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Malvastrum coromandelianum (L.) Garcke: A versatile weed with promising pharmacological applications

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ABSTRACT

Malvastrum coromandelianum (L.) Garcke, commonly known as false mallow, belongs to the family Malvaceae. This invasive alien weed is widely distributed throughout tropical and subtropical regions, where it has become well established due to its resilience and adaptability. Although often regarded as a weed, *M. coromandelianum* possesses significant pharmacological potential, particularly in traditional medicine systems where it has been used for various therapeutic purposes. The plant is a rich source of bioactive compounds such as tannins, flavonoids, alkaloids, and phenolics, all known for their medicinal properties. Recent studies have identified novel bioactive molecules in *M. coromandelianum*, revealing antimicrobial, anti-inflammatory, antioxidant, and anticancer activities. These findings underscore its promise as a source of natural therapeutic agents. However, several challenges hinder its practical application, including variability in phytochemical content, lack of standardization in herbal formulations, and the need to ensure safety and efficacy in clinical settings. Further research is required to elucidate its mechanisms of action, optimize its therapeutic use, and integrate it into modern pharmacological practices. This review aims to consolidate current knowledge, highlight its medicinal potential, and provide direction for future research.

Keywords: Antioxidant activity, Bioactive compounds, Flavonoids, Phenolics, Phytochemical content.

INTRODUCTION

Malvastrum coromandelianum (L.) Garcke, commonly known as Coromandel False Mallow, is an annual herb widely used in traditional medicine, particularly for treating wounds, inflammation, and digestive disorders [1, 2]. Also referred to as *Malva coromandelica*, it has a long-standing role in Indian and Sri Lankan ethnomedicine. Its wound-healing efficacy has been substantiated by recent studies [3, 4]. Modern research has begun to validate these traditional claims by exploring the plant's phytochemical and pharmacological properties. Integrating traditional knowledge with scientific evidence enhances the credibility of natural remedies in modern medicine. Ecologically, *M. coromandelianum* is adaptable and found in tropical Africa, across Asia (notably India and Southeast Asia), and parts of the Americas. Despite its medicinal value, it can be invasive in certain regions, necessitating ecological monitoring [4]. Phytochemical investigations reveal that *M. coromandelianum* contains flavonoids, alkaloids, and other bioactive compounds, contributing to its anti-inflammatory, analgesic, and gastroprotective effects [5]. Its antioxidant properties suggest potential roles in managing oxidative stress-related disorders [6, 7].

Traditionally, the plant has been used for treating rashes, respiratory conditions, and diabetes [8]. Notably, zinc nanoparticles synthesized from its extracts have demonstrated hepatoprotective effects by modulating antioxidant enzymes and reducing oxidative and inflammatory damage [9]. To validate its efficacy and ensure safety for contemporary use, traditional applications must be supported by systematic scientific studies [10, 11].

This review aims to identify and characterize the phytochemicals in *M. coromandelianum*, evaluate its therapeutic efficacy with a focus on anti-inflammatory and antioxidant activities, and emphasize the integration of traditional knowledge with modern scientific methods in drug discovery. These insights are particularly relevant considering the global burden of inflammation and oxidative stress-related diseases. The fusion of traditional knowledge with modern approaches such as metabolomics, genomics, and bioinformatics is reshaping medicinal plant research. This trend not only helps preserve traditional practices but also opens new avenues for drug development.

Phytochemical Composition

Phytochemical analysis of *M. coromandelianum* leaf extracts using solvents of varying polarity reveals significant differences in phenolic and flavonoid contents (Table 1). Solvent polarity plays a vital role, with aqueous methanol and methanol being particularly effective [12]. Aqueous acetone also yields good

results [13], while non-polar solvents like chloroform and petroleum ether are less effective. Thus, polar solvents are preferred for isolating antioxidant constituents for medicinal purposes.

Pharmacological Activities

M. coromandelianum demonstrates a wide range of biological activities, including anti-inflammatory, antimicrobial, antioxidant, analgesic, hepatoprotective, and pharmacognostic effects (Table 2; Figure 1). Aqueous and ethyl acetate extracts have shown anti-inflammatory and antibacterial activities in experimental models such as carrageenan-induced paw edema and the formalin-induced pain test [13, 14].

Phytochemical screening has identified compounds such as β-sitosterol, flavonoids, tannins, and phenolic constituents, which are linked to its antioxidant and antimicrobial effects. GC-MS analysis has revealed 29 bioactive compounds, including terpenoids, fatty acids, vitamins, and phenols, which support the plant's traditional applications.

Green-synthesized zinc oxide nanoparticles from *M. coromandelianum* have exhibited hepatoprotective and antioxidant properties by mitigating oxidative stress in animal models [13]. A polysaccharide extract from the plant has also demonstrated potent antioxidant activity [15].

Network pharmacology and chemoinformatic analyses further support the plant's potential in anti-aging, anti-inflammatory, and antioxidant therapies [14]. These findings collectively highlight the therapeutic promise of this plant in the development of natural drugs.

Bioactive Compounds and Therapeutic Effects

The therapeutic potential of *M. coromandelianum* is attributed to a diverse array of phytochemicals (Table 3; Figure 2). β-sitosterol, abundant in the leaves, is associated with analgesic, anti-inflammatory, and anticancer activities [16 - 20]. Apigenin derivatives offer neuroprotective, cardioprotective, and antimicrobial benefits [21 - 24].

Fatty acids such as 9,12,15-octadecatrienoic acid possess pronounced anti-inflammatory and antioxidant properties [25 - 28]. Diosgenin has been recognized for its anticancer, neuroprotective, and hypoglycemic effects [29 - 32]. Other bioactive compounds, including squalene, vitamin E, and phytol, contribute to antioxidative, anti-aging, and antimicrobial actions [33 - 49]. Altogether, these phytochemicals affirm the pharmacological potential of *M. coromandelianum* as a valuable source of natural bioactive agents.

Nanoparticle Biosynthesis

Green synthesis of nanoparticles using *M. coromandelianum* provides an eco-friendly and sustainable alternative to conventional methods. Plant extracts from various parts have been employed to synthesize silver, zinc oxide, and magnesium oxide nanoparticles. These extracts serve both as reducing and stabilizing agents due to their rich phytochemical content.

Advanced characterization techniques such as UV-Vis, FTIR, XRD, SEM, TEM, and DLS confirm their nanoscale properties. These nanoparticles display strong antimicrobial activity against *Escherichia coli* and *Staphylococcus aureus* [50]. They also show antioxidant and hepatoprotective effects in CCl_4-induced liver injury models [9] and exhibit antiviral and mosquitocidal activity against the dengue virus and its vectors [51].

Given their wide range of bioactivities, these nanoparticles hold promise for applications in biomedicine, drug delivery, catalysis, and environmental remediation [52]. However, further research is necessary to fully assess their biocompatibility, cytotoxicity, and long-term safety.

Table 1: Phytochemical composition in leaves of *M. coromandelianum* (L) Garcke

S. No.	Solvent	Phytochemical analysis		References
		Total Phenolic Content (mg GAE/g or µg GAE/mg extract)	**Total Flavonoid Content** (mg QE/g or equivalent)	
1.	Methanol	45.25±3.48	78.12±2.45	Sanghai et al. [12]
2.	Acetone	41.78±7.86	35.42±1.98	
3.	Chloroform	29.54±2.36	22.30±1.56	
4.	Petroleum ether	15.25±1.25	11.78±0.95	
5.	Aqua Methanol (AM)	88.45±1.72	54.60±1.12	Saxena and Rao [13]
6.	Aqua Acetone (AA)	67.50±1.58	43.35±0.98	

Table 2: Pharmacological activities of *M. coromandelianum* (L) Garcke

S. No.	Activity	Solvents	Plant Part used	Reference
1.	Ant inflammatory	Aqueous	Whole plant	Sanghai et al. [12]; Aderogba et al. [22]; Yadav and Mohite [14]
2.	Analgesic	Aqueous, Alcohol-water	Whole plant	Sanghai et al. [12]; Bhupesh et al. [53]
3.	Antinociceptive	Alcohol-water	Areal parts	Reddy et al. [54]; Sanghai et al. [12]
4.	Larvicidal and ovicidal	Methanol	Leaves	Saxena et al. [4]; Irudayaraj and Fabiola [55]
5.	Anthelmintic	Methanol	Leaves	Yadav and Mohite [56]; Saxena et al. [4]
6.	Anti-Mycobacterial	Methanol	Leaves	Aderogba et al. [12]
7.	Antiulcer	Ethanol	Whole plant	Balekar et al. [57]; Saxena et al. [4]
8.	Hemolytic	Methanol	Roots	Sheema et al. [5]

9.	Antidiabetic	Aqueous	Leaves	Andrade-Cetto and Heinrich [58]; Deore et al. [8]
10.	Antidiarrheal	Ethanol	Leaves	Balekar et al. [59]; Saxena et al. [4]
11.	Anticancer	Methanol	Whole plant	Yadav and Mohite [56]
12.	Antioxidant	Aqueous, Aqua methanol, Acetone	Leaves	Saxena and Rao [13]; Yadav and Mohite [14]
13.	Antibacterial and antifungal	Ethyl acetate, Ethanol, Chloroform, Hexane, DMSO, Aqueous	Areal parts, Leaves	Yadav and Mohite [14]; Sheema et al. [5]

Table 3: Bioactive compounds reported in *M. coromandelianum* (L) Garcke

S. No.	Name of compound	Chemical formula	Plant part	Biological activity	References
1.	β-sitosterol	$C_{29}H_{50}O$	Leaves	Analgesic, anthelminthic, antimutagenic, anti-inflammatory, antihepatotoxic, anti-cancer and antiviral	Sanghai et al. [12]
2.	Apigenin-7-O-β-6″ (p-coumaroyl)-glucopyranoside	$C_{30}H_{26}O_{12}$	Leaves	Anti- inflammatory, antimycobacterial, neuroprotective, cardioprotective, and intestinal protection	Aderogba et al. [22]
3.	1,2-benzenedicarboxylic acid	$C_8H_6O_4$	Leaves	Antimicrobial, neuroprotective, cytotoxic, antioxidant	Saxena and Rao [13]
4.	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	Leaves	Antimicrobial, anti-inflammatory, antitumor, antioxidant	Saxena and Rao [13]
5.	3-Bromocholest-5-ene	$C_{30}H_{50}Br$	Leaves	Antifungal and cytotoxic	Saxena and Rao [13]
6.	4H-pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl	$C_6H_8O_4$	Leaves	Antioxidant, anti-inflammatory, skin health benefits	Saxena and Rao [13]
7.	Diosgenin	$C_{27}H_{42}O_3$	Leaves	Anticancer, anti-inflammatory, antioxidant, neuroprotective, hypolipidemic and hypoglycemic, antimicrobial and immunomodulatory, antidiabetic, cardioprotective, osteogenic, antithrombotic	Saxena and Rao [13]
8.	9,12,15-octadecatrienoic acid, (Z,Z,Z)	$C_{18}H_{30}O_2$	Leaves	Anti-Inflammatory, antioxidant, antimicrobial, neuroprotective, antidepressant, antitumor and cardiovascular benefits	Saxena and Rao [13]
9.	9,12,15-octadecatrienoic acid, methyl ester,(Z,Z,Z)	$C_{19}H_{32}O_2$	Leaves	Anti-Inflammatory, antioxidant and antimicrobial	Saxena and Rao [13]
10.	γ-sitosterol	$C_{29}H_{50}O$	Leaves	Antihyperglycemic, anticancer, anti-inflammatory	Saxena and Rao [13]
11.	Guanosine	$C_{10}H_{13}N_5O_5$	Leaves	Neuroprotective, antiprotozoal, immunostimulatory, neuronal Differentiation and anticancer	Saxena and Rao [13]
12.	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	Leaves	Antioxidant, antihypocholestermic, anti-inflammatory and antibacterial	Saxena and Rao [13]
13.	Neophytadiene	$C_{20}H_{38}$	Leaves	Anti- inflammatory, anxiolytic-like and anticonvulsant	Saxena and Rao [13]
14.	Octadecanoic acid	$C_{18}H_{36}O_2$	Leaves	Antimicrobial, anti- inflammatory, antioxidant, anticancer and lipid metabolism and mitochondrial function	Saxena and Rao [13]
15.	Phenol, 2,4-Bis (1,1-dimethylethyl)	$C_{17}H_{30}OSi$	Leaves	Antimicrobial, anti- inflammatory, antioxidant, cytotoxic, anticancer, phytotoxic, insecticidal and nematicidal	Saxena and Rao [13]
16.	Phytol	$C_{20}H_{40}O$	Leaves	Antimicrobial, anti-quorum sensing, cytotoxic,	Saxena and Rao [13]

				immunoadjuvants, antinociceptive, antitumor, anticonvulsant, anti- inflammatory, anxiolytic, anticandidal, antioxidant and antihyperpigmentation	
17.	Squalene	$C_{30}H_{50}$	Leaves	Antioxidant, anti-Inflammatory, antiviral and anticancer	Saxena and Rao [13]
18.	Vitamin E	$C_{29}H_{50}O_2$	Leaves	Anti-inflammatory, antioxidative, cardiovascular health and anti-aging	Saxena and Rao [13]
19.	Sabinene	$C_{10}H_{16}$	Leaves	Antimicrobial, antioxidant, angiostatic, antiangiogenic, anti-inflammatory, anticancer	Irudayaraj and Fabiola [55]
20.	Limonene	$C_{10}H_{16}$	Leaves	Anticancer, anti-inflammatory, antioxidant,neuroprotective, antimicrobial, antileishmanial, anthelmintic and insecticidal	Irudayaraj and Fabiola [55]
21.	Caryophyllene	$C_{15}H_{24}$	Leaves	Anti-inflammatory, antimicrobial, immunomodulatory, analgesic, anticancer, neuroprotective, antioxidant	Irudayaraj and Fabiola [55]
22.	Naphthalene	$C_{10}H_8$	Leaves	Anti-inflammatory, antimicrobial, antioxidant, antiproliferative, anticancer, anticandidal, and antidiabetic	Irudayaraj and Fabiola [55]
23.	Bicyclogermacrene	$C_{15}H_{24}$	Leaves	Antimicrobial, antioxidant, cytotoxic and anti-inflammatory,	Irudayaraj and Fabiola [55]
24.	Spathulenol	$C_{15}H_{24}O$	Leaves	Antioxidant, anti-inflammatory, antiproliferative, antimycobacterial, antimicrobial, anticholinesterase, antinociceptive, anti-hyperalgesic, insecticidal and antitumor	Irudayaraj and Fabiola [55]
25.	Ledol	$C_{15}H_{26}O$	Leaves	Antimicrobial, anti-inflammatory, insecticidal, antioxidant, cytotoxic and analgesic	Irudayaraj and Fabiola [55]
26.	2-Hydrazinopyridine	$C_5H_7N_3$	Leaves	Anticancer, antibacterial and antioxidant	Irudayaraj and Fabiola [55]
27.	Tiliroside [kaempferol-3-O-β-d-(6″-E-p-coumaryl) glucopyranoside]	$C_{30}H_{26}O_{13}$	Leaves	Antidiabetic, anti-inflammatory, antioxidant, anticarcinogenic, hepatoprotective	Devi and Kumar [60]
28.	Quercetrin (quercetin 3-O-α-l-rhamnopyranoside)	$C_{21}H_{20}O_{11}$	Leaves	Antioxidant, antibacterial, wound healing, immunomodulatory and antiviral	Devi and Kumar [60]
29.	Propiophenone	$C_9H_{10}O$	Leaves	Antioxidant and anti-inflammatory	Irudayaraj and Fabiola [55]
30.	Nonanoic acid	$C_9H_{18}O_2$	Root	Antialgal, antimicrobial and anticancer	Sheema et al. [5]
31.	Oleic Acid	$C_{18}H_{34}O_2$	Root	Antioxidant, anti-inflammatory, antimicrobial, anticancer	Sheema et al. [5]
32.	Eicosane	$C_{20}H_{42}$	Root	Antioxidant, antifungal, anti-inflammatory, neuroprotective, wound healing	Sheema et al. [5]
33.	Ar-turmerone	$C_{15}H_{20}O$	Root	Anti-malignant, anti-aging, anti-inflammatory, anticancer, antioxidant, antivenom, antifungal, insecticidal, hepatoprotective, hypoglycemic	Sheema et al. [5]

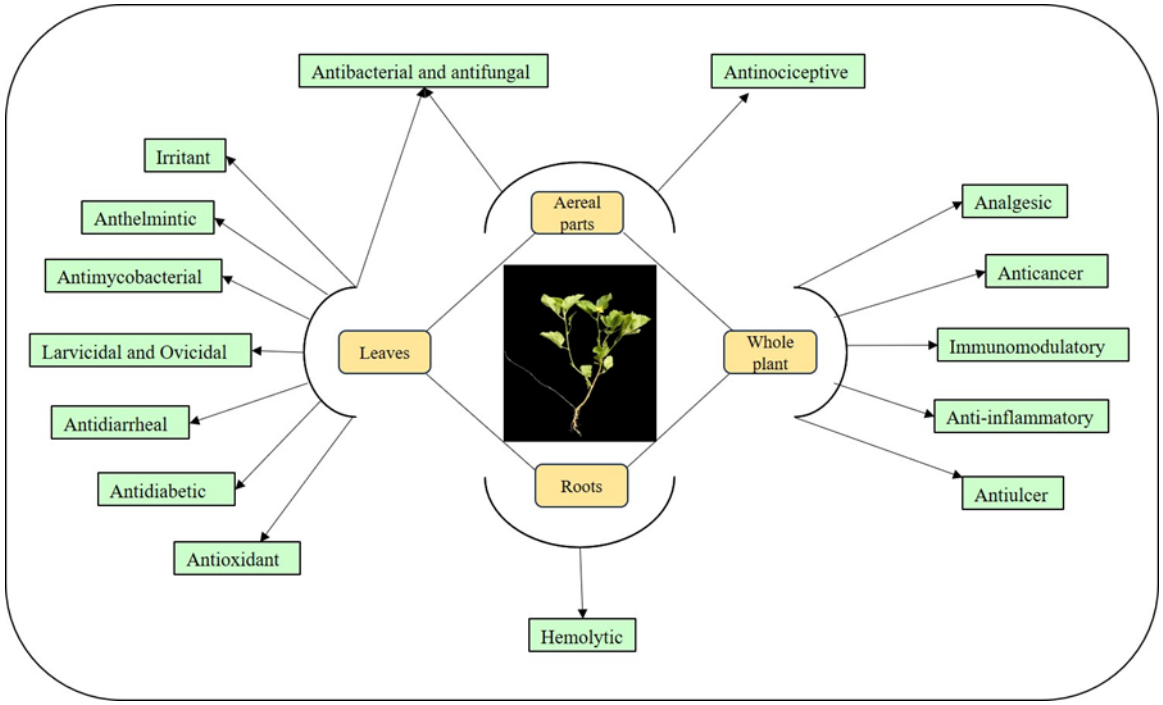

Figure 1: Pharmacological activities of *M. coromandelianum* (L) Garcke

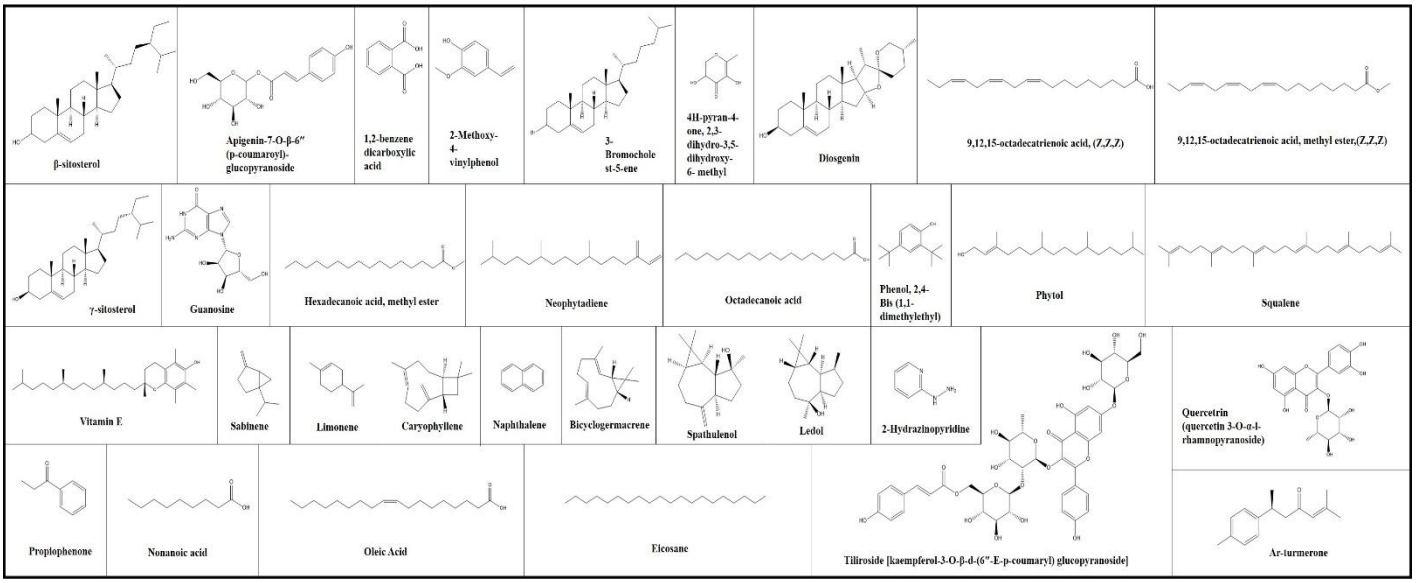

Figure 2: Chemical structures of reported compounds present in *M. coromandelianum* (L) Garcke

CONCLUSION

M. coromandelianum is a traditionally significant medicinal plant with a diverse phytochemical profile that substantiates its widespread ethnopharmacological uses. The presence of bioactive compounds such as flavonoids, β-sitosterol, fatty acids, and saponins underlies its broad spectrum of pharmacological activities, including anti-inflammatory, antioxidant, antimicrobial, and hepatoprotective effects. Recent advances in green nanotechnology using *M. coromandelianum* extracts have expanded its therapeutic potential, particularly in synthesizing biocompatible nanoparticles with promising biomedical applications. The integration of traditional knowledge with modern scientific validation techniques, including phytochemical profiling and network pharmacology, is critical for advancing *M. coromandelianum* from folk medicine to evidence-based therapeutic use. However, despite encouraging preliminary data, further comprehensive studies particularly *in vivo* and clinical trials are essential to confirm its safety, efficacy, and mechanistic pathways. Given the global rise in diseases linked to inflammation and oxidative stress, *M. coromandelianum* holds considerable promise as a source of novel bioactive compounds and sustainable nanomaterials. Continued interdisciplinary research will not only deepen understanding of its pharmacological mechanisms but also promote the sustainable utilization of this versatile plant in modern healthcare and environmental applications.

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Conflict of interest

The authors declared no conflict of interest.

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