REVIEW ARTICLE

Malvastrum coromandelianum (L.) Garcke: An Invasive Weed with Multiple Ethnopharmacological Properties

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ABSTRACT

Malvastrum coromandelianum (L.) Garcke (Malvaceae) (*M. coromandelianum*) is an invasive alien weed distributed globally in tropics, subtropics, and utilized by diverse ethnic groups of tribal populations as a conventional drug against manifold disorders in multifarious forms like powder, paste, infusion, etc. However, the phytopharmacological data are very scarce on this plant species. The present review mainly focuses on the ethnopharmacological aspects of the title plant based on the bibliographic investigation. The phytochemicals like malvastrone 1, β-sitosterol, stigmasterol, dotriacontanol, campesterol, n-hexadecanoic acid, diosgenin, guanosine, squalene, etc., have been traced and identified in the leaves. The plant holds antiinflammatory, hypoglycaemic, analgesic, larvicidal, antioxidative, antimicrobial, anthelmintic, wound healing, and antidiarrhoeal properties. The new drugs formulated from plant species can switch over many synthetic medicines.

Keywords: Ethnomedicine, *Malvastrum coromandelianum*, Morphology, Pharmacological properties.

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INTRODUCTION

Archaeological findings enlighten the herbalism (the traditional practice of medicinal herbs) about 60,000 and 8,000 years ago in Iraq and China, respectively. But a well-described record of the uses of medicinal plants dates back to 5,000 years on a Sumerian clay tablet with 12 medicinal preparation methods of 250 plant species.[1,2] Because of usefulness, traditional beliefs, and safety as compared to synthetic formulations, awareness towards the use of natural green medication is flourishing globally. Traditional drug preparations currently aid approximately 80% of the world populace for curing their ailments, and the identification of about 9,000 plants in natural habitats has been compiled along with their therapeutic attributes.[3] Unlike synthetic ones, plant-derived drugs are more efficient, cost-effective with minimum side effects, according to traditional practitioners. Marginal farmers and people of tribes in developing nations still believe in folk remedies for curing various illnesses.[4]

The *Malvastrum coromandelianum* (L.) Garcke (false mellow), the native of Tropical America, is considered a highly invasive weed species of family Malvaceae and distributed extensively in tropics and subtropics of the globe. In India, mostly penin-sular and disturbed lands of Western Ghats sea coasts are especially enriched with this plant species.[5] Though, it is found distributed throughout India and reaches up to 1,000 meters elevations in the Himalaya. Many previous studies emphasize the pharmacological potential of this species. The plant has been evaluated for its antifungal, antimicrobial, hepatoprotective, antidysenteric, analgesic, antihemorrhagic, bechic, antiulcerative, antipyretic, antiinflammatory, and stomach ache relieving properties.[6-13]

REVIEW SOURCE

In the present review, the information dealing with pharmacological and ethnomedicinal properties has been compiled by searching different bibliographies available online such as Elsevier, NCBI, PubMed, Google Scholar, Springer, Google Books, etc.

AIM OF STUDY

The present review mainly emphasizes on the ethnopharmacological attributes of *M. coromandelianum* as no earlier review demonstrating its multidimensional ethnopharmacological potential has been published so far.

SYSTEMATIC POSITION AND MORPHOLOGICAL DESCRIPTION

Division: Angiosperms
Clade: Eudicots
Clade: Core eudicots

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Clade: Superrosids
Clade: Rosids
Clade: Malvids
Order: Malvales
Family: Malvaceae
Genus: *Malvastrum*
Species: *M. cormandelianum*

M. coromandelianum is an erect, woody, annual herb, or undershrub, 60 to 90 cm tall. The leaf blade is ovate-lanceolate, petiolate (0.7 to 3 cm), pilose, with lanceolate stipules (5 to 7 mm), dentate margins, and acute apex. The flower is solitary-axillary with pilose pedicel (3 to 5 mm). The calyx is cup-shaped (5 to 7 mm) and accrescent. Petals are yellow and ovate. The fruit is schizocarpic with reniform, 8 to 12 tricuspid mericarps.[14,15] Floral morphology and flowering twig has been represented in Figure 1(a) and Figure 1(b) respectively.

PHYTOCONSTITUENTS WITH BIOACTIVE PROPERTIES

Phytoconstituents are the bioactive secondary metabolites naturally biosynthesized in different plant parts (root, stem, bark, leaf, flower, fruit, seed, etc.) with adequate antioxidant potential to combat diseases and thus, reflect their importance in medicines.[16] The presence of malvastrone 1 (sesquiterpene lactone) possessing antidiarrhoeal features, β-sitosterol (a phytosterol) with antiinflammatory, analgesic, antilipidemic, anthelmintic, and hepatoprotective properties have been reported so far.[11,17] Gas chromatography-mass spectrometry (GC-MS) analysis of *M. coromandelianum* unveiled 29 bioactive compounds, out of which the compounds of main attention are: tris (2,4-di-tert-butylphenyl) phosphate (phenol) as antioxidative; octadecanoic acid as anticancerous, antiinflammatory, hepatoprotective, antiarthritic, antibacterial; 9,12-octadecadienoic acid (Z,Z)-, methyl ester (linoleic acid ester) as antioxidative, antihistaminic, anticholesterolemic, antieczemic; 9,12,15-octadecatrienoic acid, methyl ester, (Z,Z,Z)-(plant growth regulator), n-hexadecanoic acid (palmitic acid) as antioxidative and anticancerous; 7,9-di-tert-butyl-1-oxaspiro (4,5) deca-6,9-diene-2,8-dione (steroid) as hypotensive, antimicrobial, diuretic; diosgenin (steroidal saponin) as hypocholesterolemic, anticancerous, neuroprotective, antidiabetic, antioxidant; guanosine (nucleoside) as neuroprotective and antioxidant; pyridinium, 1-hexadecyl-, chloride, monohydrate (cationic quarternary ammonium compound) as gingivitis inhibitor; squalene (triterpene) as antitumor, chemoprotective, antiatherosclerotic, xenobiotic neutralizer, hypoglycaemic, etc.[18] The chemical components such as campesterol (hypocholesterolemic), β-phenyl ethylamine (antibacterial), stigmasterol, β-sitosterol (hypocholesterolemic, immunological, antiinflamatory, anti-benign prostatic hypertrophy, anticancerous, immuno-modulatory, etc.), N-methyl-β-phenyl ethylamine, dotriacontanol, and dotriacontane have also been detected.[19-22]

Figure 1(a): Floral morphology (A - Flower, B - Epicalyx, C - Splitted calyx (abaxial), D - Calyx lobe (adaxial), E - Petal, F - Staminal column, G - Stamen, H - Pistil, I - Style and stigma, J - Mericarp, K - Seed)

Figure 1(b): Image of *Malvastrum coromandelianum*

ETHNOMEDICINAL USES

The term 'ethnobotany' was proposed by J. W. Harshberger in 1896 for studying plants used by primitive cultural people.[23] This study also supports in appraising therapeutic uses of herbs by different tribes and cultures across the globe. The plant species (*M. coromandelianum*) contributes in mollifying various ailments of tribal people such as the leaves help in checking wound bleeding and soothing dysentery[24]; gastrointestinal disorders, fever, and wounds[25]; enteritis, hepatitis, cough, sore throat, and arthritis[26]; diaphoretic and resolvent in the Eastern Ghats ethnic community[27]; pounded leaves with alcohol or salt in curing ringworm by Kickapoo Indians of Mexico; plant decoction in jaundice by Rajasthan *Bhil* tribe; and leaf infusion in treating diabetes by Mexicans. The plant species is urged to have analgesic, antidysenteric, antiinflammatory, and antimicrobial effects in the Indian traditional medicinal system.[28] The whole plant and leaf poultice help in soothing wounds, sores, and injuries[29,30]; leaf infusion for diabetic treatment in Mexico.[31]

PHARMACOLOGICAL STUDIES

Hypoglycaemic and Hypolipidemic Potential

Hyperglycaemia or diabetes is the repercussion of disturbed metabolism of carbohydrates, proteins, and fat. Statistical estimation indicates that 2.8% population experiences the disease globally, and by 2025 will show increment up to 5.4%.[32] Diabetes also contributes to lipid abnormalities like hyperlipidemia, which shows consequences like obesity atherosclerosis, coronary blockage, cerebral ischemic disorder, or even death.[33] Natural plant medications can be a safer and inexpensive resource in treating hazardous effects, increased blood sugar, and lipid concentration. The oral administration of water extract significantly reduced the level of blood sugar in alloxan-induced diabetic rats at 4 g/kg dose by 13.86, 18.09, and 22.81% than control at 2, 4, and 6 hours, respectively.[34] About 400 mg/kg aqueous extract dose of *M. coromandelianum* significantly ($p < 0.01$) reduced the blood glucose (97 ± 3.21 mg/dL) as well as total cholesterol (118 ± 1.15 mg/dL), HDL cholesterol (43 ± 1.82 mg/dL), and triglyceride level (82 ± 6.67 mg/dL) in Wistar rat within 21 days.[35] However, 1,200 mg/day aqueous extract of the same plant did not effectively lower the glucose (159 ± 53 mg/dL) and HbA1c level (7.8 ± 1.1%) in type 2 diabetes in 12 weeks.[36]

Antioxidative Potential

Antioxidants, in the living system, are the substances to serve as suppressing agents against hindrance created by free radicals.[37] The DPPH (2,2'-diphenyl-2-picrylhydrazyl hydrate) inhibiting activity (%), reported by Devi and Kumar[38] in the plant leaf extract, was more than 90 at 160 µg/mL concentration. The values of antioxidant potential reported by Saxena and Rao[18] were 80.55 ± 1.04 for DPPH (%) at 100 µg/mL concentration, while 69.40 ± 1.18, 55.39 ± 0.61, and 79.67 ± 1.3 for total antioxidant activity (µg AAE/mg extract), Fe^{2+} chelating assay (%), and Fe^{3+} reducing power (µg TE/mg extract), respectively, in methanol leaf extract at 1,000 µg/mL concentration.

Larvicidal Activity

Dengue and chikungunya are very common fevers to human beings spread mainly by *Aedes albopictus* (Asian tiger mosquito), which transmits several arboviruses and was first traced in 1985 in Houston, North America.[39,40] Plant-derived insecticidal formulations may become a substitute for targeting mosquitoes.[41] The acetone leaf extract of *M. coromandelianum* exhibited 0.62 g/L LC_{50} value against *A. albopictus* larvae in concentration-dependent manner.[42] However, no larvicidal activity against *Culex quinquefasciatus* was exhibited by methanol leaf extract.[43] The larval mortality (%) shown against *A. albopictus* third instar larvae by hexane, methanol, dimethyl sulfoxide (DMSO), isopropanol, and acetone leaf extracts of *M. coromandelianum* was 40, 50, < 50, < 50, and 50 along with 0, 337.27, 0, 410.22, and 371.45 LC_{50}, respectively, at 400 ppm concentration.[44]

Antimicrobial Potential

Weeds are equipped with a potent habit to survive in harsh nature and combat against pathogens than the cultivated ones with enormous antimicrobial properties. The whole plant extract in chloroform (6.67%) exhibited effective antibacterial (growth inhibition zone = 11.67 to 15.58 mm against *Bacillus subtilis*; 10.96 to 14.32 mm against *Staphylococcus aureus*; 13.03 to 16.00 mm against *Escherichia coli*, and 10.38 to 15.37 mm against *Proteus vulgaris*), and antifungal potential (growth inhibition zone = 10.19 to 14.25 mm against *Aspergillus niger* and 10.97 to 16.58 mm against *Aspergillus oryzae*).[45] Sittiwet *et al.*[46] reported antibacterial effect of *M. coromandelianum* aqueous extract against methicillin-resistant *S. aureus* (2.5 to 20 mg/mL MIC and 10 to 80 mg/mL MBC); methicillin-sensitive *S. aureus* (2.5 to 5 mg/mL MIC and 10 to 80 mg/mL MBC); *S. aureus* ATCC 29213 (5 mg/mL MIC and 10 mg/mL MBC), and *S. aureus* ATCC 25923 (5 mg/mL MIC and 20 mg/mL MBC). The leaf methanol extract of plant species showed antibacterial efficacy with 100 mg/mL MIC against *S. aureus* 2 (Sa2) strain via agar dilution assay.[20] The zone of inhibition (mm) evaluated was 17 (against *E. coli*) and 18 (against *E. coli*) for hexane; while 10 (against *B. subtilis*) for both hexane and methanol leaf extracts of *M. coromandelianum*, respectively.[47] The effective inhibition zone (cm) was observed in *M. coromandelianum* chloroform and aqueous leaf extracts against *Xanthomonas axonopodis* (3.3 ± 0.10 and 0.7 ± 0.05), *Pseudomonas syringae* (3.5 ± 0.06 and 1.6 ± 0.06), *Corynebacterium minutissimum* (3.1 ± 0.05 and 1.4 ± 0.05), *Clostridium difficile* (3.2 ± 0.11 and 0.9 ± 0.08), *Aspergillus niger* (2.9 ± 0.08 and 2.7 ± 0.11), *Alternaria alternata* (2.2 ± 0.20 and 1.2 ± 0.23), *Drechslera biseptata* (2.4 ± 0.15 and 2.0 ± 0.23), and *Fusarium solani* (2.0 ± 0.02 and 1.5 ± 0.26), respectively.[48] However, no inhibition zone (mm) was reported in methanol, and chloroform leaf extracts.[49]

The study of silver nanoparticles (AgNPs) during the last decade is being widespread because of their immense use in pharmacological and food industries. So, an eco-friendly methodology for nanoparticle synthesis should be considered with a cost-effective, productive, and non-toxic technique.[50,51]

The silver nanoparticles synthesized from aqueous *M. coromandelianum* leaf extract showed 1.6 mm (for *E. coli*), 1.1 mm (for *S. aureus*), and 0.6 mm (for *B. subtilis*) inhibition zone.[52]

Antiinflammatory Potential

Inflammation is a defense reaction in an organism to any tissue damage (atherosclerosis, arthritis, etc.) by suppressing adverse stimuli and soothing the tissues. Traditional medicinal plants with ample antiinflammatory agents in them are still worthy.[53] A significant inhibition (%) was shown by *M. coromandelianum* water extract on carrageenin-induced rat hind-paw edema, i.e., 1.25, 2.64, and 9.43 (after 1-hour), 10.15, 11.47, and 19.24 (after 3 hours), 30.52, 60.70, and 65.31 (after 5 hours) at doses of 50, 100, and 200 mg/kg, respectively.[54]

Wound Healing Property

Cuts and burns on the skin and internal disruptions (ulcers), etc., are the wounds, which severely affect human health. About 80% populace of developing nations use herbal formulations for curing wounds and infections.[55] A significant tensile strength (512.9 ± 12.04 and 546.8 ± 7.27) and increased granuloma weight (55.33 ± 1.07 and 67.19 ± 1.36 mg) with elevated hydroxyproline content (2.93 ± 0.24 and 4.31 ± 0.19 µg/mL) were exhibited by ethanolic (95%) leaf extract of *M. coromandelianum* at 5 and 10% w/v doses in incision wound and dead space wound models, respectively.[56]

Anthelmintic Activity

Helminthiasis is a worsening disease of humans and animals influencing the one-third world population. Since the primeval period, the herbal medications are very fruitful for treating such complaints.[57,58] A significant anthelmintic potential was shown by *M. coromandelianum* methanol leaf extract with better paralysis (within 30 ± 1.34, 23 ± 0.94, 19 ± 0.9, and 18 ± 0.61 minutes) and death activities (within 37 ± 0.18, 34 ± 0.62, 25 ± 0.57, and 24 ± 0.99 minutes) at 25, 50, 75, and 100 mg/mL concentration.[59]

Analgesic and Antinociceptive Properties

Pain is the first response or indication of any illness. Although, in the market, much synthetic pain-relieving drugs are available that impart side effects. The plant-derived secondary metabolites (terpenoids, steroids, etc.) possess excellent analgesic and antinociceptive properties with no side effects when compared to synthetic ones. The acetylsalicylic acid extract of aerial parts of *M. coromandelianum* showed the least writhing count (18 ± 0.86) and writhing inhibition (68.97%) at 200 mg/kg p.o. dose when compared to petroleum ether (writhing count = 44 ± 6.03; inhibition% = 24.14), chloroform (writhing count = 28 ± 1.62; inhibition% = 51.73), acetone (writhing count = 24 ± 5.31; inhibition% = 58.63) and methanol extracts (writhing count = 38 ± 10.12; inhibition% = 34.49) in mice.[60] The *M. coromandelianum* water extract showed significant inhibition of formalin-induced pain by 18.17, 34.63, and 52.97% during the early phase (up to 5 minutes of injection) and by 26.94, 51.00, and 59.68% during the late phase (20–40 minutes after injection) at 50, 100, and 200 mg/kg doses, respectively, in right dorsal hind paw of mice.[54] The hydro-alcoholic plant extract (400 mg/kg dose) exhibited significant analgesic effect as 5.745 ± 0.68 (up to 5 minutes), 5.281 ± 1.19 (up to 1 and 2 hours), and 95.17% by tail-flick, hot-plate method, and acetic acid-induced writhing effect methods, respectively.[61]

Immunomodulatory Effect

In *Ayurveda*, immune system modulation is very prominent for mitigating diseases like neurodegeneration, infertility, etc. The *M. coromandelianum* whole plant extract in ethanol elicited the determination of delayed-type hypersensitivity (DTH) response (1.25 ± 0.36 mm) with 69.62 ± 9.446% neutrophil adherence at 500 mg/kg dose and the total leucocyte count (more or less 15,000) at 1,000 mg/kg dose in Swiss albino mice.[62]

Antidiarrhoeal Potential

Diarrhea is prominently involved in causing a 5 to 8 million-plus mortality rate in children under the age of five each year.[63] The ethanol (95%) leaf extract of *M. tricuspidatum* significantly showed 87.9% defecation inhibition, 34.0 ± 2.5% charcoal meal movement, 1.49% intestinal fluid volume inhibition, and 54% fluid accumulation inhibition (%) for castor oil-induced diarrhea, gastrointestinal motility, magnesium sulfate-induced enteropooling, and castor oil-induced enteropooling assay, respectively, at 500 mg/kg dose.[11]

Hyperaccumulator Property

Apart from excluder plants, 'hyperaccumulator plants' are those who possess potential to accrue one or more heavy metals excessively from the soil without any phytotoxicity in their shoots and leaves (10 to 1,000 folds), and not only confined in the roots.[64] Nazir *et al.*[65] reported the lead (Pb), zinc (Zn), and copper (Cu) concentrations (mg/kg) in *M. cormandelianum* as 16, 17.25, and 13.58 (in shoots); and 37, 18.46, and 23.19 (in roots), respectively. The biological accumulating coefficient (BAC), biological transfer coefficient (BTC), and bioconcentration factor (BCF) values for *M. cormandelianum* were 0.76, 0.43, and 0.75 (for Pb); 0.13, 0.93, and 0.14 (for Zn) and 0.04, 0.58, and 9.12 (for Cu), respectively.

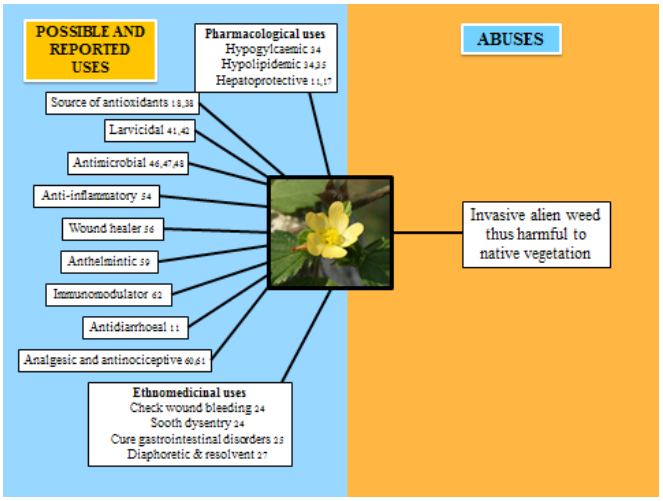

Figure 2: Uses and abuses of *Malvastrum coromandelianum*

Table 1: List of the products of *M. coromandelianum* patented by different researchers

Product	*Inventor*	*Application No.*	*Site search*
Liver cancer medicine	Xian Qifu	CN201711246933 20171121	67
Traditional remedy for thyroid cancer	Bi Enxu; Wang Aihua; Wei Guoqiang; Wang Ying	CN20161307495 20160505	68
Hypoglycaemic composition	Sukanya Jesadanont; Apijade Jesadanont; Mongkol Jesadanont; Kamol Wijitphan	EP1723960A1	69
Remedial shaving cream	Li Qiang	CN20131705714 20131219	70
Antiaging skin formulation with antioxidant	Shibazaki Shizuka; Ochiai Nobuhiko; Kobayashi Koji; Chin Dan	JP20060172583 20060622	71

Sources: https://worldwide.espacenet.com and https://www.lens.org

Medicinal Patent Background

Herbal medicines with unique benefits own a global reputation and are still being ethnopharmacologically explored in developing nations to invent and patent the novel drugs. The conservation of this innovative knowledge of traditional remedies paves the way towards development worldwide.[66] The perusal of literature indicates five different patents awarded/claimed on the formulations based on *M. coromandelianum*. These are provided in Table 1.

CONCLUSION

The present review outlines the multifarious role of the invasive weed, *M. coromandelianum* in the ethnopharmacological field (Figure 2). Various bioactive phytoconstituents *viz.*, campesterol, diosgenin, dotriacontane, octadecanoic acid, β-phenylethylamine, squalene, stigmasterol, β-sitosterol, etc., were marked out that brim the plant with several pharmacological properties such as antibacterial, antifungal, hypoglycemic, hypolipidaemic, anthelmintic, antiinflammatory, larvicidal, etc. The affordability and efficacy of medicinal plants to act as potent pharmacognosist with minimal toxic side-effects as compared to their synthetic counterparts have developed a drift towards the utilization of natural medicinal alternatives. To conclude, various pharmacological aspects of the plant can be utilized by researches, health care providers, and therapeutic industries as a curative agent against various ailments.

FUTURE PROSPECT

M. cormandelianum, like other invasive weeds, is often abused for causing detrimental changes in native vegetation in the entire range of its occurrences. However, our review demonstrates the other side of this herb by suggesting it as a resource of multiple utilities that are widely available. Using the weed plants as medicines sound ridiculous as they are disastrous for nature, and many agencies world over are busy in their eradication programs, but when it comes to their utilization as medicines, their usefulness cannot be fully neglected since they hold extra potent genetic constitution concerning the biosynthesis of phytoconstituents, enzymes and other metabolites of medicinal use than the native ones and thus, survive even in harsh environmental conditions. Identification, authentication, standardization, and application of the bioactive phytoconstituents in therapeutic practices may provide a green and safe remedy as to a substitute for synthetic drugs in the future.

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