

A Comprehensive Review on Medicinal Uses of Curry Leaves (*Murraya Koenigii*)

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Abstract

Plants have been used in traditional medicine for thousands of years, and India is widely known as a major producer of medicinal herbs. In Ayurveda, many plants are valued for their healing properties, including *Murraya koenigii* (curry leaves), a plant native to the Indian subcontinent. Commonly used as a spice in Indian cuisine, curry leaves also hold significant medicinal importance. Traditionally, curry leaves have been used to treat conditions such as nausea, diarrhea, fever, and digestive issues, and are considered a general health tonic. They are also beneficial in managing respiratory problems and improving overall health. Their therapeutic value comes from bioactive compounds, especially carbazole alkaloids like koenigin and mahanimbine, which exhibit antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and anticancer properties. Curry leaves play an important role in both nutrition and medicine, reflecting the idea that food can also serve as healing. Beyond their health benefits, they are widely used in the food and cosmetic industries for flavoring and natural formulations. Their growing demand highlights their economic importance as well. Cultivating curry leaf plants can benefit farmers by providing a sustainable source of income while supporting industries that rely on natural products.

I. Introduction

Curry leaf (*Murraya koenigii* Spreng), a member of the Rutaceae family, is also known as *Surabhinimba* in Sanskrit (1). In India, it is referred to by various regional names, including *Karivempu* in Tamil, *Barsunga* in Bengali, and *Kurrypatta* in Hindi (2) Plants are vital for food, medicine, and economy. Curry leaves (*Murraya koenigii*), widely used in Asia, offer flavor and medicinal benefits, supporting traditional healthcare systems and growing global herbal markets(3,4,5,6). Only two out of the fourteen known species in the genus *Murraya* are indigenous to India: *Murraya*

paniculata (Linn.) and *Murraya koenigii* Spreng. The Rutaceae family, to which these plants belong, comprises more than 150 genera and around 1,600 species globally. The characteristic aroma of *M. koenigii* leaves—widely used in Indian cuisine—comes from a complex blend of volatile compounds such as p-gurjunene, p-caryophyllene, p-elemene, and o-phellandrene(7). In addition, compounds like β -pinene, β -caryophyllene, β -phellandrene, and α -pinene contribute individually or synergistically to the plant's role in food preservation(8). The species exists in three distinct morphotypes, each differing in flavor and growth characteristics. Among these, the commonly found type features dark green, fast-growing leaves that are considered particularly attractive(9). Curry leaves (*Murraya koenigii*) are widely used in Indian cuisine and are rich in phenolic and flavonol compounds. Studies using ethanol, methanol, and acetone extracts identified major flavonols such as kaempferol and quercetin derivatives via LC-MS/MS.(10,11) These compounds inhibit LDL oxidation, confirmed by lag-time and TBARS assays. While 80% ethanol showed the best extraction efficiency, acetone extracts exhibited the strongest antioxidant activity. Additionally, several carbazole alkaloids were isolated and demonstrated antioxidant effects through oil stability and DPPH radical scavenging assays. Their activity is linked to aryl hydroxyl groups, though further research is needed to explore their full health benefits(12,13).

II. Taxonomical Classification:-

2.1 Table -1 Taxonomical classification of *Murraya koenigii*

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Superdivision	Spermatophyta
Class	Magnoliopsida
Subclass	Rosidae

Family	Rutaceae
Genus	<i>Murraya J.Koenig ex L.</i>
Species	<i>Murraya koenigii</i>

III. Phytochemistry

Mature leaves contain 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 extractives, 27.33% cold water extractives (at 20°C), and up to 33.45% hot water-soluble extractives(14)

Carotenoids :-

The leaves contain 9,744 ng of lutein, 212 ng of α -tocopherol, and 183 ng of carotene on a fresh weight basis. According to Palaniswamy (2003) and Bhaskarachary . (1995) reported that 100 g of leaves provide 51.4 mg of total carotene, including 7.1 mg of β -carotene(15). Furthermore, high-performance liquid chromatography (HPLC) analysis by E. Siong Tee indicates that total carotenoid content in the leaves ranges up to 14,570 μ g per 100 g. Within this total, lutein accounts for 5,252 μ g, while β -carotene contributes 9,328 μ g(16).

Carbazole alkaloids:-

Leaves

Tachibana et al. isolated a dimeric carbazole alkaloid from *Murraya koenigii* leaves, along with six known alkaloids including koenimbine and mahanine derivatives. Other studies identified additional carbazole alkaloids such as glycozoline, koenigine, koenidine, mahanimbine, and murrayacine from various extracts (acetone, hexane, petroleum ether). Novel compounds like 8,8"-bis koenigine and bicyclomahanimbicine were also reported.(17) Leaf constituents included murrayanine, scopolin glycoside, glucose, and ash. Different extraction methods revealed diverse alkaloid profiles, highlighting the plant's rich phytochemical composition, particularly carbazole derivatives with potential biological activity(18).

Stem:

From the alcoholic extract of stem bark, Saha et al. (1998) isolated koenigine-quinone A and koenigine-quinone B. Their structures were identified as 7-methoxy-3-methyl carbazole-1,4-quinone and 6,7-dimethoxy-3-methyl carbazole-1,4-quinone, respectively (Saha et al., 1998). Additionally, 9-carbomethoxy-3-methyl carbazole and 9-formyl-3-methyl carbazole were reported from *M. koenigii* by Chakraborty et al. (1997)(19). Several carbazole alkaloids including murrayazolinol (a minor constituent) (Bhattacharya, 1989), mahanimbilol (Rama Rao et al., 1980), murrayazolidine

(Chakraborty et al., 1970; 1974), murrayacine (Chakraborty et al., 1974), mukonidine (Chakraborty, 1978), murrayazolinine (Chakraborty et al., 1973), murrayanine, girinimbine, mahanimbine (Das, 1965), girinimbilol, and mahanimbilol (Reisch et al., 1994) have also been isolated. These compounds are considered potential biogenetic precursors of girinimbine and mahanimbine(20).

Seeds:

Seeds of *M. koenigii* collected from Marassana were used to isolate mahanine, girinimbine, koenimbine, isomahanine, and mahanimbine (Johannes, 1994). The petroleum ether extract of the seeds was also used to obtain 2-methoxy-3-methyl carbazole (Bhattacharya et al., 1984) (30). Later, Mandal et al. (2010) identified three bioactive carbazole alkaloids—kurryam (I), koenimbine (II), and koenine (III)—with their structures confirmed through 2D-NMR spectral analysis(21).

Fruits:

The ether extract of the fruits was used to isolate mahanimbine and koenimbine (Narsimha et al., 1968). Reisch et al. (1992) further reported the presence of isoahanine and murrayanol, along with five previously known carbazole alkaloids: mahanimbine, murrayazolidine, girinimbine, koenimbine, and mahanine(22)

IV. Plant Profile :-

Murraya koenigii, commonly known as curry leaf, is extensively distributed and cultivated throughout India (23). It occurs naturally across a wide geographic range, from the Himalayan regions such as Uttarakhand, Sikkim, and Garhwal to West Bengal, Assam, the Western Ghats, and the Travancore-Cochin region. Propagation is typically achieved through seeds, which exhibit good germination rates under partial shade (24).

Beyond India, *M. koenigii* is also found across various parts of Asia, particularly in moist forested areas at elevations ranging from 500 to 1600 meters. Notable regions include Guangdong, southern Hainan, and southern Yunnan (Xishuangbanna), as well as Bhutan, Laos, Nepal, Pakistan, Sri Lanka, Thailand, and Vietnam.

Botanically, the curry leaf plant is a strongly aromatic, unarmed, semi-deciduous shrub or small tree, growing up to 7 meters in height with a stem diameter ranging from 14 to 42 cm (25). The main stem is dark green to brownish in color, and the bark peels longitudinally to reveal the white wood beneath. The stem and branches are woody, slender yet robust, and covered in dark grey bark.

Leaves are imparipinnate, glabrous, and intensely aromatic, typically comprising 9 to 25 or more leaflets. These leaflets are alternate, short-stalked, gland-dotted, and highly fragrant.

The flowers are small, white, fragrant, and ebracteate, featuring a deeply five-cleft, pubescent

calyx (26). The five free petals are whitish, glabrous, and bear dotted glands. Fruits are borne in compact clusters and are small, ovoid to subglobose, glandular, and possess a thin pericarp enclosing one or two seeds of spinach-green color.

4.1 Table 1 Nutritional Value

S.No	Nutrients	Value of fresh curry leaves (100gm)	Value of dehydrated curry leaves(100gm)
1.	Proteins	6g	12g
2.	Fat	1g	5.4g
3.	Carbohydrate	18.7g	64.31g
4.	Calcium	830mg	2040mg
5.	Iron	0.93mg	12mg
6.	Beta-carotene	7560ug	5292ug

Source: Plant ,S.A.M.,Singh,S.,More,P.K.B.,and Madan,S.(2015).Curry Leaves (*Murraya koenigii* Linn)

V. Extraction Technique :-

5.1 Soxhlet Apparatus :-

Extraction by Soxhlet :-

In the Soxhlet extraction method, 10 g of curry leaf powder was extracted with 250 mL of various solvents such as distilled water, hexane, chloroform, ethanol (EtOH), and a mixture of ethanol and water (1:1). After completion of extraction, the solvents were removed, and the obtained extracts were preserved at 4 °C until required for antioxidant studies (17). The activity of the extracts was evaluated on the basis of the dry weight of the total extract per litre of assay solution. Among all solvents, hexane at room temperature gave the lowest yield ($4.8 \pm 0.07\%$), while Soxhlet extraction using the ethanol–water mixture showed the highest yield ($22.8 \pm 0.80\%$) (27).

Preparation of *M. koenigii* Leaves Extract:-

The method for preparing *M. koenigii* leaf extract was adopted from Sablania et al. with slight modifications. Briefly, 5 g of powdered *M. koenigii* leaves were mixed with 100 mL of methanol and kept for 56 hours in a dark or shaded place (28). This condition helps maintain a constant temperature and prevents deterioration of the extracted constituents. The sample was then centrifuged at 10,000 rpm for 10 minutes at 24 °C to obtain the aqueous extract. After complete drying, the filtrate was passed through filter paper to remove any fine solid particles. The same procedure was repeated using acetone and ethanol as solvents (29). The phytochemical properties of the extracts were then analyzed. Methanol extraction provided the highest crude extract yield (21.42%), which

supports detailed identification of phytochemical constituents present in this herbal plant (30).

5.2 Ultrasound assisted extraction:-

Curry leaves (1 g) were mixed with 20 mL of methanol at varying concentrations ranging from 40% to 80%. The mixtures were placed in an ultrasonic bath (31). Extraction conditions were adjusted by varying the temperature between 40°C and 80°C and ultrasonic power from 80 to 150 W. Each extraction process was carried out for 2 hours under these different conditions (32). A total of twenty experimental runs were conducted using different parameter combinations. The highest catechin yield (0.536 mg/g DW) was achieved at an extraction temperature of 60°C with a methanol concentration of 86.3% (33).

5.3 Microwave assisted extraction:-

A microwave-assisted technique was applied to synthesize carbon dots (CL-C dots) from curry leaf extract residue. Various analytical methods were employed to fully characterize the synthesized CL-C dots. High-resolution transmission electron microscopy (HR-TEM) revealed an average particle size of 3.55 nm. The CL-C dots exhibited green fluorescence when excited at 340 nm, with a peak emission at 425 nm. The quantum yield (QY) of these green-emitting CL-C dots was determined to be 27.13% (34). Raman spectroscopy analysis showed an intensity ratio (I_{D/I_G}) of 1.1, indicating the presence of structural defects typical of carbon-based nanomaterials. Additionally, a white light-emitting diode (WLED) device was fabricated using the synthesized CL-C dots, showing CIE chromaticity

coordinates of (0.307, 0.354) and a correlated colour temperature (CCT) of 6617 K (35). The CL-C dots were also explored as fluorescent ink in anti-counterfeiting applications, offering a simple and cost-effective alternative to commercial inks. These findings highlight their potential use in energy-related fields, materials science, forensics, optoelectronics, and anti-counterfeiting technologies (36).

5.4 Maceration:-

In the maceration process, 500 grams of curry leaf powder were immersed in 2000 mL of 96% ethanol inside a sealed container. The mixture was stored away from direct sunlight for three days and stirred intermittently (37). The liquid extract was filtered three times daily—morning, afternoon, and evening—for 72 hours. The remaining plant residue was then subjected to re-maceration using 1500 mL of 96% ethanol, following the same procedure over another three-day period (38). The filtrate obtained from this second maceration was combined with the initial extract. Subsequently, the residue from the second extraction was treated again with 1200 mL of fresh 96% ethanol and allowed to stand for an additional three days (39). All filtrates were pooled together and concentrated using a rotary vacuum evaporator to obtain a thick ethanol extract. The final yield was 52.613 grams, corresponding to 9.50% (37).

VI. Medicinal uses:-

6.1 Antibacterial activity:-

Essential oil extracted from *Murraya koenigii* leaves has demonstrated antibacterial effects against *Pasteurella multocida*, *B. subtilis*, *S. aureus*, *C. pyogenes*, and *P. vulgaris*. The oil remained effective against the first three organisms even at a dilution of 1:50033 (40). During fractionation of the acetone extract of fresh leaves, three carbazole alkaloids—mahanimbine, murrayanol, and mahanine—were isolated. These compounds exhibit antibacterial, mosquitocidal, and inhibitory activity against topoisomerase I and II (41).

6.2 Antifungal activity:-

Leaf essential oil of *Murraya koenigii* has shown antifungal activity against *Candida albicans*, *Candida tropicalis*, *A. niger*, *A. fumigates*, and *Microsporium gypseum*, even at a dilution of 1:500 (42). Ethanolic leaf extracts also showed fungitoxic effects against *Rhizoctonia solani*35 and *Colletotrichum falcatum*. However, ethanolic extracts from roots and whole plant (excluding

roots) did not show activity against *Microsporium canis*, *Trichophyton mentagrophytes*, or *Cryptococcus neoformans* (43).

6.3 Antiprotozoal activity:-

Essential oil from *Murraya koenigii* leaves has been reported to exhibit antifungal effects against *Microsporium gypseum*, *Candida albicans*, *Candida tropicalis*, *A. niger*, and *A. fumigates* at a 1:500 dilution (44). Ethanolic extracts of the leaves showed fungitoxicity against *Rhizoctonia solani*35 and *Colletotrichum falcatum* (45). However, extracts from roots or whole plant (except roots) were ineffective against *Trichophyton mentagrophytes*, *Cryptococcus neoformans*, and *Microsporium canis* (46).

6.4 Hypoglycaemic effects:-

Aqueous and methanolic extracts of *Murrayakoenigii* leaves reduced plasma glucose levels in alloxan-induced rats. Ethanolic stem extracts also significantly reduced body weight17, triglycerides, total cholesterol, and blood glucose (47). Mahanimbine, a carbazole alkaloid, shows hypolipidemic and antihyperglycemic activity. Intraperitoneal doses of 50 mg/kg and 100 mg/kg administered weekly for 30 days produced significant effects in streptozotocin-induced diabetic Wistar rats without causing diabetic shock (48). After treatment, triglycerides, LDL, VLDL, and total cholesterol levels decreased significantly, while HDL levels increased. Additionally, mahanimbine shows weak alpha-glucosidase inhibition but strong alpha-amylase inhibitory activity (49).

6.5 Hepatoprotective activity:-

Methanolic leaf extract of *Murraya koenigii* reduced elevated hepatic enzymes (AST, ALT, serum bilirubin, and alkaline phosphatase) in carbon tetrachloride-treated Sprague Dawley rats at doses of 200, 300, and 500 mg/kg (50). The highest dose (500 mg/kg) showed effects comparable to silymarin, a standard drug used for liver disorders (51). In ethanol-induced liver damage models, aqueous extract at 1g/kg showed protective effects by reducing lipid peroxidation (52).

6.6 ANTIPROTOZOAL ACTIVITY:-

Ethanolic extracts of curry leaves exhibited significant antiprotozoal activity against *Entamoeba histolytica*. They also showed antihypertensive effects in dogs and cats and antispasmodic activity on guinea pig ileum (53).

6.7 Anticancer Activity:

Curry leaf extracts demonstrated antitumor activity in vitro. Studies in tumor-bearing mice showed a reduction in tumor size and number of cancer cells (Muthumani et al., 2009). Methanolic extracts from different regions of India also showed strong activity against breast cancer cell lines (25). An MTT assay further confirmed the anticancer potential of curry leaf methanol extract (54).

6.8 Mosquitocidal activity:

Petroleum ether and acetone extracts of *Murraya koenigii* leaves were effective against *Aedes aegypti* larvae at concentrations ranging from 250 ppm to 900 ppm (55).

6.9 Anthelmintic effects

Both aqueous and ethanolic leaf extracts of *Murraya koenigii* showed anthelmintic activity against *Pheretima posthuma*, comparable to the standard drug piperazine (56). This activity is attributed to tannins present in the leaves. Tannins may exert their effect by binding to proteins in the host gastrointestinal tract or parasite cuticle, disrupting energy metabolism similar to synthetic phenolic anthelmintics such as oxclozanide, niclosamide, and bithionol (57). Methanolic extract showed dose-dependent activity, causing paralysis in 18 minutes and death in 45 minutes (58).

6.10 Nephroprotective effects:

Daily oral administration of aqueous leaf extract for 30 days in streptozotocin-induced diabetic rats significantly reduced serum urea and creatinine levels and promoted renal tissue regeneration (59).

6.11 Antimicrobial activity:

Root extracts of *Murraya koenigii* in hexane, methanol, and chloroform were tested against *Salmonella typhi*, *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, and fungal strains such as *Aspergillus niger*, *Candida albicans*, and *Trichophyton rubrum* (60). All extracts showed activity, with methanol extract being the most potent, especially against *Trichophyton rubrum* and *Staphylococcus aureus* (61). The aqueous extract of roots was ineffective (62).

6.12 Antitrichomonal Activity:

Curry leaves have attracted interest for their medicinal potential, including antitrichomonal activity (63). Studies suggest effectiveness against *Trichomonas vaginalis*, a common sexually transmitted parasite (64). Bioactive compounds such as alkaloids, flavonoids, and phenolics contribute to this activity (65). Extracts can inhibit growth and survival of *Trichomonas* species, although further research is needed to confirm mechanisms (47). Carbazole alkaloids also inhibit *Trichomonas*

gallinae, with girinimbilol and girinimbine showing IC50 values of 1.20 and 1.08 mg/mL. Acetylation further enhanced activity (66).

6.13 Anthelmintic Activity:

Curry leaf extracts possess strong anthelmintic properties due to compounds like tannins, flavonoids, and alkaloids. Their antioxidant content may reduce oxidative stress caused by parasitic infections, enhancing effectiveness (67). Studies indicate activity against various intestinal worms, suggesting potential as a natural remedy (68). Experiments with *Pheretima posthuma* showed significant activity at 100 mg/mL, with alcoholic extract being more effective than petroleum ether extract (69).

6.14 Anti-ulcer Activity:

Bioactive compounds in curry leaves, including alkaloids, flavonoids, and tannins, exhibit gastroprotective effects and help prevent ulcers (70). These extracts enhance mucosal protection, stimulate mucin secretion, and reduce gastric acid production (71). Aqueous extracts at doses of 200 and 400 mg/kg significantly reduced ulcer formation in pylorus ligation and NSAID-induced models (72). The extract decreased gastric juice volume, acidity, and lesions while increasing pH, confirming anti-ulcer potential (73).

6.15 Skin Protection Formula and Anti-ageing:

Curry leaves are rich in antioxidants such as flavonoids, phenolics, and vitamin C, which help neutralize free radicals and protect against oxidative skin damage (74). This reduces premature ageing signs like wrinkles, fine lines, and pigmentation (75). Nutrients like beta-carotene and amino acids support collagen production and skin elasticity. Anti-inflammatory properties also help manage acne and other skin conditions (76).

6.16 Oral Health/ Effect on Dental Caries:

Curry leaves contribute to oral health due to their antioxidant and antimicrobial properties, which help control oral pathogens and reduce dental caries and gum disease (47). Compounds in the leaves inhibit *Streptococcus mutans*, a primary cause of tooth decay. Their anti-inflammatory effects also support gum health (77). Regular consumption or chewing improves oral hygiene and reduces bad breath. Traditionally, curry leaf twigs are used as datun for cleaning teeth and strengthening gums. Additionally, formulations containing compounds such as isomahanine, mahanine, and murrayanol have shown antimicrobial activity against oral pathogens and are considered safe for daily use (78).

VII. Conclusion

Murraya koenigii (curry leaf) is a medicinal plant used in traditional healthcare for its wide range of therapeutic benefits. It contains bioactive compounds with antibacterial, anti-inflammatory, antidiabetic, antioxidant, and anticancer properties. Traditionally used in rural diets, its consumption has declined with urbanization and reliance on artificial additives. Scientific studies highlight its potential in treating various diseases, but further research is needed to understand its mechanisms, safety, and clinical effectiveness. Standardization and advanced studies could support drug development. Promoting its use and research may enhance natural healthcare solutions and provide safer, cost-effective alternatives to synthetic medicines.

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