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Review Article

A Brief Review on *Murraya paniculata* (Orange Jasmine): pharmacognosy, phytochemistry and ethanomedicinal uses

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Objectives: *Murraya paniculata* (family-Rutaceae), popularly known as orange jasmine, is the most important evergreen plant. The Rutaceae family is economically significant due to its diverse edible fruits and essential oils.
Methods: *Murraya paniculata* extracts (MPE) of leaf have been shown to include phenolic compounds, highly oxygenated flavonoids, flavanones, sesquiterpenoids, polymethoxy glycosides, and coumarins. Cyclocitral, methyl salicylate, trans-nerolidol, cubenol, isogermacrene, -cadinol, and cubeb-11-ene are all abundant in MPE. The usages of various parts of this plant, such as bark, leaves and flower, as a remedy for a variety of ailments as widely recorded in the traditional literature. The plant has anti-diabetic, anti-obesity, antibacterial, anti-implantation, anti-oxidative, cytotoxic, anti-diarrheal, antidepressant and anti-anxiety properties and many others.
Results: The goal of the review is to reignite interest in this potential plant, encouraging researchers to continue their research in order to uncover novel therapeutic compounds for the treatment and management of a range of infections. The current review provided a comprehensive overview of this traditional unique plant.
Conclusion: The review paves a way for exploring its active chemical elements with substantial pharmacological values further for potential benefits of mankind.

Keywords: herbal plants, murraya paniculata, therapeutic uses

INTRODUCTION

Herbal products are gaining popularity in both progressive and developing nations [1]. For thousands of years, medicinal plants have been used based on traditional and folk treatments, and their importance in treating moderate and chronic ailments is growing [2]. *Murraya paniculata* (MP), often called honey bush, orange jasmine, and kamini, is a traditional medicinal plant from the Rutaceae family. It is primarily found in India, Sri Lanka, southern China, Thailand, and eastward over the Malesian region to northeastern Australia and Caledonia [3]. MP is a genus of 12 species and evergreen shrubs [4]. It has the potential to limit *Diaphorina citri* migration into commercial citrus orchards, which is critical for better huanglongbing management [5]. Headache, bruises, gastralgia, stomachaches, rheumatism, skin irritation, and swelling are all treated with this herb. It is also utilized as a menstrual flow booster and a snake bite treatment [4, 6]. The plant is also utilized for treating toothaches [7]. The reliable databases used for the review were Science Direct, Elsevier, and Research Gate, PubMed, Google Scholar, among others.

This review explicitly elaborated on MP, emphasizing on its recently studied phytoconstituents and pharmacological activities.

DESCRIPTION

The plant can grow to be 8-12 feet tall. MP has a taproot (Fig. 1), with fragrant white flowers and oval-shaped crimson fruits. The fruit length ranges from 5 to 1 inch [8].

Figure 1. *Murraya paniculata* plant.

MP leaves are egg-shaped, and are 2-11 cm long and 1-1.5 cm wide. The leaves have a fragrant aroma, a bitter, spicy flavor, and a brownish green color. They are smooth and shiny on the surface. Leaves can be detected in the mesophyll, or the epidermis without stomata, and the epidermis. Anticlinal cell walls, a lower epidermis covered in hair and rosette-shaped stomata are all characteristic of MP leaf powders [9].

MP is popularly cultivated in tropical countries, and under glass in temperate ones. The ideal altitude is about 200 meters as MP is grown on basalt or calcareous soils. Between March and June, the flowers are harvested (Table 1) [10]. MP's chloroplast genome is 160,280 bp long, with large and small single-copy regions measuring 87,605 and 18,609 bp, respectively, which are separated by two IR regions of 27,033 bp. The sample has a GC percentage of 38.61%. De novo assembly and annotation indicated the presence of unique genes and revealed the presence of 85, 29, and 8 protein-coding, tRNA, and rRNA genes, respectively [11].

PHYTOCONSTITUENTS OF DIFFERENT PARTS OF MP

Various phytoconstituents have been discovered, including flavonoids, alkaloids, carbohydrates, phenolic compounds, amino acids and proteins [3, 12-14]. Various chemical compounds have been isolated from several parts of the plant.

1. Leaves, shoots and twigs

Extracts from MP leaves contain coumarins compounds such as murrayanone and murraculatin [15]. Eight highly oxygenated flavones, namely, 5-hydroxy-6,7,3',4',5'-pentamethoxyflavone (umhengerin), 5-hydroxy-6,7,8,3',4',5'-hexamethoxy flavone (gardenin A), 6,7,8,4'-tetra-methoxy-5,3',5'-trihydroxyflavone (gardenin E), 5,3'-dihydroxy-6,7,8,4',5'-pentamethoxyflavone (gardenin C), 6,7,8,3',4',5'-hexamethoxyflavone, 5-hydroxy-6,7,8,3',4'-pentamethoxyflavone (5-O-desmeth-ylnobiletin), 5,3'-dihydroxy-6,7,4',5'-tetramethoxyflavone, and 5,3',5'-trihydroxy-6,7,4'-trimethoxyflavone, were found in $CHCl_3$ extracts of MP leaves [16]. Two flavonoids, 5,6,7,8,3',4',5'-heptamethoxyflavone and 3,5,7,8,3',4',5'-heptamethoxyflavone, were isolated from MP leaf extracts and showed inhibitory activity against human carbonic anhydrase isozyme II (hCAII) at doses of 10.8 and 21.5 M, respectively [17]. Moreover, leaf and shoot extracts contain two glycosides of flavone methyl ethers (5,8,3'- trihydoxy-6,7,4'-trimethoxy flavone 8-O-beta glucopyranoside and 5,8-dihydoxy-6,7,3',4'-tetramethoxy flavone 8-O—beta-glucopyranoside [18]. Polymethoxylated flavonoids were withdrawn from the leaf extracts, and interpreted by the HPLC-DAD-ESI-MS/MS analytical method [19]. A total of 14 secondary metabolites showed abundance in the leaf and twig extracts [20]. Alanditrypinnone, alantryphenone, alantrypinene-B, and alantrylewnone are spiroquinazoline alkaloids isolated from *Eupenicillium* spp. leaves [21]. 2-O-ethylmurrangatin, a secondary leaf metabolite, inhibited lipoxygenase and had moderate respiratory burst inhibitory activity [22].

Table 1. Botanical classification of *Murraya paniculata* [10]

Kingdom	Plantae
Phylum	Charophyta
Class	Equisetopsida
Subclass	Magnoliidae
Superorder	Rosanae
Order	Sapindales
Family	Rutaceae
Genus	Murraya
Species	Paniculata

2. Root

MP root extracts contain indole alkaloid derivatives, such as paniculidines (D-F) with six known analogs, and the HRESIMS, UV, IR, and NMR spectroscopic techniques were used to elucidate the compounds [23]. Coumarins derivatives named panitins A-G with 34 known analogs were also identified [24].

Acetone extraction of root bark extracts have shown the levels of coumarins like minumicrolin isovalerate, murralonginol isovalerate, murrangatin isovalerate, chloculol, and an indole alkaloid called paniculol. The structures of coumarins were identified on the basis of H NMR (270 MHz) spectroscopic method [25]. Yuehchukene, a new dimeric indole alkaloid produced from root extracts, has also been identified and displays anti-implantation activity [26].

3. Flowers

Coumarins like (-)-murracarpin, omphalocarpin, murrayacarpin-A and -B along with known coumarins like scopoletin, scopolin, murracarpin, 5,7-dimethoxy-S-(3'-methyl-2'-oxobutyl)coumarin, mupanidin, 3,5,7,3',4',5'-hexamethoxytlavone (a flavonoid), and murrayaculatine (an indole alkaloid) were extracted from flower extracts [27, 28].

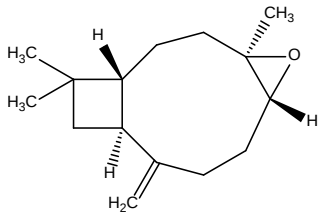
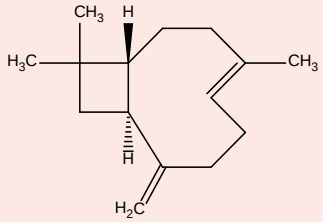
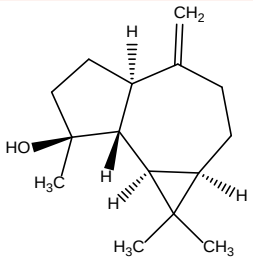
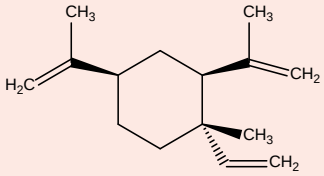
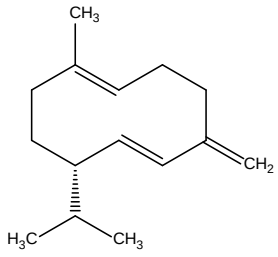
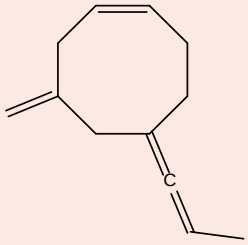
4. Aerial parts

The aerial parts of MP contain coumarins like murrmeranzin, murralonginal, minumicrolin, murrangatin, meranzin hydrate, and hainanmurpanin. Minumicrolin compounds were discovered to have anti-cholinesterase actions [29]. GS & GS-MS were used to identify the 48 categories of volatile compounds found in ethanolic extracts [30].

5. Fruits

MP fruits were used to isolate a water-soluble gum polysaccharide. The polysaccharide was highly branched using hydrolytic assays, methylation analyses, periodate oxidation research and NMR data [31]. Essential oils from the fruit contain α-copaene, -zingiberene, β-caryophyllene, germacrene D, and α-humulene [32]. A chemical component called paniculacin has been identified from an ethanolic MP extract in the form of a colorless oil [4]. The 58 identified components were validated through phytochemical investigation of the essential oil. Caryophyllene oxide, -elemene, -caryophyllene, spathu-lenol, germacrene D, cyclo-octene, and 4-methylene-6-(1-propenylidene) were the main compounds (Table 2) [33].

Table 2. Major phytoconstituents of MP leave oil [33]

S.No.	Chemical Structure with IUPAC name	Chemical constituent
1.		Caryophyllene oxide
2.		Beta-caryophyllene
3.		Spathulenol
4.		Beta-elemene
5.		Germacrene-D
6.		Cyclotene, 4-methylene-6-(1-propenylidene)

PHARMACOLOGICAL ACTIVITIES

1. Analgesic activity

The analgesic activity of MP bark extracts was evaluated on

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Swiss albino rats, which were elicited from doses of 200 and 400 mg/kg body weight [34]. Other studies found that leaf extracts exhibited antinociceptive activities in rats and mice [35, 36].

2. Anti-diarrheal, bronchodilator, and vasodilator activity

In rabbit tissue preparations, the aqueous ethanolic extracts of MP leaves displayed calcium channel blocking actions, which is effective for treating diarrhea. The spasmolytic action of the extract was discovered at a dose of 0.01-0.3 mg/mL, with an EC_{50} of 0.03610 mg/mL for anti-diarrheal activity. The leaf extract also exhibited bronchodilator and vasodilator activity in rabbits from utilizing isolated tissue preparations [37]. In another study, when the ethanolic MP extract was compared to castor oil, it showed potential anti-diarrheal activity, with a significant reduction in the incidence and severity of diarrhea in an experimental mice model [38].

3. Anti-inflammatory activity

The three types of flavonoids extracted from MP were 5,7,3',4',5'-pentamethoxyflavone (P1), 5,7,3',4'-tetramethoxyflavone (P3), and 5-hydroxy-6,7,8,3',4'-pentamethoxyflavone (P8), which possesses anti-inflammatory action upon nitric oxide inhibition at the dose of 3μM. Ethanolic leaf extracts exhibited anti-inflammatory activity, which was evaluated by using different anti-inflammatory screening models [35, 38, 39]. In one study, the anti-inflammatory activity of total flavonoids of MP (TFMP) was investigated on high glucose-induced H9c2 cells. TFMP exhibited various inhibitory activities on oxidative stress, inflammation, and apoptosis [40].

4. Antioxidant activity

Utilizing DPPH scavenging and other techniques, the antioxidant activity of a methanolic extract of leaves was ascertained. The antioxidant capacity of MP methanol extract was shown to be greater than that of the standard antioxidant (trolox) [41]. Another study looked at the antioxidant activity of MP extracts in water, ethanol, and hexane. According to the data, ethanol extracts at 500 g/mL had a 67.77% antioxidant activity when compared to the standard reference (500 g/mL of alpha tocopherol), which had a 72.24% antioxidant activity [42].

5. Antibacterial activity

The MP leaf extracts exhibited an antibacterial activity on Gram-positive and Gram-negative through the disc diffusion and micro-dilution methods. The extracts contained phenols and flavonoids in high amounts, which contribute to the antibacterial activity [43]. There is notable inhibition of growth of all bacterial strains [44]. Another study found that the flower extract showed a zone of inhibition of bacteria which was measured by high-media scales [45]. An essential oil of MP also possessed antibacterial properties [46]. One study found that ethanolic leaf extract exhibited antibacterial activity against extended-spectrum β-lactamase *Klebsiella pneumoniae*, which causes nosocomial infections and is resistant to beta-lactam antibiotics [47].

6. Anticancer activity

The isolated sterol from MP leaves exhibited antitumor activity against cancer cell lines. The cytotoxic actions of sterols were determined by an MTT assay [48]. In one investigation, the cytotoxic effect of ethyl acetate extracts of MP leaves was investigated on human gingival fibroblasts and monocytes [49]. Different bark extracts according to solvents were tested using a brine shrimp lethality bioassay [50]. In a different study, a flavonoid glycoside isolated from MP twigs was able to inhibit adherence, movement, and invasion of lung adenocarcinoma A549 cells [51].

7. Antifungal activity

Ethanolic and aqueous MP extracts possess antifungal activity against the *Trichophyton rubrum* [45]. One recent study suggested that MP leaf extracts can potentially inhibit fungal growth [52].

8. Anthelmintic activity

In vivo anthelmintic activity was dramatically increased after MP leaves were fed in one study, indicating that gastrointestinal nematodes, growth rates, and hematological abnormalities in goats were reduced [53]. In another study, MP leaf extracts showed anthelmintic activity against *Tricho strongylus* sp., *Haemonchus* sp., and *Cooperia* sp., and the infusion of 7% leaf extracts reduced larval development, infective larvae and adult

trichostronglidae the most effectively [54].

9. Antianxiety and antidepressant activity

The anti-anxiety and anti-depressant properties of several solvent extracts of MP leaf were also recorded. The extract boosted the number of animals entering the anti-anxiety model and decreased immobility in mice in the anti-depression model, according to previous findings [55].

10. Gastroprotective and renoprotective quality

The ethanol extract of MP significantly inhibited ethanol HCl induced gastric lesions and decrease the levels of hormones and cytokines, such as TNF-α, IL-6, IL-1β, MTL and GAS at the high dose. The result suggested that MP protected the gastric mucosa by the expansion of inflammation, and preventing the ethanol-HCl-induced necrosis and apoptosis [56]. Another study found that the extracted total flavonoids from the ethanol extract of the leaves had a protective effect on the kidneys in rats that were hyperlipidemic and had diabetes that had been induced by streptozotocin [57].

11. Anti-obesity activity

Pancreatic lipase activity was inhibited by the ethanolic and aqueous extract of MP leaves, indicating anti-obesity activity [58].

12. Anti-hyperglycemic activity

The anti-diabetic action of hydro alcoholic extract of MP leaves was studied in streptozotocin induced diabetic rats. Reduced blood glucose levels in diabetic rats, which varied depending on the dose, were used to corroborate this effect. The findings revealed that 400 mg/kg of extract was equal to the reference dose of glibenclamide [59]. Another study used an alloxan-induced diabetes model to scrutinize the effects of MPE on blood glucose levels in diabetic and non-diabetic rats. After 14 days of treatment, glucose levels in diabetic rats had decreased. After 21 days of therapy, non-diabetic rats displayed a reduction in blood glucose levels [60]. A hydro-alcoholic extract was given to alloxan-induced diabetic rats at doses of 100, 200, and 400 mg/kg for 60 days. Glycemic, cholesterol, and triglyceride levels were all reduced by the extract. Diabetes-induced morphological changes in the liver, pancreas, and kidney were also decreased. Fructosamine and glycated hemoglobin levels were reduced as well [61].

13. Toxicity studies

The plant was traditionally utilized as a folk medicine. There were no deaths or CNS or ANS toxicity after an acute oral administration of the extract (2,000 mg/kg and 5,000 mg/kg single dose) [62, 63]. In rats, subacute oral administration (100, 200, or 400 mg/kg for 28 days) revealed no effects on body weight, food intake, or water intake [63].

CONCLUSION

MP holds considerable therapeutic potential for conventional and pharmacological management of diseases. Significant research has not yet been conducted on phytoconstituents from MP extracts. Identified phytochemicals should also be subjected to pharmacological investigation to shed light on the molecular processes of these unreported secondary metabolites for the protection human and animal populations from diseases and other health issues. Literature showed that methanol and hydroalcoholic extracts of MP had shown high pharmacological activity. Moreover, a large body of pharmacological research has demonstrated that MP is useful against cancer, diabetes, hyperlipidemia, infections, free radicals, and other diseases. Additionally, no harmful effects have been established by preclinical data. More investigations into the pharmacological and toxicological characteristics of the phytochemicals in MP are required to completely comprehend them. This review suggests further pharmacological investigation into MP to ascertain its therapeutic potential against particular deadly illnesses. Future studies are also required to assess its pharmacological properties, including its toxicity to plants, environmental effects, and other potential uses. Additionally, we anticipate that this review will benefit researchers for their further studies.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest, financial or otherwise.

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