75Mg/Kg  | 34        |
|      |                       |                                                 |                                           | Rabbits       |          |           |
| 2    | Anti-Trichomonal      | Girinimbine, Mahanimbilol                      | Act Against Trichomonas Gallinae          | Rats          | 1.08 to 1.20 Mg/ml | 82       |
| 3    | For Oral Health       | Essential Oil                                   | By Stimulating The Salivation Process      | Rabbit And Rats | 25mg/Kg | 83        |
| 4    | Vasodilation          | Mahanimbilol, Murraysazoline.                  | By Acting On Negative Chronotropic Effect  | Frog          | 85mg/Kg  | 36        |
| 5    | Anti-Oxidation Activity | Mahanimbine, Koenigine                       | Increases The Gsh Content In The Liver And Reduction In Hepatic Malondialdehyde In Kidney | Male Wistar Rat’s | 15mg/Kg | 6         |
| 6    | Anti-Cancer Activity  | Mahanimbine, Girinimbine, Mahanine, Murraysafoline | Increase The Death Of Cancerous Cell Proteasome Inhibitor | Mice          | 150mg/Kg | 29        |
| 7    | Effect On Bronchial Disorders | Girinimbine, Mahanine               | By Blocking 5-Lipooxygenase Activity       | Frog          | 35mg/Kg  | 29        |

**Citation:** Jain M, Gilhotra R, Singh RP et al. Curry leaf (*Murraya koenigii*): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256. DOI: 10.15406/mojbm.2017.02.00050
| S.No | Uses                                      | Chemical constituent used                                                                 | Pharmacological action on                                                                 | Animal used     | Dose         | Reference |
|------|-------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------|-------------|-----------|
| 8    | Effect On Dental Caries                   | Isomahanine, Murrayanol And Mahanine                                                      | Inhibition Of Cavity Formation                                                            | Rabbits        | 50mg/Kg     | 83        |
| 9    | Anthelmintic Activity                     | Mahanine, Koenimbidine                                                                     | Cause Paralysis                                                                          | Test Worm      | 100Mg/Ml    | 61        |
| 10   | Wound Healing Effect                      | Mahanine, Mahanimbicine, Mahanimbine And Essential Oil                                    | Act Against Inflammatory Cells And The Collagen Deposition Was Reduces                   | Male Albino Rat | 65mg/Kg    | 84        |
| 11   | Anti-Amnesic                              | Koenimbidine, Mahanimbicine, Protects The Eyes And Improves Eyesight                      | Eye Sight Improvement                                                                    | Aged Mice      | 100mg/Ml    | 85        |
| 12   | Radiation Protection Activity             | Mahanimbine, Murrayafoline                                                                | Increases Glutathione, Its Enzymes Levels And Decrease The Chromosomal Damage             | Mice           | 100Mg/Kg    | 86        |
| 13   | Anti-Ulcer Activity                        | Mahanimbine And Essential Oil                                                             | Effect Against Lesion Index, Area And Percentage Of Lesion And On Ulcer                  | Albino Rats    | 85mg/Ml     | 49        |
| 14   | Anti-Microbial Activity                   | Mahanimbine, Murrayanol And Mahanine                                                      | Inhibition Of Topoisomerase I And ii                                                     | Bacteria, Fungi| 3.13-100 Mg/ Ml | 16        |
| 15   | Anti-Diarrheal Activity                   | Kurryam, Koenimbine Koenine                                                               | Prostaglandin E2-Induced Enter Pooling And Reduction In Gastrointestinal Motility        | Albino Mouse, Wister Rats | 20ml/Kg | 17        |
| 16   | Chemoprotective Activity                  | Koenimbir                                          | Reduction In Induced Chromosomal Damage                                                   | Swiss Albino Mice | 100Mg/Kg | 67        |
| 17   | Immunomodulatory Activity                 | Mahanimbine, Mahanine                                                                       | Increase In Phagocytic Index By Removing Carbon Partical From Blood                      | Albino Mice    | 125mg/Kg    | 87        |
| 18   | Haematological Activity                   | Koenimbir                                          | No Adverse Effect Against Food Efficiency Ratio                                           | Rats           | 85mg/Kg     | 47        |
| 19   | Antipyretic Activity                      | Murrayscine, Murrayazolinine.                                                              | Decrease In Fever                                                                        | Albino Rat, Rabbit | 200mg/Kg | 88        |
| 20   | Nephroprotective Activity                 | Koenimbir                                          | Reno-Protective Activity Against Unilateral Renal Ischemia                               | Male Wistar Rats | 150mg/Kg | 15        |
| 21   | Cardio-Protective Activity                | Girinimbir, Girinimbir                                                                     | Cadmium-Induced Oxidation Is Reduces                                                      | Swiss Albino Mice And Rat Cardiac Tissue | 100 Mg/Kbw | 89        |
| 22   | Anti-Cytotoxicity Activity                | Girinimbir, Koenoline, Mahanine, Pyrafoline-D And Murrayafoline-I                         | Exhibiting The Cell Death Resulted As The Mortality Of The Cell                          | Swiss Albino Mice | 150mg/Kg | 78        |
| 23   | Inotropic Activity                        | Girinimbir                                          | Positive Inotropic Effect                                                                 | Frog Heart     | 100mg/Kg    | 90        |
| 24   | Hepatoprotective Activity                 | Girinimbir, Mahanine, Mahanimbicin, Isomahanimbin, Murrayazoline, Murrayazolidine, Murrayazoline | Oxidative Stress Inducer                                                                 | Wister Rats    | 90mg/Kg     | 35        |
| 25   | Anti-Lipase Activity                      | Koenimbir, Koenimbir, Koenignite And Clausazoline-K                                      | Reduced Total Cholesterol (Tc) And Triglyceride (Tg) Levels                              | Albino Rats And Wister Rats | 120mg/Kg | 91        |
| 26   | Anti-Alzheimer’s Activity                 | Isomahanimbine, Murrayazolidine,                                                              | Improves The Values Of Protective Antioxidants                                           | Young And Aged Mice | 150mg/Kg | 20        |

Table Continued...
Curry leaf (Murraya Koenigii): a spice with medicinal property

References

1. Singh S, More PK, Mohan SM. Floral composition and taxonomy of mangroves of Andaman and Nicobar Islands. Indian Journal of Scientific Research. 2014;43(6):1037–1050.
2. Curry leaf-and its uses. Coun Sci & Indus Res. 1962;6:125–127.
3. Anwer F, Masaldan AS, Kapil RS, et al. Synthesis of Murrayacine; oxidation with DDQ of the activated aromatic methyl group of the alkaloids of Murraya koenigii Spreng. Indian J Chem. 1973;11:1314–1315.
4. Priyanka Gupta, Alok Nahata, Vinod K. et al. An update on Murayya Koenigii: a multifunctional Ayurvedic herb. Journal of Chinese integrative medicine. 2012;9(8):824–833.
5. Raghunathan K, Mitra R. Pharmacognosy of indigenous drugs. Central Council for Research in Ayurveda and Siddha. 1985;1:433.
6. Gupta S, Prakash J. Studies on Indian green leafy vegetables for their antioxidant activity. Plant Foods Hum Nutr. 2009;64(1):39–45.
7. Jain V, Momin M, Laddha K. Curry leaf (Murraya Koenigii): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256.

Other uses

i. Essential oil Murraya koenigii is utilized in soap and cosmetic industry for aromatherapy.36,79

Conclusion

Murraya koenigii is a leafy medicinal as well as green leafy plant that belongs to family Rutaceae. The various pharmacological activities of the plant has been seen such as activity on Anti diabetic, cholesterol reducing property, antimicrobial activity, antiulcer activity, Antioxidative property, cytotoxic activity, anti-diarrhoea activity, anti-cancer activity with many other phagocytic activity. The chemical composition of the Murraya koenigii consists of essential oil alkaloids and terpenoid. Thus Curry leaves merits further phytochemical, pharmacological and clinical investigations for development of an effective natural plant.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

Conflict of interest

Table Continued....

| S.No | Uses               | Chemical constituent used                      | Pharmacological action on                    | Animal used | Dose | Reference |
|------|--------------------|------------------------------------------------|----------------------------------------------|-------------|------|-----------|
| 28   | Anti-Analgesic Activity | Girinimbine, Mahanine, Mahanimbine, Isomahanimbine | Anti-Nociceptive Effects                      | Mice        | 25mg/ml In Combination With Diclofenac | 48         |
| 29   | Effect Digestive System | Mahanine, Murrayafoline                     | Stimulates Digestive Enzymes                 | Mice        | 50mg/Kg | 55        |
| 30   | Neuro-Protective Activity | Koenimbin, Koenigicine And Clausazoline-K | Decreasing Glycemic Levels                   | Mice, Rats  | 100mg/Kg | 59        |
| 31   | Anti-Inflammatory Activity | Girinimbine, Mahanine, Mahanimbine, Isomahanimbine, | Cox-Inhibitory Property                      | Albino And Wistar Rats | 50mg/Kg | 48        |

xv. The essential oil of Murraya koenigii is utilized in soap and cosmetic industry for aromatherapy.36,79

xvi. The Murraya koenigii is beneficial in bruises, eruption and to treat bites of poisonous animals.80–84

Citation: Jain M, Gilhotra R, Singh RP et al. Curry leaf (Murraya Koenigii): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256.
DOI: 10.15406/mojbm.2017.02.00050
Curry leaf (Murraya koenigii): a spice with medicinal property

9. Ayaj S, Rahul S, Sumit G, et al. Comprehensive review: Murraya koenigii Linn. Asian Journal of Pharmacy and Life Sciences. 2011;1(4):417–425.

10. Parrota JA. Healing plants of peninsular India. USA: CASI Publication; 2001. 639 p.

11. Prajapati ND, Purohit SS, Sharma AK, et al. A handbook of medicinal plants. Agrobios India. 2003;1:401.

12. Bonde SD, Nemade LS, Patel MR, et al. Murraya koenigii (Curry leaf): Ethnobotany, phytochemistry and pharmacology - a review. International Journal of Pharmaceutical and Phytopharmacological Research. 2007;4(5):45–54.

13. Khosa RL, Prasad S. Pharmacognostical studies of leaf of Murraya koenigii and Murraya paniculata. J Res Indian Med. 1972;7(3):78.

14. Khosa RL, Prasad S. Pharmacognosy of roots of Murraya koenigii and Murraya paniculata. J Res Indian Med. 1974;9(3):105.

15. Khosa RL, Sen SP, Dixit SN. Studies on Murraya paniculata. Indian J Pharm. 1970;32(3):65–66.

16. Garg SC. Antifungal activity of some essential oils. Indian J Pharm. 1974;36:46.

17. Handral HK, Pandith A, Shruthi SD. A review on Murraya koenigii: Multipotential medicinal plant. Asian Journal of Pharmaceutical and Clinical Research. 2012;5(4):5–14.

18. Ajay S. Asian journal of pharmacy and life science. 2011;1:4423.

19. Dineshkumar B, Mitra A, Mahadevappa M. Antidiabetic and hypolipidemic effects of mahanimbine (carbazole alkaloid) from murraya koenigii (rutaceae) leaves. International Journal of Phytomedicine. 2011:2;22.

20. Prakash V, Natarajan CP. Studies on Curry Leaf. Food Sci and Technol. 1974;11(6):284–286.

21. Narasimha NS, Paradak MV, Chitguppi VP, et al. Alkaloids of Murraya koenigii structures: Of Mahanimbine, Koenimbine, (+) Mahanine, Koenine, Koenigine, Koenidine And (+) Isomahanimbine. Indian Jour Chem. 1975;13(10):993–999.

22. Joshi BS, Kamat VN, Gawd DH. Structures of Girinimbine, Mahanimbine, Isomahanimbine, Koenimbidine And Murrayacine. Tetrahedron. 1970;26(6):1475–1482.

23. Kureel SP, Kapil RS, Popli SP. Two Novel Alkaloids Form Murraya koenigii: mahnimbinicine and bicyclomahanimbinicine. Chem Ind (London). 1970;29:958.

24. Rastogi RP, Mehrotra BN. Compendium of Indian medicinal plants. National institute of science communication. (New Delhi). 1980–1984;4:486–489.

25. Sindhu RK, Arora S. Phytochemical and pharmacognostical studies on Murraya koenigii (L.) Spreng roots. Drug Innovation Today. 2012;4(1):325–333.

26. Adeleke CA, Tiwalade AO, Anthony AE, et al. 2”, 3” Epoxypinicolactone from Murraya koenigii. Nigerian Journal of Natural Product and Medicine. 1997;1(1):21–24.

27. Dutta NL, Quasim C, Wadia MS. Constituents of Murraya koenigii: structure of curryangin. Indian T Chem. 1969;7:1061–1062.

28. Ganesan P, Phaighan A, Murugan Y, et al. Comparative study of bioactive compounds in curry and coriander leaves: An update. Journal of Chemical and Pharmaceutical Research. 2013;5(11):590–594.

29. Nagappan T, Ramasamy P, Effendy M, et al. Biological Activity of Carbazole Alkaloids and Essential Oil of Murraya koenigii Against Antibiotic Resistant Microbes and Cancer Cell Lines. Molecules. 2011;16(11):9651–9664.

30. Gahlawat DK, Jakhar S, Daihia P. Murraya koenigii (L.) Spreng: An ethnobotanical, phytochemical and pharmacological review. Journal of Pharmacognosy and Phytochemistry. 2014;3(3):109–119.

31. Leela KS, Natarajan AV, Devi K, et al. Chemical composition of aqueous leaf extract of Murraya koenigii. International Journal of Pharmaceutical & Biological Archives. 2013;4(3):493–497.

32. Roy MK, Thalang VN, Trakoontivakorn G, et al. Mechanism of mahennie induced apoptosis in human leukemia cell (HL-60). Biochem Pharmacol. 2004;67(1):41–51.

33. Sastri BN. The Wealth of India, A dictionary of indian raw material and industrial products. Council of Scientific and Industrial Research (New Delhi). 1949;6:446–447.

34. Prabhuk KA, Tamilnabban T. Investigation of anti-diabetic activity of stem of Murraya koenigii. International Journal of Research in Pharmacy and Pharmacotherapeutics. 2012;1(2):165–168.

35. Sathaye S, Amin PD, Mehta VB, et al. Hepatoprotective activity of Murraya koenigii against ethanol induced liver toxicity model in experimental animals. International Journal of Pharma and Bio Sciences. 2012;3(1):430–438.

36. Darvekar VM, Patil VR, Choudhari AB. Anti-inflammatory activity of Murraya koenigii Spreng on experimental animals. Journal of Natural Product and Plant Resource. 2011;1(1):65–69.

37. Mohan S, Abdelwahab SI, Cheah SC, et al. Apoptosis effect of girinimbine isolated from Murraya koenigii on lung cancer cells in vitro. Evidence-Based Complementary and Alternative Medicine. 2013;2013(2013):1–12.

38. Kumar VS, Sharma A, Tiwari R, et al. Journal of Medicinal and Aromatic Plant Sciences. 1999;21:1139.

39. Mathumani P, Venkatraman S, Ramshuk S, et al. Pharmacological studies of anticancer, anti inflammatory activities of Murraya koenigii (Linn) Spreng in experimental animals. Journal of Pharmaceutical Sciences and Research. 2009;1:137.

40. Debosree G, Syed BF, Elna M, et al. Protective effect of aqueous leaf extract of murraya koenigii against lead induced oxidative stress in rat liver, heart and kidney: a dose response study. Asian J Pharm Clin. 2012;5:54–59.

41. Ito C, Itoigawa M, Nakao K, et al. Induction of apoptosis by carbazole alkaloids isolated from Murraya koenigii. Phytomedicine. 2006;13(5):359–365.

42. Sathaye S, Bagul Y, Gupta S, et al. Experimental and toxicologic pathology : official journal of the gesellschaft fur toxikologische pathologie. Experimental and Toxicologic Pathology. 2011;63(6):587–591.

43. Nagappan T, Segaran TC, Wahid MEA, et al. Efficacy of carbazole alkaloids, essential oil and extract of Murraya koenigii in enhancing subcutaneous wound healing in rats. Molecules. 2012;17(2):14449–14463.

44. Gupta V, Sharma M. Protective effect of Murraya koenigii on lipid peroxide formation in isolated rat liver homogenate. Int J Pharma Bio Sci. 2010;1(3):1–6.

45. Bandyopadhyaya S, Roy KC, Roy M, et al. Herbal composition of blend of active components prepared form Murraya koenigii And piper betle useful for blocking of 3- Lipooxygenase Activity. USA: US Pat Appl Publ. 2012. p.1–86.

46. Lawal HA, Atiku MK, Khelptai DG, et al. Hypoglycaemic and hypolipidaemic effect of aqueous leaf extract of Murraya koenigii in normal and alloxan-diabetic rats. Niger J Physiol Sci. 2008;23(1-2):37–40.
Curry leaf (Murraya Koenigii): a spice with medicinal property

47. Tembhumre SV, Sakarkar DM. Hypoglycemic effects of fruit juice of Murraya koenigii (L.) in alloxan induced diabetic mice. Int J PharmTech Res. 2009;1(4):1589–1593.

48. Gupta S, George M, Singhjal M, et al. Leaves extract of Murraya koenigii Linn for anti-inflammatory and analgesic activity in animal models. J Adv Pharm Technol Res. 2010;1(1):68–77.

49. Patidar DK. Anti-ulcer activity of aqueous extract of Murraya koenigii in albino rats. Int J Pharma Bio Sci. 2012;2(1):524–529.

50. Kesari AN, Kesari S, Singh SK, et al. Studies on the glycemic and lipidemic effect of Murraya koenigii in experimental animals. J Ethnopharmacol. 2017;112(2):305–311.

51. Syam S, Abdul AB, Sukari MA, et al. The growth suppressing effects of ginsirmin on HepG2 involve induction of apoptosis and cell cycle arrest. Molecules. 2011;16(8):7155–7170.

52. Shivashankara AR, Azmidah A, Hanidaka R, et al. Dietary agents in the prevention of alcohol-induced hepatotoxicity: Preclinical observations. Food Funct. 2012;3(2):101–109.

53. Sathaye S, Bagul Y, Gupta S, et al. Hepatoprotective effects of aqueous leaf extract and crude isolates of Murraya koenigii against in vitro ethanol-induced hepatotoxicity model. Exp Toxicol Pathol. 2011;63(6):587–591.

54. Purohit SS, Sharma AK, Prajapati ND, et al. Handbook of medicinal plants: a complete source book. Agrobios (India). 2009;2:352–353.

55. Rana VS, Juyal JP, Rashmi, et al. Chemical constituents of the volatile oil of Murraya koenigii leaves. J Aromather. 2004;14(1):23–25.

56. Kishore N, Dubey NK, Tripathi RD, et al. Fungitoxic activity of leaves of some higher plants. Natl Acad Sci Lett. 1982;5(1):9.

57. Vajayanthimala J, Anandi C, Udha V, et al. Anticandidial activity of certain South Indian medicinal plants. Phytotherapy Research. 2000;14(3):207–209.

58. Noolu B, Ajumera R, Chauhan A, et al. Murraya koenigii leaf extract inhibits proteasome activity and induces cell death in breast cancer cells. BMC Complement Altern Med. 2013;13:7.

59. Ahmad, Kartini. Chemical constituents of Murraya koenigii (Rutaceae) and their biological activities. Malaysia: Universiti Putra Malaysia; 1999. p 1–25.

60. Pagariya A, Chatur S, Nawab F. In vitro anthelmintic activity of root extract of Murraya koenigii (linn) ssburgh. International Journal of Pharmaceutical Innovations. 2013;3(11):114–117.

61. Pagariya A, Maithili V. Anti-diarrhoeal activity of Murraya koenigii Linn root extracts. Journal of Natural Remedies. 2009;9(1):8–11.

62. Susanna D, Bhavana D, Mounika D, et al. Study of synergistic anti-inflammatory activity of Murraya koenigii and Aegle marmelos. Annals of Biological Research. 2015;6(6):33–38.

63. Kaur G, Daftardar S, Kalyani, Barve H. Modifying anti-inflammatory effect of diclofenac with Murraya koenigii. Recent Patents on Inflammation and Allergy Drug Discovery. 2013;8(1):77–81.

64. Vasudevan M, Parle M, Sengottuvvelu S, et al. Nootropic Potential of Murraya koenigii leaves in Rats. Oriental Pharmacy and Experimental Medicine. 2008;8(4):365–373.

65. Punuru P, D Sujatha, Kumari BP, et al. Evaluation of aqueous extract of Murraya koenigii in unilateral renal ischemia reperfusion injury in rats. Indian J Pharmacol. 2014;46(2):171–175.

66. Dasgupta T, Rao AR, Yadava PK. Chemomodulatory action of curry leaf (Murraya koenigii) extract on hepatic and extrahepatic xenobiotic metabolising enzymes, antioxidant levels, lipid peroxidation, skin and forestomach papillomagenesis. Nutrition Research. 2003;23:1427.

67. Jamil R, Nasir NN, Ramli H, et al. Extraction of essential oil from Murraya koenigii leaves: potential study for application as natural-based insect repellent. Journal of Engineering and Applied Sciences. 2016;11(4):1–5.

68. Gupta C, Singh VP. In-vitro antifungal effect of the essential oils of some medicinal plants. Sci Cult. 1982;48:441.

69. Harve G, Kamath V. Larvicidal activity of plant extracts used alone and in combination with known synthetic larvicidal agents against Aedes aegypti. Inj Exp Biol. 2004;42(12):1216–1229.

70. Arulselvapan V, Subramanian SP. Beneficial effects of Murraya koenigii leaves on antioxidant defence system and ultra structural changes of pancreatic beta cells in experimental diabetes in rats. Chem Biol Interact. 2007;165(2):155–164.

71. Srinivasan K. Plant foods in the management of diabetes mellitus, spices as beneficial antidiabetic food adjuncts. Int J Food Sci Nutr. 2005;56(6):399–414.

72. Xie JT, Chang CZ, Mehendale SR, et al. Curry leaf reduces blood glucose and blood cholesterol level in ob/ob mice. Am J Clin Med. 2006;34(2):279–284.

73. Khan BA, Abraham A, Leelamani S. Role of Murraya koenigii and Brasica juncea in lipid peroxidation. Indian Journal of Physiology and Pharmacology. 1996;40(2):155–158.

74. Shree C, Islam A, Ahmad F, et al. Structure function studies of Murraya koenigii trypsin inhibitor revealed a stable core beta sheet structure surrounded by alpha helices with a possible role for alpha helix in inhibitory function. Int J Biol Macromol. 2007;41(4):410–414.

75. Bhattacharya P, Chowdhury BK. 2-Methoxy-3-Methyl Carbazole from Murraya koenigii. Indian J Chem Sect. 1984;24B(4):452.

76. Narsimha NS, Paradkar MV, Chitguppi VP. Structure of mahanimbine and koenimbine. Tetrahedron Lett. 1968;53:5501–5504.

77. Fiebig M, Pezzuto JM, Soeijarto DD. Part-40 Koenoline a further cytotoxic carbazole alkaloid from Murraya koenigii. Phytochemistry. 1985;24(12):3041–3043.

78. Chakraborty DP, Chemical taxonomy XXXX. Structure of murrayacine, a new carbazole alkaloid from Murraya koenigii. Chem Ind (London). 1974;165–166.

79. Chowdhury BK, Chakraborty DB Taxonomy XVIII. Mukoeic Acid-first carbazole carboxylic acid form plant sources. Chem Ind. (London). 1969;17:549.

80. Chakraborty DP, Bhattacharyya P, Roy S, et al. Structure and synthesis of Mukonine, a new carbazole alkaloid from Murraya koenigii. Phytochem. 1978;17:834–835.

81. Adejugo AC, Avoola OF, Iwalewa EO, et al. Anti-trichomonal, biochemical and toxicological activities of methanolic extract and some carbazole alkaloids isolated from the leaves of Murraya koenigii growing in Nigeria. Phytomedicine. 2006;13(4):246–254.

82. Fumihiko T, Yamazaki Y, Koji S. Oral disinfectant formulations. Tokkyo Koho. 1995;8:231.

83. Patidar DK, Yadav N, Nakra V, et al. Wound healing activity of Murraya koenigii leaf extract. Int J Compr Pharm. 2010;4(9):1–2.

84. Vasudevan M, Parle M. Antiamnesic potential of Murraya koenigii leaves. Phytother Res. 2009;23(3):308–316.

85. Ningappa MB, Dineshara R, Srinivasa L. Antioxidant and free radical scavenging activities of polyphenol-enriched curry leaf (Murraya koenigii L.) extracts. Food Chem. 2008;106(2):720–728.

Citation: Jain M, Gilhotra R, Singh RP et al. Curry leaf (Murraya Koenigii): a spice with medicinal property. MOJ Biol Med. 2017;2(3):236–256.
DOI: 10.15406/mojbiomed.2017.02.00050
Curry leaf (Murraya Koenigii): a spice with medicinal property

86. Paul S, Bandyopadhyay TK, Bhattacharyya A. Immunomodulatory effect of leaf extract of Murraya koenigii in diabetic mice. *Immunopharmacol Immunotoxicol*. 2011;33(4):691–699.

87. Rageeb MD, Usman MD, Barhate SD. Phytochemical evaluation and effect of antipyretic activity on Murraya koenigii Spreng. Leaves extract. *International Journal of Pharmaceutical and Chemical Sciences*. 2012;1(1):231–236.

88. Kadam SH, Dombe S, Naikwadi P, et al. Cardiovascular Effects of Aqueous Extract of Murraya koenigii on Isolated Perfused Frog Heart Preparation. *Journal of Pharmacy Research*. 2011;4(2):462–463.

89. Shah KJ, Juvekar AR. Positive inotropic effect of Murraya koenigii (Linn.) spreng extract on an isolated perfused frog heart. *Indian J Exp Biol*. 2006;44(6):481–484.

90. Birari R, Roy SK, Singh A, et al. Pancreatic lipase inhibitory alkaloids of Murraya koenigii leaves. *Nat Prod Commun*. 2009;4(8):1089–1092.

91. Selamoglu Z. Polyphenolic compounds in human health with pharmacological properties. *J Tradit Med Clin Natur*. 2017;6:e137.

92. Selamoglu Z, Havva Eda Ustuntas, Senay Orgen. Traditional and complementary alternative medicine practices of some aromatic plants in the human health. *Research Journal of Biology*. 2006;4(2):52–54.

93. Harit K, Choudhary B, Mittal J, et al. Analysis of steroidal lactones in Withania somnifera leaf and roots. *International Journal of Institutional Pharmacy and Life Sciences*. 2015;5(4):221–226.

94. Mittal J, Sharma MM, Batra A. Tinospora cordifolia: a multipurpose medicinal plant- A review. *Journal of Medicinal Plants Studies*. 2014;2(2):32–47.