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A review on pharmacognosy, phytochemistry and therapeutic importance of *Murraya koenigii*, *Azadirachta indica* and *Piper nigrum*

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Abstract:

From ancient age herbal remedies remained as medicine's backbone due to its economic, safety and easy availability to most of the population in world. Among diverse herbal treasure *Murraya koenigii*, *Azadirachta indica* and *Piper nigrum* are highly esteemed trees with several beneficial properties and applications especially for their therapeutics and ethno medicinal values. *Murraya koenigii* which is known as a flavouring agent for vegetables and having a versatile medicinal property. *Azadirachta indica* is known as free tree of India, wonder tree, nature's drug store and divine tree. It is among highly exploits medicinal plant of Indian origin. It has been used in different medicinal systems Ayurveda, Unani, homoeopathic medicine. All parts of the neem plant have some medicinal properties, *Piper nigrum* L. (Family Piperaceae) is a well-known spice considered as "The King of spices" among various spices. Here we are giving a brief review of the pharmacognosy, photochemistry and pharmacological properties of three well known plant *Murraya koenigii*, *Azadirachta indica* and *Piper nigrum*.

Key words: Medicinal Plant, *Murraya koenigii*, *Azadirachta indica* and *Piper nigrum*.

Introduction

Herbal medicine is also called botanical medicine or phytomedicine. It is referring to using a plant's seeds, berries, roots, leaves, bark, or flowers for medicinal purposes. Herbal medicine is still the mainstay of about 75 - 80% of the world population, mainly in the developing countries, for primary health care [1]. This is primarily because of the general belief that herbal drugs are without any side effects besides being cheap and locally available [2]. According to the World Health Organization (WHO), the use of herbal remedies throughout the world exceeds that of the conventional drugs by two to three times³. The use of plants for healing purposes predates human history and forms the origin of much modern medicine. Many conventional drugs originated from plant sources: a century ago, most of the few effective drugs were plant based. Examples include aspirin (willow bark), digoxin (from foxglove), quinine (from cinchona bark), and morphine (from the opium poppy) [4].

India is frequently known by enormous biodiversity of medicinal plants [5]. Among them *Murraya koenigii*, *Azadirachta indica* and *Piper nigrum* have a lot of bioactive principles due to which plant has been proven as the medicinally important plant proved and reported by many researchers.

In this article we aim to describe some pharmacognosy, phytochemistry and pharmacological importance of *koenigii*, *Azadirachta indica* and *Piper nigrum*.

Murraya koenigii

Murraya koenigii is a most attractive, small evergreen tree with wonderfully sweet, curry-pungent foliage.

Biological source

The species name commemorates the botanist Johann König. The genus Murray commemorates Swedish physician and botanist Johann Andreas Murray who died in 1791. Hence the botanical name of the curry leaves is *Murraya koenigii*.⁶ It belongs to Rutaceae family and it also commonly known as Curry Leaf (English), Karepaku (Andhra Pradesh),

Mahanimb (Sanskrit); Karivempu (Tamilnadu). And in French: Feuilles de cury; in German: Curryblatter; in Indonesian: Daun kari.

Geographical distribution

Murraya koenigii native from east and south part of India, Pakistan, Sri Lanka, China and Hainan but widely cultivated in South-East Asia and some parts of the United States and Australia.⁷ It grows throughout India at an altitude of 1500 to 1655m. It is also available in other part of Asian region like in Guangdong, Out of the 14-global species that belong to the genus *Murraya*, only two are known to be found in India, which is *Murraya koenigii* (Spreng) and *Murraya paniculata* (Jack) [8,9].

Botanical description

Tree

Murraya koenigii is semi deciduous, unarmed aromatic small spreading shrub or tree with strong woody stem but slender with the stem which is dark green to brownish in colour the tree is 4–8.7m (13–31 feet) height, with a trunk up to 81cm¹⁰ diameter [11]. The diameter of main stem is about 16cm [11,12].

Flower

The flowers are small, white fragrant and funnel-shaped, regular, pentamerous, stalked, complete, ebracteate, hypogynous, persistent, inferior, green, corolla, polypetalous, androecium, polyandrous, lanceolate, stigma, bright, sticky, style, short, ovary, inflorescence, a terminal cyme, the diameter of a flower is 1.12cm in the fully opened form, each cluster bear approximately 60 to 90 flowers at a time after flowering at once, 5-lobed calyx, with petals in having length 5 mm and the petals are 5 in number, with stamen in number 10 and in small in size approximate number 4 mm, dorsifixed, arranged into circles, with long superior gynoecium with size 5 to 6mm [13] Curry tree flowers have a sweet fragrance, bisexual with self-pollinated for produce black berries in small size with shiny appearance containing a large visible seed with the number 1 [14].

Leaf

Curry leaves are aromatic in nature having characteristic aroma, leaves of curry leaves are shiny and smooth with paler undersides.¹⁵ Leaves are pinnate, exstipulate, having reticulate venation and having ovate lanceolate with an oblique base,¹⁵ with 11-21 leaflets whose size description is each leaflet is 0.79–1.57inch long and 0.39–0.79 inch broad. Leaflets are short stalked, alternate, gland dotted and having 0.5-cm-long petiole. The leaf margins are irregularly serrate.^{13,16} The yield of a bush in approximately found about 480 g in three to four pickings [17].

Stem and bark

The stem of *Murraya koenigii* is brown to dark green in colour, with dots on the bark like small node on it, when the bark was peeled off longitudinally under the exposing the white wood underneath; the girth of the main stem is 16cm up to 6 meters in height and 15 to 40cm in diameter [18].

Fruit

Fruits of the *Murraya koenigii* occur in cluster form varies in 32 to 80 in number [19]. The fruits are in the ovoid or subglobose and small in size in the spinach green colour seed in one or two number which are enclosing each other in thin pericarp.²⁰ The fruits are 1 to 1.2cm in the diameter with length 1.4 to 1.6cm, purple black after ripening and they are edible and yields 0.76% of a yellow volatile oil [21]. Curry leaf fruit is 11mm long and weigh about 445mg Fruits. The plant produces small white flowers which can self-pollinate. The weight of pulp is 880mg and the volume is 895 microliters [14, 10]. The seeds of the *Murraya koenigii* are poisonous in nature and should not be consumed for any purpose [20].

Microscopy

Leaves: The leaves have the obliquely ovate or fairly rhomboid with acuminate obtuse or acute apex. The petiole is about 20 to 30cm in length and the leaves have reticulate venation and dentate margin with an asymmetrical base [22]. In the microscopic studies, it was elucidate that the stomata were distributed on adaxial surface and the adaxial surface does not have stomata and the type of stomata that was found is anomocytic. The transverse section of the leaves has a layer of epidermis which is composed of rectangular cell. The upper epidermis was covered with cuticle and in the midrib the epidermis has 1 to 4 layers of collenchymatous hypodermis with 2-5 layers of chlorenchyma cells [23]. The ground tissue is oval to polygonal parenchyma cell with vascular bundle. Calcium oxalate found in sandy and prismatic crystals [24]. The curry leaf shows the presence of unicellular trichomes with obliterated lumen, parenchymatous pith in petiole, long pericyclic fiber in the midrib, large cruciferous stomata and prismatic calcium oxalate crystals. Fresh leaves on steam distillation under pressure yield 20.6% of volatile oil and without pressure less than 2% [25, 25] The fibers measure 2000μ in length.

Root: The root shows tetrarch to pentarchstele, phelloderm fibers are absent and concentric grains of parenchyma are present [27].

Powder: Green in colour with no distinct odour or taste, unicellular, bent or curved trichomes, two layered palisade, portion of secretory canals, well developed pericyclic fibers and a few prismatic crystals of calcium oxalate are the important identifying characters [27].

Phytochemical properties

Murraya koenigii is very rich source of phytoconstituents such as alkaloids, flavonoids carbohydrates, and sterol [19, 28–31]

It also contains essential oils like *i* D-Sabinene, D- α -Terpinol, di- α -phellendrene, D- α - pinene, caryophyllene and dipentene [32].

The fresh leaves of *Murraya koenigii* contain 61.77-66.2% of moisture, 2.1-12.5% of protein, 14.6-18.97% of total sugar, 9.7- 13.06% of total ash, 1.35-1.82% of acid insoluble ash, 1.35-1.82% of alcohol soluble extractive and water extractive value ranges between 27.33-33.45% [33].

Seed of *Murraya koenigii* consist of furocoumarin lactone, carbazole alkaloids, glycolipids, Phospholipids and terpinene. It also contains 4.4% of total lipids in which 85.4% are neutral lipids, 5.1% are glycolipids and 9.5% are phospho-lipids. 73.9% triacylglycerol, 10.2% free fatty acids and small amounts of diacylglycerols, monoacylglycerols and sterols. The seeds also contain terpinene like terpinene, terpinen-4-ol, linolol [34]. ocimene, limblee, limbolee and simbolee [35–37].

The matured stem and bark of *Murraya koenigii* consists phytochemicals like carbazole alkaloids, coumarin galactoside, Carbazole carboxylic acid, glycolipids, Phospholipids etc.

Medicinal properties

It is a warming, strongly aromatic herb that improves appetite and digestion [38]. The leaves, roots and bark can all be used internally in the treatment of digestive problems [38]. It has been shown that the leaves increase digestive secretions and relieve nausea, indigestion and vomiting [39]. The leaves can be used internally in treating constipation, colic and diarrhea [38]. The leaves are used in the treatment of diarrhea and dysentery [40,41]. The juice of the fruit, mixed with lime juice (*Citrus aurantiifolia*) is applied to soothe insect bites and stings [39]. A paste made from the bark is applied to the bites of poisonous insects and other animals [40].

Reported pharmacological activity

Plant name	Part and extract	Activity reported
<i>Murraya koenigii</i>	Aqueous leaf extract	Dose dependent negative chronotropic effect on cardiovascular system [42]
	Isolated compound Mahanimbine from <i>M. Koenigii</i> dried plant petroleum ether extract	Antidiabetic effect [43]
	Ethanol extract of leaves	Hypocholesterolemic activity [44]
	Aqueous and ether extracts of leaves	Antiulcer activity [45,46]
	N-hexane extract of the seeds	Antidiarrheal activity [47]
	Methanolic extract of leaves	Analgesic activity [48]
	Whole plant	Activity of lipid peroxidation [49]
	Methanolic extract of plant	Radio protective and chemoprotective effect [50]
	Petroleum ether extract of leaves	Antiamnesic activity [44]
	Petroleum ether and alcoholic extracts	Anthelmintic activity [51]
	Ethanol extract of leaves	Wound healing activity [52]

Piper nigrum (white)

Piper nigrum is a valuable medicinal plant. It is one of the most commonly used spices and considered as 'The King of spices' among various spices. It belongs to Family: Piperaceae.

Biological source

It consists of dried unripe fruits of *Piper nigrum* (Black) Linn. While the white piper is prepared by removing the thin darker-coloured skin (flesh) of the ripe fruit.

Geographical distribution

Piper nigrum is grown in many tropical regions like Brazil, Indonesia and India [53]. Geographically, it is native to Western-Ghats (Kerala) of South India [54]. However, some reports of cultivation from Malaysia, Indonesia, Brazil, Sri-Lanka and West Indies are also available [55].

Botanical description

A climber that grows to a height or length of 10 m or more. Once the main stem is established it grows many side shoots to create a bushy column. The plants form short roots, called adventitious roots, which connect to surrounding supports.

Leaves

Almond-shaped, tapering towards the tip, dark green and shiny above, paler green below, arranged alternately on the stems.

Flowers

Borne in clusters along flowering stalks known as spikes. 50-150 whitish to yellow-green flowers are produced on a spike.

Fruits

Round, berry-like, up to 6 mm in diameter, green at first but turning red as they ripen, each containing a single seed. 50-60 fruits are borne on each spike.

Microscopy character [56]

Epicarp shows an outer layer of polygonal cells having a distinct cuticle and containing a dark brown to blackish contents, followed by 2-3 layers of thin walled parenchyma cells intermingled with greatly thickened isodiametric to radically elongated stone cells. Mesocarp is a comparatively broad zone constituting the greater area of the pericarp. The outer 7-8 layers of cells are parenchymatous and certain small starch grains and scattered among these cells will be noted larger secretion sacs with suberized walls and oil/resin contents. The next several layers of cells are compressed and fibrovascular bundles ramify in these regions. Beneath the compressed cells a layer of larger oil cells having suberized walls and then a zone of two layers of small parenchyma cells are present. Endocarp consisting of single layer of stone cells whose radius & inner walls are more strongly signified than outer layer. Testa consisting of 2-3 layers of compressed elongated cells beneath which is a pigment layer containing a dark – brown tannin substance. Inner zone of peri sperm cells are radically elongated which embeds largely oleoresins besides starch and proteins substance. Tracheid are pitted, some of them show helical thickenings on their secondary wall.

Powder microscopy [56]

Powder is dark brown to blackish in colour with pungent odour and bitter acrid taste. Powder stained with safranin shows isodiametric or slightly elongated stone cells, interspersed with thin walled polygonal hypodermal cells, beaker shaped stone cells from endocarp and abundant polyhedral, elongated cells

Phytochemical Constituents

The phytochemicals present in *Piper nigrum* are like alkaloids, amides, propenylphenols, lignans, neolignans, terpenes, steroid, kawapyrone, piperolides, chalcones, dihydrochalcones, brachyamide, dihydropiperidine, 3,4-dihydroxy-6 (N-ethylamine), benzamide, (2E, 4E)-N-eicosadienoyl piperidine, N-trans-feruloyltryamine, N-formyl piperidine, guineensine, (2E, 4E)-N-5[(4-Hydroxyphenyl)- pentadienoyl] piperidine, (2E,4E)-N-isobutyldecadienamide, (2E,4E)-N-isobutyl-eicosadienamide, (2E,4E,8Z)-N-isobutyl-eicosatrienamide, (2E,4E)- N-isobutyloctadienamide, piperamide, piperamine, piperettine, pipericide, piperine, piperolein, trichostachine, sarmentine, sarmentosine, tricholein, retrofractamide [57-63].

Traditional medicine

Black peppercorns feature as remedies in Ayurveda, Siddha and Unani medicine in South Asia. They are most frequently used as an appetizer and to treat problems associated with the digestive system, particularly to eradicate parasitic worms. Some traditional uses of black pepper are supported by scientific evidence.

In Ayurvedic medicine, black pepper has been used to aid digestion, improve appetite, treat coughs, colds, breathing and heart problems, colic, diabetes, anemia and piles. Stomach ailments such as dyspepsia, flatulence, constipation and diarrhoea are all treated with black pepper, which may be mixed with other substances such as castor oil, cow's urine or ghee.

Black pepper has been prepared in tablet form as a remedy for cholera and syphilis, sometimes combined with other substances. It has also been used in tooth powder for toothache, and an infusion of black pepper has been suggested as a remedy for sore throat and hoarseness. Black pepper may be chewed to reduce throat inflammation.

Externally, it has been applied as a paste to boils and to treat hair loss and some skin diseases. Oil of pepper is reputed to alleviate itching. A mixture of sesame oil and powdered black pepper has been recommended for application to areas affected by paralysis. A mixture of black pepper and honey is regarded as a remedy for night blindness. Black pepper has been given by inhalation to comatose patients. It is also believed to be useful against hepatitis, urinary and reproductive disorders. In Ayurveda and Siddha medicine, a paste made using white pepper is applied to treat some eye diseases.

In Unani medicine, black pepper has been described as an aphrodisiac and as a remedy to alleviate colic. A preparation called 'jawa rishai thurush' is composed of pepper, ginger, salt, lemon juice and the plants vidanga (*Embelia ribes*; Primulaceae, primrose family) and mint (*Mentha* species; Lamiaceae). It has been prescribed to alleviate indigestion and stomach acidity.

Reported pharmacological activity

Plant name	Part and extract	Activity reported
<i>Piper nigrum</i> (white pepper)	Essential oil and oleoresin of white piper	Antioxidant [64,68] and antimicrobial activity [64]
	White piper extract	Antibacterial effect [65]

	Dichloromethane extract	Anti-inflammatory activity [66]
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Azadirachta indica

Azadirachta indica is a fast-growing evergreen popular tree found commonly in India, Africa and America. It belongs to Family: Meliaceae. It also known as neem (english), Nim or Nimb (Bengali, Hindi) and Indischer Zedrach (German).

Synonym: Melia Azadirachta linn

Common names

Sanskrit: Ravipriya; Vembaka, Nimba, Arishta.

Bengali, Hindi,

Panjabi: Nim or Nimb, Nimgachh.

Gujarati: Limba.

Tamil: Vembu.

English: Neem or Margosa tree; Indian Lilac.

German: Indischer Zedrach.

French: Azadiraed'Ind

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Tamil: Vembu.
English: Neem or Margosa tree; Indian Lilac.
German: Indischer Zedrach.
French: Azadiraed'Ind

Biological source

Azadirachta indica, commonly known as Neem, belongs to Family Meliaceae

Geographical distribution

A native to east India and Burma, it grows in much of south East Asia and West Africa, and more recently Caribbean and south and Central America. In India it occurs naturally in Siwalik Hills, dry forests of Andhra Pradesh, Tamil Nadu and Karnataka to an altitude of approximately 700 m. It is cultivated and frequently naturalized throughout the drier regions of tropical and subtropical India, Pakistan, Sri Lanka, Thailand and Indonesia. It is also grown and often naturalized in Peninsular Malaysia, Singapore, Philippines, Australia, Saudi Arabia, Tropical Africa, the Caribbean, Central and South America [71].

Two species of *Azadirachta* have been reported, *Azadirachta indica*, A. Juss native to Indian subcontinent and *Azadirachta excels* Kack. – confined to Philippines and Indonesia.

Botanical description:

It is a tree 40-50 foot or higher, with a straight trunk and long spreading branches forming a broad round crown; it has rough dark brown bark with wide longitudinal fissures separated by flat ridges. The leaves are compound, imparipinnate, each comprising 5-15 leaflets. The compound leaves are themselves alternating with one another. It bears many flowered panicles, mostly in the leaf axils. The sepal are ovate and about one cm long with sweet scented white oblanceolate petals. It produces yellow drupes that are ellipsoid and glabrous, 12-20 mm long. Fruits are green, turning yellow on ripening, aromatic with garlic like odour. Fresh leaves and flowers come in March-April. Fruits mature between April and August depending upon locality [71, 72 5-6].

Phytochemistry:

Biologically active principles isolated from different parts of the plant include: Azadirachtin, meliacin, gedunin, nimbidin, nimbolides, salanin, nimbin, valassin, meliacin forms the bitter principles of Neem oil, the seed also contain tignic acid responsible for the distinctive odour of the oil [73]. Neem kernels contain 30-50 % of oil mainly used by the soap, pesticide and pharmaceutical industries and contain many active ingredients which are together called triterpene or limnoids [74]. The four best limnoids compounds are: Azadirachtin, Salannin, Meliantriol, and Nimbin. Limonoids contain insecticidal and pesticidal activity [75].

Medicinal use:

All parts of the tree have been used medicinally for centuries. It has been used in Ayurvedic medicine for more than 4000 years due to its medicinal properties. The earliest Sanskrit medical writings refer to the benefits of Neem's fruits, seeds, oil, leaves, roots and bark. Each has been used in the Indian Ayurvedic and Unani medicine, and is now being used in pharmaceutical and cosmetics industries [76].

Advantages of various Neem parts [76]

Neem oil: useful for pest control, cosmetics, medicines, etc.

Neem seed cake

Natural fertilizer and insecticide.

Neem leaves: useful for chickenpox, increase immunity of the body, reduce fever caused by malaria, treating various foot fungi, useful against termites, used in curing neuromuscular pains.

Neem bark and roots

Control fleas and ticks on pets, fights against skin infections such as acne, psoriasis, scabies, eczema, etc, treats diabetes, AIDS, cancer, heart disease, herpes, allergies, ulcers, hepatitis and several other diseases.

Health and Personal Care products

Neem personal care products derived from seed, oil and leaf include; Skin care - including eczema cream, antiseptic cream, and nail care; hair care - shampoo, and hair oils; oral hygiene - toothpaste and neem twigs; therapeutic - loose Neem leaves – tea, vegetarian capsules, powders; household products - soaps, insect repellent (spray and lotion), and candles.

Therapeutic uses

Hot water extract of the bark is taken orally by the adult female as a tonic and emmenagogue. Anthraquinone fraction of dried flower, fruit and leaf is taken orally for leprosy. Hot water extract of the flower and leaf is taken orally as an anti-hysterical remedy, and used externally to treat wound. The dried flower is taken orally for diabetes. Hot water extract of dried fruit is used for piles and externally for skin disease and ulcers. Hot water extract of the entire plant is used as anthelmintic, an insecticide and purgative. Juices of bark of *Andrographis paniculata*, *Azadirachta indica*, *Tinospora cardifolia*, are taken orally as a treatment for filariasis. The hot water extract is also taken for fever, diabetes, and as a tonic, refrigerant, anthelmintic. Fruit leaf and root, ground and mixed with dried ginger and "Triphala" is taken orally with lukewarm water to treat common fever [72]. Leaves due to insecticidal properties are kept with woollen and other cloths for long time. Leaf juice is given in gonorrhoea and leucorrhoea. Leaves applied as poultice to relieve boils, their infusion is used as antiseptic wash to promote the healing of wound and ulcers. A paste of leaves is used to treat wounds, ring worms, eczema and ulcers. Bathing with Neem leaves is beneficial for itching and other skin diseases. Leaf juice is used as nasal drop to treat worm infestation in nose. Steam inhalation of bark is useful in inflammation of throat. Decoction can cure intermittent fever, general debility convalescent, and loss of appetite after fever [77]. Infusion of flower is given in dyspepsia and general debility [78]. The tender twigs of the tree are used as tooth brush which is believed to keep the body system healthy, the breath and mouth clean and sweet [79, 80]. Seed oil is used in leprosy, syphilis, eczema, chronic ulcer [77, 79].

Reported pharmacological activity

Plant name	Part and extract	Activity reported
<i>Azadirachta indica</i>	Aqueous extract	Larvicidal properties [81]
	Petroleum ether, methanol and aqueous extracts of the leaves	Anti-microbial activity [82]
	Plant extract	Hypoglycemic potency [83]
	Young flowers and leaves extracts	Antioxidant potential [84]
	Acetone water neem leaf extract	Anti-hiv/aids properties [85]
	Bark extract	Anti-ulcer activity [86]
	Tablet suspension of the bark and leaf	Antimalarial activities [87]
	Plant extract	Chemopreventive capability [88]
	Seed extract	Pregnancy termination in rodents and primates [89]
	Aqueous extract	Doca salt prevented the development of hypertension [93]
	Leaf extract	Decreased serum cholesterol [94,95]

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