



PHARMACOGNOSY, PHYTOCHEMISTRY, PHARMACOLOGY OF CURRY LEAF (*Murraya koenigii*)

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ABSTRACT

India is the source of knowledge for medicinal plants that are included in day-to-day use in every household one such plant is *Murraya koenigii*. Fresh leaves are a vital part of not only Indian cuisine but also in Indian traditional medicines. Curry leaves help treat anemia because they contain iron and folic acid. Curry leaf is also one of the traditional folk remedies that contains several interesting bioactive compounds with health-promoting properties. Curry leaves contain flavonoids, tannins, coumarins, xanthenes, procyanidins, and other compounds have been shown to be radical scavengers and are a promising class of therapeutic drugs. The present article covers the pharmacognosy, phytochemistry, pharmacological aspects of *Murraya koenigii*.

Key words:

Curry leaves, *Murraya koenigii*, Medicinal value, Traditional medicine, Ethanomedicine.

INTRODUCTION

India is rich in Plant-based Knowledge on traditional medicine¹. Curry leaf or *Murraya koenigii* is a tropical and subtropical tree that is local to Asia². The word “curry” is borrowed from the Tamil word *kari* meaning “blackened”. Fresh leaves are a vital part of not only Indian cuisine but also in Indian traditional medicines. The curry leaves vary from; regular, dwarf. Curry leaves have an emitting and diffusing scent, having a strong aroma and characteristic flavour. Freshly used in dishes, curry leaves give a citrus-like flavor. The leaves are a good source of beta-carotene². The leaves are rich in antioxidants and vitamin C, antimicrobial properties, antifungal, and antihyperlipidemic properties. In addition, Curry leaf has been reported to have antitumor, anti-inflammatory, and hypoglycemic effects⁴. Curry leaves are said to be capable of preventing Alzheimer’s disease because of the presence of pro-cholinergic effects, and they also have anti-diabetic properties. Curry leaves help treat anemia because they contain iron and folic acid. It also protects the liver from damage due to drinking. Most herbal medicines rely on the bioactive compounds that act as a defense against many diseases³. Medicinal plants are the richest source of

bioactive compounds used in traditional and modern medicine as nutraceuticals and food supplements, pharmaceutical intermediates, and chemical entities for synthetic drugs⁴.

Curry leaf is also one of the traditional folk remedies that contains several interesting bioactive compounds with health-promoting properties⁴. Due to their many chemical components, many plants with traditional medicinal use are known to have antioxidant properties. These compounds can work alone or in concert with one another to produce certain synergistic effects. Flavonoids, tannins, coumarins, xanthenes, procyanidins, and other compounds have been shown to be radical scavengers and are a promising class of therapeutic drugs for diseases caused by free radicals²². Antioxidants obtained from natural plant sources are more potent and safer due to their harmless nature⁵.

Additionally, they are applied externally to treat animal bites and outbreaks⁵. It is said that the green leaves can be eaten uncooked to cure diarrhoea, and that the infusion of the cleaned leaves prevents vomiting. Curry leaves are utilized to treat calcium deficiencies as well⁵. It is rich in calcium, iron, vitamin B2, vitamin C, vitaminB2, and

vitamin A. Both young and old benefit from its nutritional value⁵. Curry leaves are a great natural calcium supplement for women who have osteoporosis, calcium

shortage, etc. When combined with sugar and lime juice works well to alleviate morning sickness, nausea, and vomiting brought on by indigestion and overindulgence⁵.



Fig-1: Image of Curry leaf

HISTORY

Curry leaves were mentioned in Tamil and Kannada Literature back in 1st to 4th centuries CE, in which the curry leaves have a prosperous history embedded in South India. In Tamil literature, “Kari” means spiced sauces. There was a spice trade between Britain and Tamil. In the late 16th century, it was introduced to England. Carl Linneaus in *Mantissa Plantarum*, first published the spices *Bergera koenigii*. The scientist John Andreas Murray gave the name genetic name, Murraya.

The South Asian Immigrants spread the plant to Malaysia, South Africa and the Reunion Islands⁵. Curry leaf trees are naturalized in forests and wasteland throughout the Indian subcontinent except in the higher parts of the Himalayas.

From the Ravi River in Pakistan, its distribution extends eastwards towards Assam in India and Chittagong in Bangladesh, and southwards to Tamil Nadu in India.

The use of Curry Leaves as A Flavouring for Vegetables is described in early Tamil literature dating back to the 1st to 4th centuries AD. Its use is also mentioned a few centuries later in Kannada literature. Curry leaves are still closely associated with South India where the word 'curry' originates from the Tamil 'kari' for spiced sauces. An alternative name for curry leaves throughout India is kari patta. Today curry leaves are cultivated in India, Sri Lanka, Southeast Asia, Australia, the Pacific Islands, and Africa as a food flavouring.

CLASSIFICATION

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Sapindales
Family	Rutaceae
Genus	Murraya J.
Species	<i>Murraya koenigii</i> (L.) Spreng.

Table 1: Classification of Curry leaf

PHARMACOGNOSY ASPECTS

Macroscopical characters

Part	Description
Fruit type	Small, white and fragrant, borne in terminally or axillary corymbs
Stem	A small to medium-sized, much branched shrub or small tree with a grayish-brown bark.

Size	2-4 cm in length and 1-2 cm in width
Color	Light green when younger which changes to dark green when grown up
Leaves	Pinnately compound, typically with 11-21 leaflets.
Seeds	Seeds are large and make up most of the fruit's mass

Table 2: Macroscopical Characters**Microscopical characters**

Part	Under the Microscope
Epidermis	Presence of stomata (more on the lower surface), epidermal cells with wavy anticlinal walls, and a thin cuticle
Mesophyll	Differentiated into palisade and spongy parenchyma. Palisade cells are elongated and arranged in one or two layers.
Vascular bundles	Located in the midrib and lateral veins, showing xylem and phloem elements
Calcium Oxalate crystals	Prisms and druses are often observed in mesophyll cells.
Trichomes	Present on both surfaces, contributing to the characteristic aroma due to the presence of volatile oils.

Table 3: Microscopical Characters**PHYTOCHEMISTRY OF CURRY LEAVES**

S.No	Phytochemical Group	Main Compounds	Part of Plant Found	Key Function
1	Alkaloids	Carbazole, girinimbine, koenimbine, and mahanimbine	Leaves	Antimicrobial, anti-inflammatory, hepatoprotective, anticancer
2	Flavonoids	Quercetin, rutin, and kaempferol	Leaves	Antioxidant and anti-inflammatory properties
3	Glycoside	Coumarins	Leaves	Contribute to aroma and may have anticoagulant and biological effects
4	Phenolic Compounds	Tannic acid, gallic acid, caffeic acid, cinnamic acid, chlorogenic acid, ferulic acid, and vanillic acids	Leaves	Antioxidant potential
5	Volatile Oils	α -pinene, sabinene, β -phellandrene, and β -caryophyllene	Leaves	Characteristic aroma and flavour
6	Minerals and Vitamins	Calcium, phosphorous, iron, vitamin A and Vitamin C	Leaves	Vision, immunity, antioxidant activity, bone health, blood circulation, energy production

Table 4: Phytochemical Aspects of Curry Leaves

The mature curry leaves include 63.2% moisture content of, 1.15 % nitrogen from protein, 14.6% total sugars from carbs, and 13.06% total ash. Curry leaves include important bioactive components, such as oxalic acid, resin, carbazole alkaloids, and the primary bioactive ingredient, which includes loenigin, bicyclomahanimbincine, cyclomahanimbine,

murrayastine, coumarine, koenidine, and pypayafoline carbazole^{3,6}.

Murraya koenigii roots contain bioactive compounds called murrayagetin, marmesin-1''-O-rutinoside, and murrayanol. Additionally, three monomeric and five binary carbazole alkaloids, including biloeniquinone-A, bismurrayaquinone-A, bis-2- hydroxy-3 methyl carbazole, bismahanine, mukoenine-A, B, and C, and

murrastifoline-F, were extracted from the bark. Root benzene extract contains compounds mukoline and mukolidine. Furthermore, girinimbine was found in the root, and koenoline, which is a synonym for 1-methoxy-3-hydroxy methyl carbazole, was found in the root bark⁶.

PHARMACOLOGICAL ACTIVITIES

Anti-inflammatory and analgesic effects

Analgesics are the drugs that relieve pain. Pain is an uncomfortable sensory and spiritual practise that is related with real or possible tissue destruction. Pain is divided into 2 classes acute and chronic pain. Pain is the major expression of injuries and disease.²⁸ *M.koenigii* leaf extracts have been shown to productively alleviate pain caused by intraperitoneal acetic acid and subplantar formalin injection⁸. This effect is mediated by inhibition of proinflammatory mediators¹¹. This proves that curry leaves have the ability to effectively reduce the pain and inflammatory effects. Studies using carrageenan-induced paw edema in rats have shown significant anti-inflammatory effects with extracts of *murraya koenigii*¹².

Antimicrobial Activity

Agents that stop or kill the bacteria show antimicrobial activity.²⁹ Extracts and essential oils from curry leaves have demonstrated inhibitory effects against various bacteria and fungi¹³. This activity is attributed to several bioactive compounds that can interfere with microbial growth. Studies have shown efficacy against common pathogens like *staphylococcus aureus* and *Escherichia coli*, as well as fungi¹⁴.

Antidiabetic Activity

World Health Organization (WHO) definition of diabetes is, "Diabetes is a chronic metabolic disorder of carbohydrate, fat & protein metabolism characterized by high blood sugar levels because the pancreas does not produce enough insulin, or cells do not respond to insulin produced"³⁰. *Murraya koenigii* leaves are shown to have a positive effect on oxidative stress levels, glucose levels, lipid profiles, and a number of other diabetes-related indicators¹⁵. Studies provide that curry leaf extracts can favour lowering blood glucose levels^{8,15}. The effect is potentially due to the inhibition of enzymes like aldose reductase and α -glucosidase, which are involved in glucose metabolism. Certain alkaloids and other constituents may enhance glucose utilization and improve insulin sensitivity¹⁶. Animal studies have demonstrated significant reductions in blood glucose levels and improvements in health of the pancreas and kidneys in diabetic rats treated with curry leaf extracts¹⁵.

Antioxidant Activity

Every living cell has the innate ability to produce oxidants and to defend against them. Organisms developed antioxidative systems to reduce oxidative damage, which are believed to be triggered by increased production of ROS²². This antioxidative defence mechanism, which is made up of enzymes and metabolites in all subcellular compartments, balances oxidants like ROS.³¹ The formation of ROS is decreased or is eliminated, due to the presence of phytochemicals in *M. koenigii*²². Curry leaves have shown that the antioxidant effect of aromatic plants is due to the presence of hydroxyl groups in their phenolic compounds⁵. Curry leaves are a rich source of phenolic compounds and flavonoids, which are potent antioxidants⁴. These compounds can scavenge free radicals and protect against oxidative stress, which is implicated in various chronic diseases¹⁷. The findings demonstrated that tolerant types have greater concentrations of flavonoids and phenolic compounds than sensitive types. Curry leaf, which is resistant to CLAs, had significant levels of carbazole alkaloids and hydroxycinnamates¹⁷. Findings imply that citrus tolerance to HLB may be improved by high concentrations of flavonoids and phenolic substances¹⁷. Studies using different assays (like DPPH and ABTS) have confirmed the significant antioxidant potential of curry leaf extracts¹⁸.

Cardioprotective Activity

Certain extracts of the curry leaf contained one or more phytochemicals or phytonutrients that contributed to cardioprotection. Numerous significant phytoconstituents including phenols, flavonoids, condensed tannins, and alkaloids, which have been shown to have protective effects against oxidative stress, were found in the curry leaf aqueous extract according to chemical analysis²².

Hepatoprotective Activity

Any type of naturally occurring liver illness might be nearly identical to toxic liver harm caused by medications and chemicals. Hepatoprotective effect tests were conducted against medications and substances such as alcohol, CCl₄, galactosamine, thioacetamide, paracetamol, isoniazid, rifampicin, etc^{3,19}. Chronic consumption of alcohol is a pervasive and consequential aspect resulting in liver diseases which are fatal⁸. Some studies suggest that curry leaves may have a protective effect on the liver⁸. The compounds such as Carbazole alkaloids such as mahanimbine, girinimbine, isomahanimbine, murrayazoline and mahanine, have hepatoprotective activity^{3,8}. The hepatoprotective activity opposed to ethanol-induced hepato-toxicity is proved to be from the compounds such as, tannins and carbazole

alkaloids found in some aqueous extracts, which are more spectacular when in comparison with L-ornithine L-aspartate⁸.

Anticancer Activity

The leaf of *Murraya koenigii* has demonstrated an anti-cancer agent against colorectal cancer and HeLa cells^{3,8}. Furthermore, it has been claimed that *Murraya koenigii*'s methanol extract can inhibit the growth of breast cancer cells^{3,8}. Alkaloids isolated from the leaves have also been shown to exhibit cytotoxic activity against breast cancer cells⁸. Several Studies have shown that mahanine, pyrafoline-D, murrayoline-I have potent effects on HL-60 cells. A carbazole alkaloid called girmimbine that was derived from *M.koenigii* showed anticancer efficacy against lung cancer and human hepatocellular carcinoma⁸. Another substance that was separated from *M.koenigii*, koenimbin, had the ability to inhibit MCF-7 breast cancer cells³. By activating the intrinsic mechanism of apoptosis and down-regulating the Akt/mTOR survival pathway, murrayazoline and O-methyl murrayamine A, which were isolated from the leaves of these plants, showed efficacy against colorectal cancer⁸. It has been demonstrated that mahanimbine, which was also extracted from *M.koenigii* leaves, inhibits P-glycoprotein, which is implicated in lung cancer chemoresistance⁸.

MEDICINAL VALUE

Curry leaves (*Murraya koenigii*) are more than just an aromatic addition to our dishes; they possess a wealth of medicinal properties and nutritional benefits⁷.

Vitamins: A, B (including B1, B2, B3, B6, and B9), C, and E

Minerals: Calcium, phosphorous, iron, magnesium, zinc, copper, and manganese.

Fiber: A good source of dietary fiber.

Antioxidant properties: curry leaves effectively combat free radicals in the body, reducing oxidative stress and potentially lowering the risk of chronic diseases²⁰, packed with powerful plant compounds like alkaloids (including mahanimbine, mahanine, and murrayanol), flavonoids, glycosides, and phenolic compounds¹⁷.

Heart Health: May help reduce cholesterol and triglyceride levels, thus supporting cardiovascular health. compounds like rutin and tannins contribute to these cardioprotective effects²¹.

Blood Sugar Management: Studies suggest curry leaves may help regulate blood glucose levels due to their antihyperglycemic properties and potential to improve insulin sensitivity^{8,15}.

Digestive Aid: They stimulate digestive enzymes, which can improve digestion and alleviate issues like indigestion, bloating, constipation, and diarrhea.

Hair Health: Traditionally used to promote hair growth, strengthen hair follicles, and prevent premature greying. They are rich in proteins and beta-carotene, which are beneficial for hair health.

Skin Health: The vitamins and antioxidants in curry leaves can help reduce acne, blemishes, and signs of aging. They also possess antimicrobial properties that may prevent skin infections.

Eye Health: Being a good source of vitamin A, curry leaves may help improve vision and prevent conditions like cataracts.

Bone Health: They are rich in calcium, which is essential for maintaining strong bones and preventing conditions like osteoporosis

Immunity Boost: Research suggests that curry leaf extracts may enhance immune function⁴.

Wound Healing: Agents that can heal wounds quickly are called wound healing agents.³² The antiinflammatory and antimicrobial properties may aid in wound healing. Curry leaves have been shown to have antioxidant properties and are capable of scavenging free radicals, thus providing anti-aging benefits as well as reducing the risk of cancer⁴. Essential oils have been traditionally used for 35 different respiratory tract infections, and are used nowadays as ethical medicines for colds. In the medical field, inhalation therapy of essential oils has been used to treat acute and chronic bronchitis and acute sinusitis. Inhalation of vapours of essential oils or their volatile terpenes has a significant role in controlling the central nervous system and had an anti-inflammatory effect on the trachea and to reduce asthmatic symptoms. Essential oils and their individual aroma components also showed cancer suppressive inactivity when tested on a number of human cancer cell lines including glioma, tumors, breast cancer, leukemia and others⁵.

MISCELLANEOUS

Pesticide contamination: A Study shows that commercially cultivated curry leaves can be contaminated with a high number of harmful pesticides due to unhealthy agricultural practices.

Toxicity of pods: some sources indicate that the small seeds of the curry leaf plant are potentially toxic and should be avoided.

Alkaloid Content: Curry leaves contain alkaloids, which contribute to their medicinal properties. However, excess intake of alkaloids may lead to adverse effects on the

central nervous system, digestion and potentially the immune and reproductive systems⁷.

MARKET VALUE

The market value of curry leaves in Hyderabad can vary, but generally, fresh cut leaves cost between 4 rs and 200 rs per kilogram.

Summary Table of Pharmacological Activities

S.No	Plant part	Activity	Extract	Model	Standard drug	Dose	Parameters	Mechanism	Stats	Author year	References
1	Leaf	Antiinflammatory and analgesic activity	Methanol extract	plethysmometry	Diclofenac sodium	10 mg/kg, p.o	Carrageenan-induced paw edema	-	P<0.05	Shailly Gupta Et al., 2010	12
2	Leaf	Cardioprotective activity	Aqueous extract	-	Cadmium	0.44 mg/kg bw s.c	Inhibiting α -keto glutarate dehydrogenase activity	-	P<0.001	Elina Mitra Et al., 2012	22
3	Leaf	Vasodilating activity	Crude ethanolic extract	-	-	-	Increasing availability of calcium from extracellular sites	-	-	Harish K Handral Et al., 2012	25
4	Leaf	CNS stimulating activity	Aqueous extract	-	Imipramine	200 mg/kg	-	-	P<0.001	Lokesh Brind Et al., 2014	26
5	Leaf	Hypoglycemic activity	Ethanol leaf extracts	-	Tolbutamide	5.0 ml/kg	-	-	P<0.05	Tembhurne S.V Et al., 2009	27
6	Leaf	Antioxidant activity	Ethanolic extract	FRAP Assay	-	-	Comparing with TF and total phenolic contents	Reduction of Fe (III)-TPTZ to Fe (II)-TPTZ at low pH	P<0.05	Ali Ghasemzadeh Et al., 2014	4
7	Leaf	Anticancer activity	Ethanolic extract	IC50 value	Tamoxifen	240 μ g/ml	-	-	-	Ali Ghasemzadeh Et al., 2014	4
8	Leaf	Antioxidant activity	Volatile extract	Xanthine oxidase inhibition	Quercetin	0.29 μ g/ml	-	Essential oils, eugenol and quercetin scavenge OH	-	Mini Priya Rajendran Et al., 2013	9

9	Leaf	Antioxidant activity	Aqueous extract	-	Piroxicam	30 mg/kg	LPO, PCO, GSH level, TSH content	Provides protection against gastric mucosa damage	P<0.001	-	-
10	Leaf	Antiulcer activity	Ethanollic extract	PAS and alcian blue staining	Piroxicam	30 mg/kg	Histological changes	Protective against ulcerative damage	P<0.001	Elina Mitra Et al., 2012	22
11	Leaf, Bark	Antimicrobial extract	Petroleum ether, Alcoholic, Acetone extracts	Against multiple bacterial strains	Amikacin	-	-	Volatile oil effective against Staph. and Strep. species	-	Elina Mitra Et al., 2012	22
12	Bark, Stem	Anticancer	Petroleum ether	HepG2 cell line	-	-	-	Induces programmed cell death	-	Harshita Sisodia Et al., 2023	24
13	Leaf	Antifungal	Alcohol, Acetone, Petroleum Ether, Chloroform, Methanol	Against Rhizoctonia and Fusarium	-	-	-	Varied effectiveness	-	Harshita Sisodia Et al., 2023	24
14	Seeds	Antidiarrhoeal	n-Hexane	-	Castor oil	-	-	-	-	-	-
15	Leaf	Antitumor	Petroleum ether	-	Mahanine	10.6 µg/ml	-	Extrinsic apoptosis pathway via mahanine	-	Harshita Sisodia Et al., 2023	24
16	Leaf	Antiulcer	Aqueous	Pylorus ligation	Omeprazole	20 mg/kg	Gastric volume, lesions, acidity	Effective ulcer reduction	P<0.01	Praveen Sharma Et al., 2011	23

17	Leaf	Cardiovascular	Aqueous	Dose dependent	Doxorubicin	-	Kreb's cycle enzyme activities	High flavonoid and phenol content, antioxidant	P<0.001	Harshita Sisodia Et al., 2023	24
18	Leaf	Hypocholestromic activity	Ethanol	-	Simvastatin	-	-	Carbazole alkaloids presence	-	Harshita Sisodia Et al., 2023	24
19	Leaf	Antiulcer activity	Aqueous extract	Ethanol-induced ulcers	Omeprazole	20 mg/kg	Gastric volume, lesions, acidity	Effective ulcer reduction	P<0.01	Praveen Sharma Et al., 2011	23
20	Leaf	Antiulcer activity	Aqueous extract	Aspirin-induced ulcers	Omeprazole	20 mg/kg	Gastric volume, lesions, acidity	Effective ulcer reduction	P<0.01	Praveen Sharma Et al., 2011	23

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