The Biobrio ISSN : 2393-9508 e-ISSN: 2582-4902
An International Quarterly Journal of Life Sciences
Website: www.thebiobrio.in SJIF: 8.525
13(1&2): 1792-1795, 2026

Ethnomedicinal uses and pharmacological potential of *Mentha* species: From traditional knowledge to modern therapeutics

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Received : 12th April, 2026 ; Accepted : 12th May, 2026
DOI:- https://doi.org/10.5281/zenodo.21212062

ABSTRACT

Mentha species (family Lamiaceae) are aromatic medicinal plants widely used in traditional medicine due to their rich content of essential oils, phenolics, flavonoids and terpenoids. They have been traditionally employed to treat gastrointestinal, respiratory, microbial, dermatological, and neurological disorders. Scientific studies have demonstrated their antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anticancer and neuroprotective activities. This review summarizes the ethnomedicinal uses, pharmacological properties, and therapeutic potential of *Mentha* species, highlighting their importance as promising natural resources for pharmaceutical and nutraceutical applications.

Key Words - *Mentha*, ethnomedicine, pharmacology, medicinal plants, menthol

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INTRODUCTION

Medicinal plants have long been used in traditional healthcare systems due to their therapeutic potential. Among them, the genus *Mentha* (family Lamiaceae) is widely recognized for its aromatic properties and medicinal value. Species such as *Mentha arvensis*, *M. spicata*, *M. longifolia*, and *M. aquatic, M. piperita*, have been traditionally used in Ayurveda, Unani, Traditional Chinese Medicine, and other folk systems to treat digestive, respiratory, skin, and inflammatory disorders. Their therapeutic effects are mainly attributed to bioactive compounds including menthol, menthone, carvone, flavonoids, and phenolic acids, which exhibit antimicrobial, anti-inflammatory, antioxidant, and other pharmacological activities. This review summarizes the ethnomedicinal uses, pharmacological properties, and therapeutic potential of *Mentha* species, highlighting their significance in modern medicine and natural product research.

Ethnomedicinal Importance of *Mentha* Species

Mentha species have long been utilized in traditional healthcare systems, including Ayurveda, Unani, Traditional Chinese Medicine, and European folk medicine, owing to their diverse therapeutic properties. Their therapeutic properties are mainly attributed to essential oils and other bioactive compounds, including menthol, menthone, flavonoids, phenolic acids, and terpenoids. Traditionally, mint has been used to manage digestive, respiratory, dermatological, neurological, and microbial disorders. Major ethnomedicinal applications of *Mentha* species are summarized in Table 1. The diverse ethnomedicinal applications of *Mentha* species have been supported by pharmacological studies demonstrating anti - oxidant, antimicrobial, anti - inflammatory, analgesic, and neuroprotective activities. These findings validate their long-standing use in traditional healthcare systems and highlight their potential in modern therapeutic applications.

Table 1. Traditional ethnomedicinal uses of *Mentha* species

Traditional use	Common disorders treated	Major active compounds	Therapeutic effects
Gastrointestinal disorders	Indigestion, flatulence, nausea, vomiting, abdominal pain, irritable bowel syndrome	Menthol, menthone	Carminative, antispasmodic, digestive stimulant
Respiratory disorders	Common cold, cough, bronchitis, asthma, sinusitis, nasal congestion	Menthol, cineole, limonene	Decongestant, expectorant, bronchodilator, soothing
Microbial infections	Bacterial, fungal and oral infections	Menthol, carvone, phenolics	Antimicrobial, antiseptic
Dermatological disorders	Minor burns, insect bites, itching, skin irritation	Menthol, rosmarinic acid, flavonoids	Cooling, anti-inflammatory, wound soothing
Neurological disorders	Headache, stress, anxiety, mental fatigue	Menthol, essential oils	Analgesic, calming, cognitive enhancement

PHARMACOLOGICAL ACTIVITIES

Mentha species exhibit diverse pharmacological activities owing to the presence of bioactive compounds such as menthol, rosmarinic acid, flavonoids, terpenoids, and phenolic acids. These compounds contribute to antioxidant, antimicrobial, anti-inflammatory, anticancer, and antidiabetic effects, supporting the traditional medicinal use of mint (Table 2).

Table 2. Major pharmacological activities of *Mentha* species

Activity	Major bioactive compounds	Mechanism of action	Therapeutic significance	References
Antioxidant	Rosmarinic acid, caffeic acid, luteolin, eriocitrin	Scavenges free radicals, inhibits lipid peroxidation, enhances antioxidant defense	Protects against oxidative stress and chronic diseases	Dorman *et al*., 2003; McKay & Blumberg, 2006; Mimica-Dukić & Božin, 2008
Antimicrobial	Menthol, menthone, carvone, phenolics	Disrupts microbial cell membranes and inhibits microbial growth	Effective against bacteria and fungi; useful in pharmaceutical and food applications	Mimica-Dukić & Božin, 2008
Anti-inflammatory	Menthol, rosmarinic acid, flavonoids	Suppresses inflammatory mediators (IL-1β, TNF-α, IL-6) and reduces oxidative stress	May help manage inflammatory disorders	Sharma & Tyagi, 2013
Anticancer	Rosmarinic acid, luteolin, apigenin, carvacrol	Induces apoptosis, inhibits cell proliferation and angiogenesis	Shows promising in vitro anticancer activity	Bhalla *et al.,* 2013
Antidiabetic	Phenolics, flavonoids, menthol	Improves insulin sensitivity, glucose uptake and antioxidant status	May support diabetes management	McKay & Blumberg, 2006; Mahboubi, 2018; Salehi *et al.,* 2018

Table 3. Major bioactive compounds of *Mentha* species and their mechanisms of action

Bioactive compound	Major mechanism of action	Pharmacological effects	References
Menthol	Activates TRPM8 receptors; relaxes smooth muscles; disrupts microbial membranes	Cooling sensation, decongestant, antispasmodic, antimicrobial	Eccles, 1994; Eccles, 2003
Menthone	Modulates smooth muscle activity and contributes to antimicrobial action	Digestive aid, antimicrobial, respiratory relief	Mahboubi, 2018
Rosmarinic acid	Neutralizes reactive oxygen species (ROS) and prevents lipid peroxidation. suppresses TNF-α, IL-1β and IL-6	Antioxidant, anti-inflammatory, tissue protection	Dorman *et al.,* 2003; Mimica-Dukić & Božin, 2008
Flavonoids (Luteolin, Apigenin)	Neutralize free radicals; inhibit inflammatory signaling; induce apoptosis	Antioxidant, anti-inflammatory, anticancer	Bhalla *et al.,* 2013; Sharma & Tyagi, 2013
Carvone	Disrupts microbial cell membranes and inhibits microbial growth	Antimicrobial, digestive support	Mimica-Dukić & Božin, 2008
Limonene	Modulates oxidative stress and inflammatory pathways	Antioxidant, anti-inflammatory, respiratory support	Mahboubi, 2018
Phenolic compounds	Chelate metal ions, scavenge free radicals and enhance endogenous antioxidant enzymes	Antioxidant, antidiabetic, cytoprotective	McKay & Blumberg, 2006; Salehi *et al.,* 2018

Overall, the pharmacological activities of *Mentha* species support their traditional medicinal applications and highlight their potential as natural sources for the development of pharmaceutical and nutraceutical products. However, further clinical studies are required to establish their efficacy and safety in humans.

Additionally, the therapeutic effects of *Mentha* species are mainly attributed to bioactive compounds such as menthol, rosmarinic acid, flavonoids, and terpenoids, which act through multiple molecular mechanisms. The major compounds and their mechanisms of action are summarized in Table 3.

CLINICAL PROSPECTS AND CHALLENGES

Mentha species have shown promising therapeutic potential in preclinical studies due to their antioxidant, antimicrobial, anti-inflammatory, anticancer, and antidiabetic properties. However, most evidence is derived from in vitro and animal studies, with limited clinical trials in humans. Variations in phytochemical composition among species, lack of standardized formulations, uncertainty regarding optimal dosage, and limited information on long-term safety and bioavailability remain major challenges. Future research should focus on well-designed clinical trials, standardization of herbal preparations, pharmacokinetic studies, and safety evaluation to establish the efficacy and therapeutic potential of *Mentha*-based products in modern medicine.

FUTURE PERSPECTIVES

Future research shall focus on the development of standardized Mentha-based formulations, large-scale clinical trials, and comprehensive safety evaluations to validate their therapeutic efficacy. Advances in nanotechnology may improve the bioavailability and targeted delivery of mint-derived bioactive compounds. In addition, the growing use of Mentha in functional foods, nutraceuticals, and natural drug discovery offers promising opportunities for its application in modern healthcare.

CONCLUSION

Mentha species are valuable medicinal plants with diverse ethnomedicinal uses and scientifically validated pharmacological activities. Their rich phytochemical composition contributes to antioxidant, antimicrobial, anti-inflammatory, anticancer, and antidiabetic effects, highlighting their potential for pharmaceutical and nutraceutical applications. Further clinical validation and standardized formulations are essential to facilitate the integration of Mentha-based products into evidence-based healthcare.

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