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Unveiling the Healing Treasures: Exploring the Ethnomedicinal, Phytochemical, and Pharmacological Marvels of *Murraya koenigii*

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Abstract: In the system of Ayurveda, *Murraya koenigii* (family Rutaceae) is an important medicinal plant of Indian history. The ethnomedical uses, major phytoconstituents, and pharmacological activity of isolated compounds and extracts from different *Murraya koenigii* parts are all discussed in this review study. Online databases like SciFinder, Wiley, Web of Science, PubMed, Elsevier, Science Direct, Scielo, and Scopus were used to access scientific studies, literature, book chapters, and journal articles that contained crucial details about *Murraya koenigii* pharmacological properties, phytochemistry, and ethnomedical applications. This plant has traditionally been employed to treat leukemia, diarrhea, dysentery, blood diseases, stomach problems, vomiting, hemorrhoids, inflammation, and itching. Alkaloids, terpenoids, polyphenols, and derivatives of flavonoids are reported in *Murraya koenigii*. It has been established that these phytochemicals and crude extracts from various plant sections possess anti-inflammatory, neuroprotective, antioxidant, anti-microbial, and anti-tumor inhibitory qualities.

Keywords: *Murraya koenigii*, Antioxidant, Conventional medicine, Pharmacological action, Phytochemistry, Ethnomedical, Alkaloids, Terpenoids, Polyphenols, Flavonoids

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Introduction

Natural plant products are increasingly being used by scientists and the general public to improve health, both in terms of prevention and treatment of disease. This is due to their predicted usefulness as a less harmful and more cost-effective replacement for the development of cutting-edge

medicines. Traditional medicine derived from plants has a long history, going back to ancient civilizations (Chanda and Dave, 2009). Around sixty thousand species of plants are used worldwide for their nutritional, aromatic, and therapeutic properties (Barata *et al.*, 2016). The genus *Murraya* includes about 17 species consisting predominantly of trees and shrubs that thrive in diverse habitats in equatorial regions of Asia, Australia, and the Pacific.

Various pharmacological properties such as cytotoxicity, anti-inflammatory, antidiarrheal, antihyperlipidemic, and antioxidant activities, are exhibited by several *Murraya* species, like *M. euchrestifolia, M. paniculata, M. alata, M. exotica, M. tetramera,* and *M. gleinei*. These properties are attributed to the diverse array of phytoconstituents present in these species, including coumarins, terpenoids, flavonoids, aromatics, and alkaloids (Yohanes *et al.*, 2023). Similarly, *Murraya koenigii*, a medium-sized shrub belonging to the Rutaceae family, has remarkable therapeutic significance within the Ayurvedic system of medicine (Patil *et al*., 2024). The Rutaceae family covers an extensive number of morphologically distinct shrubs and tree species to have secondary metabolites, which include alkaloids, flavonoids, coumarins, and essential oils which have been proven to be medicinally useful (Price, 1963; Groppo *et al*., 2008). *Murraya koenigii*, commonly known as "curry leaf" or "kari patta," originates from Sri Lanka, India, and various other tropical and subtropical regions worldwide (Wojdyło *et al.*, 2007). Due to its unique taste and medicinal attributes, *Murraya koenigii* holds significant value. Various botanical components from this plant are utilized in treating conditions such as leukoderma, diarrhea, dysentery, blood disorders, stomach ailments, vomiting, haemorrhoids, inflammation, and itching (Ajay *et al*., 2011). *Murraya koenigii* is distinguished by its content of alkaloids, terpenoids, polyphenols, and flavonoid derivatives. These phytochemicals contribute to the plant's crude extracts exhibiting properties such as anti-inflammatory, anti-tumor, anti-diabetic, antioxidant, and antimicrobial effects across various plant sections (Balakrishnan *et al*., 2020). The current review presents a summary of *Murraya koenigii* pharmacological activities, primary phytoconstituents, and medicinal uses which can provide a great help for new researchers on this plant in the future.

The present investigation collected data on the pharmacological properties, phytochemistry, and medicinal applications of *Murraya koenigii* from a range of sources including scientific studies, literature, book chapters, and journal articles accessed through online databases such as SciFinder, Wiley, Web of Science, PubMed, Elsevier, Science Direct, Sicelo, and Scopus. The period from September to December 2023 was used to search for this data. Terms used in the search included “ethnobotany”, “ethnomedicinal uses”, “medicinal uses”, “photochemistry”, “biological activities”, “pharmacological properties”, “*Murraya koenigii”* and the common English names “Curry Leaf” and “Kari Patta”.

Taxonomy, Distribution, and Description of Murraya koenigii:

Murraya koenigii is a diminutive deciduous shrub or tree, typically reaching heights of 2.5 meters with a diameter ranging from 15 to 40 cm. The bark, ranging from green to brown in colour, is adorned with numerous dots. Its naturally bipinnate leaves measure about 30 cm in length, lack stipules, and feature reticulated leaf veins. Each leaflet is lanceolate, approximately 4.9 cm long and 1.8 cm wide, with a petiole measuring 0.5 centimetres in length. Typically, each leaf bears 24 leaflets. The inflorescence bears 60 to 90 blooms, which are complete, bractless, regular, actinomorphic, pentameric, bisexual, white, funnel-shaped, fragrant, and hypogynous. The average diameter of a fully bloomed flower is 1.12 cm. Flowers feature a persistent, inferior, 5-lobed calyx; a white, polypetalous, inferior corolla comprising five lanceolate petals measuring 5 mm in length; and a polyandrous, inferior androecium consisting of ten stamens grouped in five circles. Originating from India, *Murraya koenigii* thrives in woodlands and wastelands, flourishing at altitudes

ranging from 1500 to 1655 meters above sea level across the Indian subcontinent (Khosa and Prasad, 1974). Additionally, *Murraya koenigii* is present in the Ravi River valley in Pakistan and thrives in moist forests at elevations ranging from 500 to 1600 meters in Bhutan, Nepal, Bangladesh, Sri Lanka, the Andaman Islands, Vietnam, and Thailand (Khosa *et al*., 1970). The plants were spread to Malaysia (Handral *et al*., 2012), Africa and Reunion Island (Anwer *et al*., 1974; Gupta *et al*., 2011) by South Asian immigrants; extensively grown in certain regions of Australia, the United States, and South-East Asia (Singh *et al.*, 2014), and recorded in the tropical region; Malindi and Mombasa, semi-arid regions of Kibwezi and Makindu in Kenya (Mang'era *et al*., 2019).

Medicinal Uses of Murraya koenigi:

Murraya koenigi has been used for food preparation since ancient times; the plant's leaves, roots, and bark are among its various medicinal aspects. Several scientific research supports its therapeutic advantages. Curry patta leaves with coconut oil showed a very good effect in hair care to reduce hair loss and dandruff when used to prepare the decoction of the leaves of *Murraya koenigi*, which is said to have a very good antipyretic effect; to add shine and lengthen hair, it is used along with fenugreek powder and fresh leaves as it has an aromatic effect and is used in the preparation of various dishes. When consumed raw, leaves help prevent diarrhea, and when combined with hot milk, leaf paste helps treat poisonous bites and other rashes. Root extracts, widely used in our ancient medical system, are used to treat kidney pain (Tembhurne and Sakarkar, 2009). The leaves and root extracts have been reported to have anti-diabetic, analgesic, blood-purifying, digestive, stomachic, anti-diarrheal, anti-inflammatory, and anti-fungal properties (Joshi *et al*., 2018). Plant-derived essential oils are also utilized in the cosmetics industry (Rao *et al*., 2011).

Phytochemistry of Murraya koenigi:

When developing novel medicine with significant pharmacological potential, phytoconstituents derived from natural sources are essential. Several studies have revealed the presence of a diverse array of phytoconstituents in different parts of *Murraya koenigii*. These constituents encompass minerals such as calcium, magnesium, sodium, and potassium, along with carbohydrates, flavonoids, phenolic compounds, alkaloids, tannins, glycosides, lipids, proteins, and vitamins A, C, thiamine, and riboflavin. Some reported phytoconstituents in plants are illustrated in Table 1.

Mahanimbine, a derivative of Pyrano[3,2-a]carbazole, was isolated from the hydroalcoholic extract of *Murraya koenigii* leaves (Dahiya *et al*., 2016). Sumit *et al.* (2009) employed the petroleum ether fraction of an ethanol extract and crude petroleum ether from the leaves of the plant to isolate 5,8-dimethyl furanocoumarin, 1-al, 3[6′, 6′-dimethyl 5-hexene carbazole, and β-sitosterol (Sumit *et al*., 2009). Through GC/MS analysis, the presence of Pentadecanoic acid, n-Hexadecanoic acid, 9,12-Octadecadienoic acid (Z, Z), Isolongifolene, 1-Methyl-pyrrolidine-2-carboxylic acid, Ethyl α-D-glucopyranoside, Isolongifolene, C-Himachalene, 1,2-Ethanediol, monoacetate, and 1,2-Benzenedicarboxylic acid, di-isooctyl ester was confirmed in the alcoholic extract of leaves (Mathur *et al*., 2011; Azhagu *et al*., 2021). Essential oils have been identified in *Murraya koenigii* leaves, including β-selinene, α-pinene, β-pinene, sabinene, (E)-caryophyllene, terpinen-4-ol, γ-terpinene, β-elemene, limonene, (E)-nerolidol, and α-thujene (Verma *et al.*, 2013). Moni *et al.* (2021) documented the existence of epiyangambin, stigmasterol, α-terpineol, eucalyptol, ethyl cinnamate, and fatty acids in the methanol extract of leaves. Kamaraj *et al.* (2014) utilized the ethyl acetate extract from curry patta leaves to isolate Myristic acid and β-caryophyllene. Ng *et al.* (2018) isolated four carbazole alkaloids, namely girinimbine, mahanimbine, murrayanine, and murrayacin, from the roots and stem bark of *Murraya koenigii*. In addition to these carbazole alkaloids, a triterpenoid, stigmasterol, was also isolated (Ng *et al.*, 2018). Various carbazole

Table 1: Reported Compounds in *Murraya koenigii* with their value

S. No.	Reported Compound	Value (mg/100 g or Percentage)	Reference
1.	Flavonoid	7.43 mg/100g	Igara *et al*. (2016)
2.	Phenols	4.25 mg/100g	Igara *et al*. (2016)
3.	Alkaloids	1.90 mg/100g	Igara *et al*. (2016)
4.	Tannins	0.86 mg/100g	Igara *et al*. (2016)
5.	Glycosides	0.11 mg/100g	Igara *et al*. (2016)
6.	Carbohydrates	39.44 %	Igara *et al.* (2016)
7.	Lipid content	6.30 mg/100g	Igara *et al.* (2016)
8.	Protein	8.38 %	Igara *et al.* (2016)
9.	Vitamin A	6.04 mg/100g	Igara *et al.* (2016)
10.	Vitamin C	0.04 mg/100g	Igara *et al.* (2016)
11.	Thiamine	0.89 mg/100g	Igara *et al.* (2016)
12.	Riboflavin	0.09 mg/100g	Igara *et al.* (2016)
13.	Niacin	2.73 mg/100g	Igara *et al.* (2016)
14.	Vitamin E	0.03 mg/100g	Igara *et al.* (2016)
15.	Calcium	19.75 mg/100g	Igara *et al.* (2016)
16.	Magnesium	49.06 mg/100g	Igara *et al.* (2016)
17.	Sodium	16.50 mg/100g	Igara *et al.* (2016)
18.	Potassium	0.04 mg/100g	Igara *et al.* (2016)
19.	Zinc	0.04 mg/100g	Igara *et al.* (2016)

alkaloids, including mukonicine, bismahanine, euchrestine B, bismurrayafoline E, Girinimbine, mukoenine-A, Girinimbilol, bis-2-hydroxy-3-methylcarbazole, mahanine, pyrayafoline-D, murrafoline-I, bikoeniquinone-A, and 3,3'-[oxybis(methylene)]bis(9-methoxy-9H-carbazole), as well as ismurrayaquinone-A, were extracted from different parts of *M. koenigii* using various organic solvents (Chihiro *et al*., 1993; Tachibana *et al*., 2001; Rahman and Gray, 2005; Mohanraj *et al*., 2014; Nachiar *et al*., 2020). Ghasemzadeh *et al.* (2014) employed Ultra-High Performance Liquid Chromatography (UHPLC) to assess flavonoids, including catechin, myricetin, and quercetin, while also evaluating their anticancer and antioxidant capabilities. The stem bark of *Murraya koenigii* was utilized to isolate two carbazole quinones, namely 7- methoxy- 3 – methylcarbazole - 1, 4 - quinone and 6,7-dimethoxy-3-methylcarbazole-1,4-quinone, employing alcohol as the solvent (Saha and Chowdhury, 1998), 9-carbethoxy-3-methylcarbazole, 9-formyl-3- methylcarbazole (Chakrabarty *et al.*, 1997), Girinimbine, murrayanine, and mahanimbine (Das *et al*., 1965), additionally, found in the stem bark extract, it was assessed for its antifungal potential against *Microsporum gypseum*, *M. audouinii*, *Trichophyton rubrum*, and *Nocardia asteroids*. Bhattacharyya and Chakraborty (1984) isolated mukunol from the stem barks of *Murraya koenigii*. The pharmacological potential of phytoconstituents isolated from different parts of *Murraya koenigii* is summarized in Table 2.

Pharmacological Properties and Safety Evaluation of Murraya koenigii:

Different parts of *Murraya koenigii* have been utilized in traditional medicine for centuries and have been investigated through research for their possible therapeutic uses, including as an anti-diabetic (Iyer and Mani, 1990; Mitra and Mahadevappa, 2010), vasodilating (Shah and

Table 2: Isolated Phytoconstituents from various parts of *Murraya koenigii* with their reported pharmacological activities

S. No.	Phytoconstituents	Molecular Formula	Plant Part	Pharmacological Activity	Reference
1.	Mahanine	$C_{23}H_{25}NO_2$	Leaves	Cytotoxic effect, mosquitocidal, antimicrobial	Ramsewak *et al*. (1999); Samanta *et al.*, (2018)
2.	Mahanimbine	$C_{23}H_{25}NO$	Leaves, stem bark	Cytotoxicity, anti-oxidant, anti-microbial, **anti-diabetic**, and hyperlipidemic	Mitra and Mahadevappa (2010); Ilangovan *et al*. (2016); Tiwari and Talreja (2020); Hobani (2022)
3.	Murrayanol	$C_{24}H_{29}NO_2$	Leaves	Mosquitocidal, antimicrobial	Ramsewak *et al.* (1999)
4.	Koenimbine	$C_{19}H_{19}NO_2$	Leaves, seeds	Antiproliferative, apoptotic effects, antidiarrheal, anti-inflammatory	Mandal *et al.* (2010b); Hobani (2017); Iqbal Andrabi *et al.* (2024)
5.	O-Methylmurrayamine A	$C_{19}H_{20}NO_2$	Leaves	Anticancer	Arun *et al*. (2017)
6.	Koenigicine (Koenimbidine)	$C_{20}H_{21}NO_3$	Leaves	Pancreatic Lipase Inhibitory	Birari *et al*. (2009)
7.	Koenigine	$C_{19}H_{19}NO_3$	Leaves	Antioxidant	Rao *et al*. (2007)
8.	Murrayone	$C_{15}H_{14}O_4$	Leaves	Chemopreventive agent	Zhai *et al.* (2020)
9.	Mahanimbicine	$C_{23}H_{25}NO$	Leaves	Wound healing	Nagappan *et al*. (2012)
10.	Phebalosin	$C_{15}H_{14}O_4$	Leaves	Antifungal	Missau *et al.* (2014)
11.	Isomahanimbine	$C_{23}H_{25}NO$	Leaves	Effect on dental caries, Hepatoprotective, Anti-Alzheimer's Activity, Anti-Analgesic Activity, Anti-Inflammatory Activity	Prakash and Natarajan (1974); Gupta *et al*. (2010); Patidar *et al*. (2010); Sathaye *et al.* (2012)
12.	Koenimbidine	$C_{20}H_{21}NO_3$	Leaves, Stem, roots	Anti-Diabetic, Anthelmintic Activity, Anti-Amnesic, Anti-Diarrheal Activity, Haematological Activity, Nephroprotective Activity	Khosa *et al.* (1970); Ningappa *et al*. (2008); Handral *et al.* (2012); Prabhu and Tamilanban (2012); Tembhurne and Sakarkar (2009), Pagariya and Maithili (2009)
13.	Euchrestine B	$C_{24}H_{29}NO_2$	Leaves	Antioxidant	Tachibana *et al.* (2001)
14.	Bismurrayafoline E	$C_{48}H_{56}N_2O_4$	Leaves	Antioxidant	Tachibana *et al.* (2001)
15.	Isomahanine	$C_{23}H_{25}NO_2$	Leaves, seeds, fruits	Antimicrobial, Effect On Dental Caries	Patidar *et al.* (2010); Dharmaratne *et al*. (2015
16.	Mahanimbinine	$C_{23}H_{27}NO_2$	Leaves, seeds	Antimicrobial, antioxidant	Prabaharan *et al.* (2023)
17.	Girinimbilol	$C_{18}H_{19}NO$	Leaves	Antitrichomonal	Adebajo *et al.* (2006)
18.	Pyrayafoline-d	$C_{23}H_{25}NO_2$	Leaves	cytotoxicity against HL-60 cells	Ito *et al.* (2006)
19.	Cyclomahanimbine	$C_{23}H_{25}NO$	Leaves	Antimicrobial activity	Kureel *et al*. (1969)
20.	Isomurrayazoline	$C_{23}H_{25}NO$	Leaves	Antimicrobial activity	Bhattacharya *et al.* (1982); Rahman and Gray (2005)
21.	Mahanimboline	$C_{23}H_{25}NO_2$	Leaves	Antistress activity	Roy *et al.* (1979); Saraf, *et al*. (2011)
22.	Mukonicine	$C_{20}H_{21}NO_3$	Stem bark	Antimicrobial	Mukherjee *et al.* (1983); Mitra and Mahadevappa (2010); Gahlawat *et al*. (2014)
23.	Mukonal	$C_{13}H_9NO_2$	Stem	Anti-cancer	Gahlawat *et al.* (2014); Wang *et al.* (2020)

24.	Mukeic acid	$C_{14}H_{11}NO_3$	Stem	Cytotoxic	Gahlawat *et al.* (2014); Samanta *et al.* (2018)
25.	9-Carbethoxy-3-methyl carbazole	$C_{16}H_{15}NO_2$	Roots, stems, leaves	Antioxidant, cytotoxic, anticancer	Gahlawat *et al.* (2014); Shobhana *et al.* (2022)
26.	Mahanimbinol	$C_{23}H_{27}NO$	Stem barks	Antioxidant, cytotoxic	(Rao *et al*.1981; Tachibana *et al.*, 2001; Tantapakul *et al.* (2014)
27.	Osthol	$C_{15}H_{16}O_3$	Stem barks	Antioxidant	Tachibana *et al.* (2001); Gahlawat *et al.* (2014)
28.	Mukoeic acid	$C_{14}H_{11}NO_3$	Stem barks, leaves	Antioxidant, antimicrobial, antitumor, hepatoprotective	Tachibana *et al.* (2001); Gahlawat *et al.* (2014)
29.	Murrayazolinol	$C_{23}H_{25}NO_2$	Stem barks, leaves	Antioxidant, anti-inflammatory, antidiabetic, neuroprotective	Tan *et al*. (2014); Balakrishnan *et al.* (2020)
30.	Umbelliferone	$C_9H_6O_3$	Stem barks	Antioxidant, antimicrobial, antitumor	Balakrishnan *et al.* (2020)
31.	Murrayakonine A	$C_{37}H_{36}N_2O_2$	Leaves and stems	Antimicrobial, anti-inflammatory	Yedukondalu Nalli *et al.* (2016)
32.	Murrayakonine B	$C_{23}H_{23}NO_2$	Leaves and stems	Antimicrobial, anti-inflammatory	Yedukondalu Nalli *et al.* (2016)
33.	Murrayakonine C	$C_{24}H_{25}NO_3$	Leaves and stems	Antimicrobial, anti-inflammatory	Yedukondalu Nalli *et al.* (2016)
34.	Murrayakonine D	$C_{23}H_{25}NO_2$	Leaves and stems	Antimicrobial, anti-inflammatory	Yedukondalu Nalli *et al.* (2016)
35.	Girinimbine	C18H17NO	Roots, stem bark, and seeds	Antioxidant, antimicrobial, antitumor, hepatoprotective	Srivastava and Srivastava (1993); Gahlawat *et al.* (2014)
36.	Quercetin	$C_{15}H_{10}O_7$	Leaves	Anticancer	Noolu *et al.* (2016)
37.	Apigenin	$C_{15}H_{10}O_5$	Leaves	Anticancer	Noolu *et al.* (2016)
38.	Kaempferol	$C_{15}H_{10}O_6$	Leaves	Anticancer	Noolu *et al.* (2016)
39.	Rutin	$C_{27}H_{30}O_{16}$	Leaves	Anticancer	Noolu *et al.* (2016)
40.	Catechin	$C_{15}H_{14}O_6$	Leaves	Anticancer	Noolu *et al.* (2016)
41.	Myricetin	$C_{15}H_{10}O_8$	Leaves	Anticancer	Noolu *et al.* (2016)
42.	4-O-_-d-Rutinosyl-3-methoxyphenyl-1-propanone	$C_{22}H_{32}O_{12}$	Leaves	Hepatoprotective	Ma *et al.* (2013)
43.	2-hydroxy-4-methoxy-3,6-dimethylbenzoic acid	$C_{10}H_{12}O_4$	Bark	-	Tan *et al.* (2017)
44.	Blumenol A	$C_{13}H_{20}O_3$	Leaves	-	Mori and Khlebnikov, 1993); Ma *et al.* (2013)
45.	β-sitosterol	$C_{29}H_{50}O$	Leaves and bark	-	Ma *et al.* (2013)
46.	Squalene	$C_{30}H_{50}$	Leaves and bark	-	Mori and Khlebnikov, 1993); Ma *et al.* (2013)
47.	Lutein	$C_{40}H_{56}O_2$	Leaves	Antioxidant activity	Tachibana *et al*. (2003)
48.	α-pinenee	$C_{10}H_{16}$	Leaves	-	Ma *et al.* (2013)
49.	β-pinene	$C_{10}H_{16}$		-	Mori and Khlebnikov (1993); Ma *et al.* (2013)

(Shah and Juvekar, 2006), hypocholesterolemic (Tembhurne and Sakarkar, 2010), anti-diarrheal (Mandal *et al.*, 2010a), anti-ulcer (Handral *et al.*, 2012), phagocytic (Shah *et al.*, 2008), analgesic (Gupta *et al.*, 2010), anti-lipid peroxidation (Khan *et al*., 1995), radioprotective and chemo-protective effect (Handral *et al.*, 2012), antiamnesic (Tembhurne and Sakarkar, 2010), antihelminthic (Khuntia and Panda, 2011), wound healing (Anand *et al.*, 2011), antimicrobial

(Rahman and Gray, 2005; Panghal *et al*., 2011), antioxidant (Tachibana *et al.*, 2001), and cytotoxic activity (Ito *et al.*, 2006).

Antidiabetic activities:

Diabetes is a metabolic condition caused by an insufficient amount of insulin in the body. It can lead to several problems, including disorders of the heart and brain. As a result, prompt attention is required. Mahanimbine, a carbazole alkaloid which was isolated by Mitra and Mahadevappa (2010) from *Murraya koenigii* leaves, showed antidiabetic efficacy at doses of 50 mg/kg and 100 mg/kg. It has been observed that the action of this carbazole alkaloid is linked to aberrant lipid profiles and related cardiovascular problems (Mitra and Mahadevappa, 2010). The *in vitro* antidiabetic effect of the zinc oxide nanoparticles derived from *Murraya koenigii* aqueous leaf extract was investigated. In addition to exhibiting significant antioxidant and antibacterial behaviour, the nanoparticles possessed strong antidiabetic and cytotoxic effects (Sharma *et al.*, 2023). When curry leaves; and aqueous extract were given to rabbits with normal and diabetic blood sugar concentrations at doses of 200, 300, and 400 mg/kg and compared with the standard drug tolbutamide, results demonstrated a significant reduction in blood sugar levels. Following oral administration of 300 mg/kg for four hours, a notable reduction was observed in individuals with normal diabetes (14.68%) and mild diabetes (27.36%). In the glucose tolerance test performed after two hours, the same dose exhibited a significant enhancement in glucose tolerance by 46.25% in pre-diabetic (AR) rabbits and 38.5% in moderately diabetic rabbits (Kesari *et al.*, 2005). The administration of an ethanolic extract of *M. koenigii* leaves at a dosage of 200 mg/kg/bw/day for 30 days led to a significant decrease in urea, uric acid, creatinine, and glycosylated haemoglobin levels in the treated diabetic animal group (Arulselvan *et al*., 2006). According to reports, the juice extracted from *Murraya koenigii* fruit exhibits hypoglycemic effects in mice when given at doses of 2.5 and 5.0 ml/kg (Tembhurne and Sakarkar, 2009). In order to evaluate its antidiabetic potential, aqueous and methanol extracts of *Murraya koenigii* leaves were prepared at doses of 600 and 200 mg/kg body weight, respectively. A noteworthy decrease in plasma glucose levels was observed, possibly attributed to the phytoconstituents present in the *Murraya koenigii* extract enhancing insulin sensitivity (Vinuthan *et al*., 2004). The ethanol extract derived from the stem was evaluated for its ability to counteract diabetes using the alloxan-induced diabetic model. Diabetic rats were administered 300 mg/kg of the ethanol extract, and after 15 days of treatment, a notable decrease in their elevated glucose levels was observed compared to untreated diabetic rats. This discovery lends credence to the traditional use of *Murraya koenigii* as an antihyperglycemic agent (Prabhu and Tamilanban, 2012). The antihyperglycemic effects of the ethanol extract of *Murraya koenigii* were assessed using the streptozotocin and nicotinamide (STZ-NA) diabetic animal model, with doses of 200 and 400 mg/kg body weight. Blood glucose levels were monitored after the administration of the extract, revealing significant reductions in comparison to untreated animals. Furthermore, the extract exhibited antioxidant properties, along with a reduction in MDA and GSH levels (Husna *et al.*, 2018). Moreover, studies have revealed that the ethanol extract of *M. koenigii* mitigated dexamethasone-induced hyperglycemia and insulin resistance, as evidenced by improved glucose tolerance and enhanced insulin-stimulated AKT phosphorylation in skeletal muscle tissue (Pandey *et al.*, 2014). Curry leaves aqueous extract at doses of 75 and 150 mg/kg body weight. provoked a significant reduction in blood sugar levels following the treatment (Saha and Mazumder, 2013). Additionally, there was a decrease in oxidative stress, demonstrated by lowered MDA levels and increased GSH, SOD, and catalase activity (Saha and Mazumder, 2013).

Vasodilatory effect:

The timing of the heart's contractions, known as "chronotropic," was influenced in a dose-dependent manner by the aqueous extract of *M. koenigii* leaves, resulting in a negative impact on the circulatory system of the frog's heart. Furthermore, the higher rate of drops per minute observed in the frog hind limb perfusion experiment indicated a vasodilatory effect (Kadam *et al*., 2011), In a separate study, the ethanol extract from leaves demonstrated a dose-dependent positive inotropic effect on the frog's heart, likely by increasing the availability of calcium from extracellular areas (Shah and Juvekar, 2006). These findings indicate that *Murraya koenigii* might possess the potential in safeguarding the heart.

Hypocholesterolemic effect:

The oil extracted from the leaves of *Murraya koenigii* is noted for its cholinesterase-inhibiting properties (El-Shiekh *et al*., 2023), In a separate experiment, it was observed that the ethanol extract from the leaves, at doses of 500 mg/kg and 300 mg/kg, induced a dose-dependent decrease in cholesterol levels in elderly mice when compared to the commonly used drug simvastatin (Tembhurne and Sakarkar, 2010).

Anti-diarrheal activity:

Rats received diphenoxylate at a dosage of 5 mg/kg to evaluate the anti-diarrheal effects of koenimbine, a carbazole alkaloid extracted from the n-hexane extract of *Murraya koenigii* seeds, against diarrhea induced by castor oil and enteropooling induced by PGE2 (Mandal *et al.*, 2010a). The therapeutic effectiveness of aqueous and alcoholic extracts of curry leaves against castor oil-induced diarrhea was demonstrated in the charcoal flour test and the PGE2-induced diarrhea model. These extracts were compared with loperamide, a standard antidiarrheal medication (Sharma *et al.*, 2012). The hydroalcoholic extract derived from *Murraya koenigii* leaves exhibited notable antidiarrheal properties by effectively suppressing gastro-intestinal motility (Ramasamy *et al*., 2016). Both ethanol and aqueous extracts of *Murraya koenigii* roots markedly reduced the frequency of defecation and the amount of wet fecal droppings. Additionally, the movement of charcoal meal through the gastrointestinal tract was notably slowed down (Pagariya and Maithili, 2009). The potential antidiarrheal impact of curry leaves could be attributed to the presence of phytoconstituents within the plant.

Anti-ulcer activity:

Mohan *et al.* (2020) conducted an assessment of girinimbine, extracted from curry leaves, in countering ethanol-induced peptic ulcers. Girinimbine's protective effects were evident in the restoration of reduced levels of GSH and NP-SH, leading to a reduction in MDA levels. Notably, girinimbine selectively inhibited COX-2 enzyme expression while sparing COX-1. Moreover, tissue from rats treated with girinimbine exhibited significant down-regulation of iNOS and substantial up-regulation of HSP70 at both the transcriptional and translational levels. These findings indicate a notable gastro-protective effect, attributed to its ability to curb inflammatory responses and its antioxidant properties (Mohan *et al.*, 2020). Employing an NSAIDs-induced ulcer model and pylorus ligation in albino rats, researchers evaluated the anti-ulcer properties of an aqueous extract derived from *Murraya koenigii* leaves. The study utilized doses of 200 mg/kg and 400 mg/kg of the extract, comparing them with 13.5 mg/kg of omeprazole, the standard drug. Results indicated a 75.27% protection against NSAID-induced ulcers at 400 mg/kg, 58.71% at 200 mg/kg, and 78.06% for the standard drug. In the pylorus ligation-induced ulcer model, protection rates were 58.82% (400 mg/kg), 47.06% (200 mg/kg), and 70.59% (omeprazole). Both extracts exhibited significant reductions in ulcer index, free acid, total acid content, and gastric volume (Patidar, 2011). The antiulcer properties of melatonin and aqueous curry leaf extract against piroxicam-induced gastric ulcers have also been investigated (Firdaus *et al*., 2014).

While melatonin administered at 20 mg/kg body weight and leaf extract at 50 mg/kg body weight separately did not offer full protection, the combined administration of both at the same dosage provided complete protection against piroxicam-induced damage (Firdaus *et al*., 2014). The potential antioxidant activity of *M. koenigii* likely offered protection against oxidative stress in the stomach.

Phagocytic activity:

The role of phagocytic activity as a fundamental defense mechanism against infections and its significance in maintaining the immune system cannot be overstated. To assess the immunomodulatory effects of *M. koenigii* leaf methanol extract on both humoral and cell-mediated immune responses to ovalbumin, various tests were conducted. Phagocytic activity was evaluated through a carbon clearance test, measuring nitric oxide (NO) release from murine peritoneal macrophages, and assessing myelo-suppression induced by cyclophosphamide. The results indicated a notable enhancement in phagocytic activity, as evidenced by increased nitric oxide production from cultured mouse peritoneal macrophages. Moreover, there was a significant increase in the phagocytic index, reflecting enhanced clearance of carbon particles from the blood. Furthermore, elevated levels of ovalbumin-specific antibodies were detected, suggesting an augmented immune response. Notably, the extract exhibited a significant protective effect against cyclophosphamide-induced myelosuppression (Shah *et al.*, 2008). The aqueous leaf extract exhibited a significant enhancement in ovalbumin-induced delayed-type hypersensitivity reaction at dosages of 250 and 500 mg/kg (Shah and Juvekar, 2010). To assess the impact of an aqueous extract of *M. koenigii* leaves at a concentration of 350 mg/kg, foot pad thickness was measured. The extract demons-trated a notable enhancement in the primary anti-SRBC titer (Kaur *et al.*, 2014).

Antioxidant activity:

The aqueous leaf extract of *Murraya koenigii* has demonstrated moderate abilities in scavenging free radicals (Sharma *et al.*, 2023). Sasidharan and Menon (2011) assessed the total phenol content and antioxidant activity of hexane, chloroform ethanol, and ethanol-water (1:1) extracts of curry leaves using DPPH, ABTS, and total reductive potential assays at both ambient temperature (25°C) and boiling point temperature. The highest total phenol content was observed in ethanol-water (1:1) at ambient temperature, measuring 501 ± 4.6 mg/g GAE, whereas in hot ethanol-water (1:1) extract, it was 28.7 ± 0.9%. Regarding antioxidant activity, the ethanol-water (1:1) extract showed 82% radical scavenging activity at 10 µg/ml when assessed by the DPPH method and 100% by the ABTS method at the same concentration under ambient conditions. Conversely, for the hot ethanol-water (1:1) extract, the DPPH method yielded 43% activity, while the ABTS method showed 53.6% activity. These findings suggest that the ambient ethanol-water extract exhibits higher antioxidant activity compared to the hot extract (Sasidharan and Menon, 2011).

Tachibana *et al.* (2001) identified five carbazole alkaloids from the methylene chloride leaf extracts of *Murraya koenigii*, specifically euchrestine B (1), bismurrayafoline E (2), mahanine (3), mahanimbicine (4), and mahanimbine (5). These compounds were then assessed for their radical scavenging ability against 1-1-diphenyl-2-picrylhydrazyl (DPPH). The results indicated the following order of antioxidant activity: ascorbic acid > compound 2 > compound 1, 3, and α-tocopherol > BHT > compounds 4 and 5. Based on these findings, it can be inferred that bismurrayafoline exhibits the highest antioxidant activity, followed by euchrestine B, mahanine, mahanimbicine, and mahanimbine (Tachibana *et al.*, 2001). Zahin *et al.* (2013) used various solvents (petroleum ether, acetone, ethyl acetate, benzene) to extract *Murraya koenigii* leaves, followed by assessing antioxidant activity using the phospho-molybdenum method. The results were compared

with positive controls, BHT and ascorbic acid. Among the extracts, benzene exhibited the highest antioxidant activity (3510.4 µmol) at a concentration of 100 µg/ml, followed by ethyl acetate (1982.3 µmol), petroleum ether (1967.2 µmol), and acetone (1783.1 µmol). Additionally, free radical scavenging activity was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, ferric reducing antioxidant power (FRAP), and cupric reducing antioxidant capacity (CUPRAC) assays (Zahin *et al*., 2013). The reported antioxidant activity of essential oils extracted from *Murraya koenigii* leaves follows a similar trend (Rajendran *et al*., 2014). Mathur *et al.* (2011) isolated 9,12-octadecadienoic acid from the methanolic extract of *Murraya koenigii* leaves and assessed its antioxidant activity. The IC_{50} value of 9,12-octadecadienoic acid was determined to be 45.65 µg/ml, while ascorbic acid exhibited an IC_{50} value of 78.17 µg/ml in comparison (Mathur *et al.*, 2011). The ethanolic leaf extract of *Murraya koenigii* exhibited potent DPPH scavenging activity, likely attributed to the polarity of the solvent, its acidic pH, and the ability of phenolics to undergo reduction within the solvent (Ramos *et al*., 2017; Sablania *et al*., 2019). Male Wistar rats were employed in assessing the antioxidant capabilities of *Murraya koenigii* (L.) Spreng leaves. Oxidative stress was induced using potassium dichromate. The *in vivo* antioxidant activity of *Murraya koenigii* effectively mitigated the toxicity induced by potassium dichromate (Gill and Sharma, 2014).

Hepatoprotective activity:

Hepatoprotective activity of carbazole alkaloid and tannin fractions derived from an aqueous extract of *Murraya koenigii* leaves was investigated using liver carcinoma cell lines, aiming to evaluate their effectiveness against alcohol-induced hepatotoxicity. The results revealed a notable decrease in lipid peroxidation and a reduction in cell damage caused by alcohol. These findings suggest the hepatoprotective potential of the aqueous extract of *M. koenigii* leaves (Sathaye *et al*., 2011). The protective effect of an ethanol extract derived from *Murraya koenigii* leaves against carbon tetrachloride-induced hepatotoxicity was investigated (Sangale and Patil, 2017). The findings indicated a substantial reduction in the serum levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP), suggesting the hepatoprotective potential of the extract. Elevated levels of ALT and AST enzymes are typically associated with hepatitis, while increased ALP levels are linked to hepatobiliary disorders. Furthermore, the increase in liver weight observed in control animals treated with the hepatotoxin was prevented. Additionally, the ethanol extract significantly elevated the levels of superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH), which are beneficial in protecting the liver from oxidative stress, while simultaneously decreasing the levels of lipid peroxidation (LPO) (Sangale and Patil, 2017). The acetone extract obtained from the bark of *Murraya koenigii* exhibited notable hepato-protective effects against carbon tetrachloride-induced liver injury. There was a remarkable reduction in the levels of serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), alkaline phosphatase, and bilirubin (Pande *et al*., 2009).

Anthelmintic activity:

Sujith *et al.* (2018) utilized fractions obtained from the methanol extract of *Murraya koenigii* leaves, which were fractionated using solvents including n-hexane, chloroform, n-butanol, and water. Sub-fractions derived from chloroform exhibited ovicidal and larvicidal activities (Sujith *et al*., 2018). Motility Assay (AMA), Egg Hatch Assay (EHA), and Faecal Egg Count Reduction (FECR) method were used to assess the anthelmintic efficacy of aqueous and methanol leaf extracts of *Murraya koenigii*. Significant anthelmintic activity was observed with both extracts at concentrations of 12.5, 25, and 50 mg/ml, resulting in paralysis and/or mortality eight hours after exposure to various doses (Molla and Bandyopadhyay, 2016). The alcoholic preparation and extract derived

from *Murraya koenigii* leaves were employed against helminths, revealing a higher mortality rate in the alcohol preparation (25%, 50%, and 100%) compared to crude extracts (25%, 50%, and 100%) of *Murraya* leaves. Additionally, a direct correlation was observed between the mortality rate and higher concentrations of *Murraya* leaves (Kanchan and Samriti, 2018). The anthelmintic activity of ethanol extract from *Murraya koenigii* leaves was assessed using earthworms (*Pheretima posthuma*) as test subjects. Albendazole (20 mg/ml) served as the reference standard drug, while distilled water was used as the control. Paralysis and death times of the worms were noted. The ethanol extract exhibited noteworthy anthelmintic activity at a concentration of 500 mg/ml (Raghuvanshi *et al*., 2016). Waghmare *et al.* (2015) explored the anthelmintic potential of ethanol and petroleum ether extracts derived from *Murraya koenigii* fruits (MKF) against *Pheretima posthuma*. Various doses ranging from 50 to 200 mg/ml of each extract were administered, alongside piperazine citrate (15 mg/ml) as the reference drug, to ascertain the paralysis and mortality time of the earthworms. A progressive increase in anthelmintic activity was observed with higher doses of the extracts, resulting in earthworm paralysis and eventual death. The ethanol extract demonstrated superior anthelmintic activity compared to the petroleum ether extract (Waghmare *et al*., 2015).

Nephroprotective activity:

Pawar documented the nephroprotective effects against cyclophosphamide-induced nephro-toxicity. The study employed doses of 150 mg/kg of cyclophosphamide and 100 mg/kg and 200 mg/kg of *M. koenigii* extract. Treatment with *M. koenigii* extract notably reduced renal function markers such as blood urea nitrogen and creatinine levels (Mahipal and Pawar, 2017).

Anti-cancer activity:

Mahanine, derived from *Murraya koenigii* leaves, demonstrated noteworthy antiproliferative effects without exhibiting any harmful toxicity to normal cells (Samanta *et al.*, 2018). Girinimbine, a carbazole alkaloid extracted from *M. koenigii*, induced apoptosis in HT-29 human colon cancer cells while exhibiting no cytotoxic effects on normal colon cells. Treatment with girinimbine led to changes in nuclear condensation, cytochrome c translocation, cell permeability, and mitochondrial membrane potential in HT-29 cells, indicating involvement of the mitochondria in apoptosis. Annexin V and acridine orange/propidium iodide assays confirmed early-stage apoptosis. Girinimbine treatment also caused G0/G1 phase arrest, accompanied by increased expression of cyclin-dependent kinase proteins p21 and p27. Apoptosis was initiated via the intrinsic pathway, involving the activation of caspases 3 and 9, followed by the execution phase. Bax upregulation and Bcl-2 downregulation further confirmed apoptosis in girinimbine-treated cells. Moreover, girinimbine significantly upregulated the tumor suppressor protein p53. *In vivo* studies on zebrafish embryos revealed girinimbine-induced apoptosis within 24 h of treatment, evidenced by a noticeable increase in apoptotic cell distribution (Iman *et al.*, 2016). Ghasemzadeh *et al.* (2014) demonstrated potent anticarcinogenic effects that notably inhibited MDA-MB-231 cells and restrained the proliferation of the breast cancer cell line (MDA-MB-231). Fractions obtained from the petroleum ether and chloroform extracts of the *Murraya koenigii* plant were analyzed to assess their anti-tumor properties. A reference dose of 5-fluorouracil at 20 mg/kg was used for comparison. The findings indicated a noteworthy reduction in both cancer cell count and tumor weight following treatment with the selected fractions (Muthumani *et al.*, 2009). Murrayazoline and O-methyl-murrayamine, isolated from *Murraya koenigii* leaves, were assessed for their efficacy against colon cancer. The results revealed significant anti-colon cancer activity against DLD-1 colon cancer cells, with IC_{50} values of 5.7 M and 17.9 M, respectively. The anticancer effects of these

compounds were associated with alterations in cell morphology, G2/M phase cell cycle arrest, changes in reactive oxygen species levels, and mitochondrial membrane depolarization in colon cancer cells. Additionally, the compounds activated caspase-3 protein and increased the expression ratio of Bax/Bcl-2 protein, ultimately inducing caspase-dependent apoptosis in DLD-1 cells (Arun *et al*.,2017). Silver nanoparticles (Ag-NPs) were synthesized using silver nitrate solution and the extract from *Murraya koenigii* plant, then assessed for their anticancer potential using the MTT assay on the HT-29 colon cancer cell line. Ag-NPs exhibited potent cytotoxic effects against the HT-29 human colorectal adeno-carcinoma cell line, particularly at elevated concentrations (Roshni *et al*., 2018). The anticancer potential of ethanolic and methanolic extracts derived from *Murraya koenigii* (MK) leaves was investigated against U373MG cell lines via the colorimetric SRB assay. The efficacy of the plant extracts against the U373MG cell line was evident from the decreased viability of the cells. Additionally, a dose-dependent and statistically significant rise in the percentage of deceased cells was observed. Moreover, the methanolic extract exhibited notably higher cytotoxicity compared to the ethanolic extract (Sanaye and Pagare, 2016). The hydro-methanolic extract of curry leaves was investigated for its potential in breast cancer treatment using human breast cancer cell lines: MCF-7 and MDA-MB-231, along with a normal human lung fibroblast cell line, WI-38. Cytotoxicity was evaluated through the MTT assay. The hydro-methanolic extract decreased cell viability and exhibited dose-dependent alterations in the growth dynamics of both breast cancer cell lines. Notably, significant cell cycle arrest was observed in the S phase, exclusively in cancer cells. Annexin V binding data indicated apoptosis as the mechanism of cell death in both cancer cell lines. Moreover, treatment with the hydro-methanolic extract of curry leaves significantly reduced 26S proteasome activity in cancer cells, while no such effect was observed in normal cells (Noolu *et al.*, 2013). The curry leaf extract's flavonoids exhibited a dose-dependent inhibition of endogenous 26*S* proteasome activity in MDA-MB-231 cells. Reduction in tumor growth was linked to decreased proteasomal enzyme activities in the treated groups. Enhanced apoptosis was indicated by increased caspase-3 activity and the presence of TUNEL-positive cells following treatment with *Murraya* leaf extract. Additionally, diminished expression of angiogenic and anti-apoptotic gene markers suggested inhibition of angiogenesis and promotion of apoptosis in the tumors treated with the leaf extract (Noolu *et al.*, 2016). The apoptotic impact of giriminbine, a carbazole alkaloid extracted from *Murraya koenigii* Spreng leaf extract, was evaluated in lung cancer using A549 lung cancer cells. Antiproliferative activity was examined via MTT assay, while apoptosis detection was conducted using Annexin V and lysosomal stability assays. Giriminbine was found to induce cell death with an IC_{50} of 19.01 M according to the MTT assay. Significant initiation of early-phase apoptosis was confirmed by both Annexin V and lysosomal stability assays (Syam Mohan *et al.*, 2013). The mahanin-enriched fraction (MEF), derived from the ethanol extract of *Murraya koenigii* leaflets, exhibited significant efficacy in syngeneic mouse models of ovarian and breast cancer, demonstrating an ED_{50} of 300 mg/kg body weight (Satyavarapu *et al*., 2020). Noolu and Ismail (2015) assessed the cytotoxic and proteasomal inhibitory properties of *M. koenigii* leaf in four distinct human cell lines: colon, prostate, liver, and cervical cancer, utilizing MTT assays. A time- and dose-dependent reduction in cell viability was observed across all tested cell lines. Significantly decreased cell viability was noted in HeLa and Caco2 cell lines at all **doses** examined, compared to vehicle-treated cells. Conversely, in HepG2 and LNCaP cells, the decline in viability was significant from 15 µg/ml and 12 µg/ml, respectively. The 50% inhibitory concentration (IC_{50}) was determined to be 8.07

µg/ml for the Caco2 cell line, 4.8 µg/ml for the HeLa cell line, 17.55 µg/ml for the HepG2 cell line, and 16.45 µg/ml for the LNCaP cell line (Noolu and Ismail, 2015).

Antiinflmmatory activity:

The anti-inflammatory properties of *Murraya koenigii* were demonstrated by girinimbine's notable dose-dependent inhibition of nitric oxide production in lipopolysaccharide/interferon-gamma-induced cells. Additionally, girinimbine significantly inhibited the translocation of nuclear factor-kappa B from the cytoplasm to the nucleus in stimulated RAW 264.7 cells (Iman *et al.*, 2016). In a carrageenan-induced hind paw edema animal model, the methanol extract of dried leaves from *Murraya koenigii* exhibited dose-dependent anti-inflammatory effects compared to both the control and the standard drug, diclofenac sodium (10 mg/kg, p.o). These inhibitory effects were found to be statistically significant (Gupta *et al.*, 2010). Administering oral doses of total alkaloid extract from *Murraya koenigii* (MKA) at 10, 20, and 40 mg/kg body weight effectively and dose-dependently alleviated edema arthritis induced by carrageenan, histamine, serotonin, and formaldehyde (Mani *et al*., 2013). Murrayakonine A, O-methylmurrayamine A, and murrayanine, obtained from the $CHCl_3$: MeOH (1:1) crude extracts of the stems and leaves of *Murraya koenigii*, exhibited significant activity by efficiently inhibiting the release of TNF-α and IL-6 in a dose-dependent manner. Moreover, they demonstrated reduced TNF-α and IL-6 production induced by LPS in human PBMCs (Nalli *et al.*, 2016). At a concentration of 500 µg/ml, ethanol extracts of *M. koenigii* demonstrated a considerable inhibition (88%) of heat-induced albumin denaturation, a key contributor to inflammation. In comparison, aspirin, an established anti-inflammatory medication, exhibited the highest inhibition rate of 99% at a concentration of 100 µg/ml when compared to the control (Sriram *et al.*, 2019).

Wound healing activity:

Nagappan *et al*. (2012) investigated the wound healing effects of carbazole alkaloids (mahanin, mahanimbicin, mahanimbine), essential oil, and ethanol extract from *Murraya koenigii*. These substances were applied topically over 18 days, and wound contraction rate, epithelialization, wound granulation, and collagen deposition were assessed histologically. By day 4, significant wound contraction rates were observed, particularly in the extract-treated group (19.25%) and the mahanimbicin-treated group (12.60%). Complete epithelialization was achieved by day 18 in all treatment groups. The highest collagen deposition rates were found in the mahanimbicin and *M. koenigii* extract-treated groups, at 88.54% and 91.78%, respectively (Nagappan *et al.*, 2012).

The application of hydroalcoholic extract of *Murraya koenigii* fruit extract ointment topically resulted in notable wound closure and epithelialization compared to the control group, with statistical significance. The study indicates that the hydroalcoholic extract of *Murraya koenigii* fruits possesses significant wound healing properties (Pitchaiah *et al*., 2016).

Antimicrobial activity:

The antimicrobial activity of ethanol and methanol extracts from *Murraya koenigii* leaves was assessed using the paper disc diffusion method. The results revealed significant antibacterial effects, especially against *Escherichia coli* and *Staphylococcus* bacteria, when compared to commonly used antibiotics such as gentamicin and amikacin (Al Harbi *et al*., 2016). Antimicrobial activity of methanol extract of root of *Murraya koenigii* was reported against the pathogenic microorganisms such as *Staphylococcus aureus* and *Trichophyton rubrum* (Malwal and Sarin, 2011).

Conclusion

This review focuses on the pharmacological, ethnomedicinal, and phytochemical characteristics of *Murraya koenigii*, alongside an emphasis on its anti-lipid peroxidation, anti-diarrheal, anti-ulcer, phagocytic, analgesic, anti-diabetic,

radioprotective, anthelminthic, antimicrobial, and wound healing attributes. The scientific evidence of *Murraya koenigii* phytochemistry and pharmaco-logical characteristics, in addition to its varied applications among different cultural groups, suggest that the species has promise for therapeutic purposes. Furthermore, fresh biological investigations are still required to validate some of its ethnopharmacological uses, ensuring that the species remains a viable option for managing and treating diseases in future generations.

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