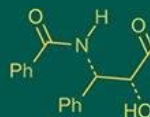


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(12): 1533-1537
www.biochemjournal.com
Received: 15-10-2024
Accepted: 19-11-2024

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A phytopharmacological review on *Murraya koenigii*: A medicinal plant

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DOI: <https://doi.org/10.33545/26174693.2024.v8.i12Ss.3417>

Abstract

Medicinal plants have proven to be very beneficial in the evolution of human society. Medicinal plants have always been at the forefront of all civilizations cultures as a source of medicine. India is appropriately known as the "Botanical Garden of the World," since it is the world's largest producer of medicinal herbs. *Murraya koenigii* (L.) Spreng., a plant of the Rutaceae family, and is usually utilized in the Ayurvedic system of medicine as a medicinally important herb of Indian provenance. The plant originated in India and is now grown in Burma, Ceylon, China, Australia, and the Pacific Islands. The plant is now grown in the backyards of every home in South India, yet its nutritional worth and medicinal benefits are still underappreciated. Different parts of this plant, including leaves, flowers, seeds, fruit, contain ingredients that regulate a variety of biological processes. Ethanobotanical, phytochemical, pharmacological, and pharmacognostic qualities of *Murraya koenigii* have been extensively investigated in recent years. It is widely utilised as an anti-diabetic medication in the indigenous medical system. It also has anti-inflammatory, anti-dysenteric, antioxidant, and a variety of phytopharmacological activities. The purpose of this review is to provide updated information on *Murraya koenigii* and their phytopharmacological activities against different pathological conditions.

Keywords: Antioxidant, medicinal plant, *Murraya koenigii*, pharmacological activities, Rutaceae

Introduction

Medicinal plants have been employed as raw materials for extracting active compounds that are used in the production of various medications since the beginning of human development. For thousands of years, nature has provided medical equivalents, and a remarkable number of modern medications have been isolated from natural sources. Many of these isolations were based on traditional medicine's usage of the replacements. Traditional medicine systems based on plants continue to play an important role in health care, with around 80% of the world's population relying on traditional medicines for their primary health care ^[1].

The appropriate method in the development of novel medications from plants is to use a scientific and systemic approach for biological evaluation of herbal formulations based on their use in traditional medicine. India is a rich resource of traditional medicinal plants. The term "medical plants" refers to a variety of plants used in herbalism, some of which have medicinal properties. Medicinal plants constitute the "backbone" of traditional medicine, which means that over 3.3 billion people in developing countries use them on a daily basis ^[2]. The potential health risks and side effects of synthetic compounds have sparked a growing interest in developing natural, plant-based alternatives. Plant-derived phytochemicals and extracts have shown remarkable promise in traditional medicine. One such herb, *Murraya koenigii*, a member of the Rutaceae family, has been revered in Ayurveda and other ancient systems like Siddha and Unani for its multifaceted medicinal properties. Originating from India, *M. koenigii* has been harnessing attention for its therapeutic potential, making it an attractive candidate for developing novel, natural remedies ^[3, 4]. The leaves, root, bark, and fruit of *M. koenigii* have been shown to promote a variety of biological functions. Even after drying, the aromatic bioactive compound of *M. koenigii* leaves maintain their flavour and other properties. The leaves, root, bark, and fruit of *M. koenigii* have been shown to promote a variety of biological actions. Even after drying, aromatic bioactive components in *M. koenigii* leaves maintain their flavour and other properties ^[5-10]. *Murraya koenigii* is now cultivated as a food flavouring agent in India, Sri Lanka, Southeast Asia, Australia, the

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the Pacific Islands, and Africa ^[11]. Johann Andreas Murray (1740-1791), a Swedish student of Linnaeus and professor of medicine and botany in Gottingen, is the name of the genus. *Murraya koenigii* is the botanical name of curry leaves ^[12]. Curry leaves have a long history starting in the early first century AD. It was updated as the word 'kari' with its uses in Tamil and Kannada literature. *Murraya koenigii* is currently commonly referred to as a curry leaf, which comes from the Tamil term Kari, which means 'spiced sauce' ^[13].

Taxonomic Status ^[14]

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

It grows up to 6 m tall and 15-40 cm in diameter with a short trunk, thin smooth grey or brown bark, and a dense shaded crown ^[15]. It is distributed practically everywhere in the Indian subcontinent. The bark of *M. koenigii* is grey in colour, with longitudinal striations, and white bark beneath it. Bipinnately compound leaves are 15-30 cm long, with 11-25 leaflets alternated on the rachis, 2.5-3.5 cm long, oblong lanceolate with an oblique base, and petioles 2-3 mm long. The flowers are hermaphroditic, featuring a white, funnel-shaped corolla with a sweet fragrance, borne on stalks, and characterized by a lack of bracts. Fruits are ovoid to subglobose in shape, wrinkled or rough, and contain glands. It is 2.5 cm long and 0.3 cm in diameter when ripe, and turns purple black when ripe. The seeds are usually spinach green in colour, 11 mm long, 8 mm wide, and weigh up to 445 mg ^[16]. *Murraya koenigii* is a medicinal herb with many uses. Almost every part of the plant can be used for medical purposes. As a result, it can be considered a promising potential for drug discovery and development.

Traditional uses

The former is more well-known due to its wide range of therapeutic benefits, as well as the fact that its leaves have been used as a natural flavouring agent in various curries and foods for centuries ^[17].

Murraya koenigii fresh leaves include 61.77-66.2 percent moisture, 14.6-18.97 percent total sugar, 39.4% carbohydrate, 2.1-12.5 percent protein, 1.15% total nitrogen, 6.15% fat, 18.92% total sugars, 14.6% starch, 6.8% crude fibres, 9.7-13.06 percent total ash, 1.35 percent acid insoluble ash, 1.82 percent alcohol soluble extractive, and a water extractive value of 27.33-33.45 percent ^[18, 19]. Furthermore, using essential oils in food processing and packaging is a promising solution for avoiding auto-oxidation and extending food product shelf life ^[20]. Curry leaves are cooked in coconut oil until they are reduced to a blanked residue, which is then used as a hair tonic to maintain natural hair tone and stimulate hair development. It has been used as an analgesic, cooling, alexiteric, antiemetics, antidiarrheal, febrifuge, blood purifier, antifungal, depressant, anti-inflammatory, bodily aches,

kidney discomfort, and vomiting for centuries ^[21-33]. Several chemical elements of distinct carbazole alkaloids and other significant metabolites, such as flavonoids, terpenoids, phenolics, vitamins C, nicotinic acid and carotenoids, have been attributed to the therapeutic qualities of *M. koenigii* from various parts of the plant ^[34]. Vitamin C is one of the most basic vitamins, and it is produced in plants from glucose or other simple sugars ^[35].

Medicinal uses

Antioxidant, cytotoxic, antimicrobial, antibacterial, anti-ulcer, positive isotropic and cholesterol-lowering properties have been reported in *M. koenigii* ^[36-45]. In a cultivated human leukaemia cell line ^[46-47], some of them revealed anticarcinogenic characteristics. Many secondary metabolites may have beneficial biological effect against HeLa carcinoma cells, HT-29 intestinal cancer, HL-60 blood cancer, HTB-37 colon cancer, HB-8065TM, and Breast cancer MBA-NB-231 ^[48-52]. Most cancer chemotherapy medications are cytotoxic to cells and can cause genotoxic, carcinogenic, and teratogenic effects in non-tumor cells. As a result, there is a demand for natural-source medications that are less toxic, have fewer side effects, and are more potent in their mode of action ^[53]. Its potential for export was established by the existence of various valuable therapeutic characteristics and other uses ^[54, 41].

Pharmacological studies

Antibacterial activity

Murraya koenigii essential oils were found to be antibacterial against *Corynebacterium pyogenes*, *Streptococcus aureus*, *Bacillus subtilis*, *Pasteurella multocida*, and *Proteus vulgaris*. Even at a dilution of 1:500, the oil was found to be active against the bacteria. After fractionation, the acetone extract of fresh curry leaves yields bioactive compounds such as murrayanol, mahanine, and mahanimbine ^[55, 56]. Another study published in 2016 by Harbi and colleagues tested the activity of ethanol extraction of leaves against *Staphylococcus*, *E. coli*, *Streptococcus proteus*, *Klebsiella pneumonia*, and *Pseudomonas aeruginosa* bacterial strains. Except for *Klebsiella pneumonia* and *Pseudomonas aeruginosa*, all strains showed a clear zone of inhibition, which was comparable to antibiotics such as Amikacin and Gentamycin ^[57].

Antifungal activity

Several studies have reported *M. koenigii*'s antifungal activity. The essential oil of the leaves, for example, has been shown to have antifungal activity ^[58]. The presence of phytochemical constituents with complex molecular structures and diverse action mechanisms, such as terpenoids, alkaloids, flavonoids, tannins, saponins, and phenolics, is responsible for the antifungal activity of *M. koenigii* leaves. Several studies support the plant's traditional use as an antifungal agent. *In vitro* antifungal activity may explain why curry leaves are used in folk medicine to treat diarrhoea, dysentery, and skin eruptions ^[59]. *M. koenigii* bioactive compounds have a significant ability to inhibit mycelial growth and thus promote antifungal activity. *Murraya koenigii* leaf extracts were found to have antifungal activity against *Candida tropicalis*, *Candida albicans*, *Aspergillus fumigates*, *Aspergillus niger*, and *Microsporum gypseum*. The alcoholic extract of the

leaves was found to be fungitoxic to *Rhizoctonia solani* and *Colletotrichum falcatum* ^[60]. Methanolic and ethanolic extracts were found to be effective against mycelia growth in *Rhizoctonia solani* and *Fusarium oxysporum* with varying degrees of efficiency ^[61].

Anti-ulcer activity

The anti-ulcer activity of hot aqueous leaves extract was observed at doses of 250 and 400 mg/kg. The extract inhibited gastric lesion induced by nonsteroidal anti-inflammatory drugs and the pylorus ligation model. The extract decreased gastric volume, ulcerative lesion, free and total acidity, but increased the pH of gastric juice in the pylorus ligation model. According to the findings, the extract has significant anti-ulcer activity ^[62, 63].

Anti-diarrheal activity

Murraya koenigii has been used to treat diarrhoea for centuries and is mentioned in Ayurvedic literature, but it also showed significant results in experiments. In rats, there was a significant inhibitory activity against castor oil-induced diarrhoea. In a charcoal meal test, the bioactive molecules koenimbine, carbazole, and kurryam obtained from the fractionated n-hexane extract of *M. koenigii* seeds showed activity against diarrhoea and gastrointestinal motility ^[64-66].

Neuroprotective activity

β-myrcene (MYR), a monoterpene found in the leaves of *M. koenigii*, was studied for its neuroprotective properties. MYR treatment protected C57BL/J6 mice from cerebral ischemia/reperfusion (I/R)-induced oxidative stress, apoptosis, and histopathological damage ^[67].

The neuroprotective effect of nerolidol (NRD), a sesquiterpene alcohol, in the essential oil of *Murraya koenigii* leaves was discovered in studies with a rotenone-induced model of Parkinson's disease ^[68]. The levels of oxidative stress markers were significantly improved by NRD supplementation (SOD, CAT, GSH, and MDA). NRD also reduced the production of pro-inflammatory cytokines and inflammatory mediators. Furthermore, NRD treatment inhibited rotenone-induced glial cell activation as well as the loss of dopaminergic neurons and nerve fibres, thereby mitigating rotenone-induced dopaminergic Neurodegeneration ^[69]. From another study, NRD considerably enhanced locomotor activity and cognitive impairment, as well as decreased AChE activity and oxidative stress ^[70]. As a result, NRD demonstrates its neuroprotective potential through antioxidant and anti-inflammatory action, which could be beneficial in the treatment of NDs ^[71].

Conclusion

Medicinal plants are used as raw materials in the development of new pharmaceuticals, and many modern medicines are derived indirectly from them. Curry leaves can be used to make a variety of economically precious materials in South Asia, many of which are high in nutrition and promote a healthy diet. The leaves, roots, and bark of this plant are rich sources of volatile oil, carbazole alkaloids and triterpene which are a vital component of research breakthroughs in the pharmaceutical sector. As a result, more phytochemical, pharmacological, and clinical research on curry leaves is needed to produce effective natural raw

materials that can provide therapeutically useful lead compounds.

Conflict of Interests

The author declared no conflicts of interest.

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