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REVIEW ARTICLE: THE THERAPEUTIC POTENTIAL OF *MICROMERIA BIFLORA*: A COMPREHENSIVE REVIEW

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ABSTRACT

Plants constitute a rich source of secondary metabolites and novel therapeutic compounds that naturally enhance human health with controlled adverse effects. Natural products play a vital role in the pharmacological and commercial industries, producing numerous healthcare and medicinal products such as antimicrobial agents, anti-tumor agents, hepatoprotective agents, cardiotonics, CNS stimulants, and nutraceuticals. Additionally, important bioactive clusters such as alkaloids, flavonoids, saponins, terpenoids, polysaccharides, and tannins present in plants significantly contribute to various biological activities in traditional and modern therapeutic principles.

KEYWORDS: Plants constitute a rich source of secondary metabolites and novel therapeutic compounds that naturally enhance human health with controlled adverse effects.

INTRODUCTION

Natural products continue to serve as the molecular basis for drug discovery and development. Compounds present in plants contain molecular skeletons of high interest for breakthrough discoveries (Ezzatzadeh et al., 2012). In the current era of healthcare revolution, a biologically guided approach to the phytochemical investigation of medicinal plants holds great potential for yielding new compounds of remarkable interest in the cure, prevention, and management of emerging diseases. The introduction of newer technologies

has brought safety and toxicological issues of using plant extracts or herbal medicine for disease management into focus. Extensive phytochemical investigation, biological activity screening, and isolation of pure compounds have evolved from a necessity to a requirement for curing and managing diseases with better drug efficacy and minimized side effects (Jin-Mang et al., 2003).

However, in some cases, extensive phytochemical analysis of plants with no significant traditional therapeutic use can yield chemical constituents of notable therapeutic value. This may be because the traditionally used chemical constituents were ineffective for therapy.

Literature Review

Phytochemical Composition and Biological Activities

Josphat et al. (2007) analyzed the hydro-distilled essential oil from *Micromeria biflora* growing in Kenya using gas chromatography-mass spectrometry (GC-MS). They identified twenty-two compounds, constituting 99.29% of the total oil, with a high percentage of linalool (50.60%). Other major monoterpenes included α-terpineol (2.80%), β-ocimene (2.25%), β-pinene (1.96%), and cis-linalool oxide (1.91%). The oil showed antimicrobial activity against both gram-positive and gram-negative bacteria, except for *Pseudomonas aeruginosa*, and marked antifungal activity against *Candida albicans*.

Rohit et al. (2010) found that the essential oil obtained from the leaves of *Micromeria biflora* was rich in thymol (54%), iso-thymol (9.9%), gurjunene (3.3%), and β-caryophyllene (6.6%). The oil exhibited excellent antibacterial activity against *Streptococcus mutans* with a minimum inhibitory concentration (MIC) of 0.15 mg/mL and an IC50 of 0.10 mg/mL, and was less effective against *Lactobacillus acidophilus*.

Okach et al. (2013) conducted a phytochemical screening of *Micromeria biflora* and revealed the presence of sterols, terpenoids, tannins, saponins, alkaloids, flavonoids, and glycosides in the stems, leaves, and roots.

Mahesh et al. (2013) identified sixteen compounds contributing to 91.9% of the total essential oil of *Micromeria biflora*, with oxygenated sesquiterpenoids dominating the composition. The oil and extract demonstrated good to moderate pharmacological activity in anti-inflammatory, analgesic, and antipyretic activities on Swiss albino mice.

Muhammad Aurang et al. (2015) investigated the antibacterial activity of various fractions of *Micromeria biflora*. All fractions showed activity against fungal species, with the chloroform fraction exhibiting the highest activity against *Fusarium oxysporum*. The n-hexane fraction showed the widest inhibition zone against *Streptococcus*, while the chloroform fraction was very effective against *Staphylococcus aureus* and *Streptococcus*.

Ghias Uddin et al. (2016) reported the antinociceptive activity of *Micromeria biflora* methanolic extract (MBM) and water extract (MBW). Both extracts exhibited significant inhibition of noxious stimulation due to acetic acid-induced pain and showed significant DPPH free radical scavenging activity.

Abdur Rauf et al. (2017) examined the antibacterial, cytotoxic, and phytotoxic profiles of *Micromeria biflora*. The results revealed marked susceptibility of both the crude extracts and aqueous fractions against *Klebsiella pneumoniae* and *Bacillus subtilis*, with significant cytotoxicity and phytotoxic effects observed.

Kirti Nagarkoti et al. (2023) analyzed the essential oil (EO) of *Micromeria biflora* and found it to be dominated by E-caryophyllene, geranial, neral, and caryophyllene oxide. The EO showed excellent insecticidal, nematicidal, antifeedant, antimicrobial, and herbicidal activities, as well as antioxidant and anti-amylase activities.

Fakhria (2024) assessed the effectiveness of *Micromeria biflora* against acute arthritic manifestations using formaldehyde and Complete Freund's Adjuvant in Sprague-Dawley rats. The results demonstrated the plant's ability to treat arthritis, showing significant reductions in paw volume, arthritic score, and histological characteristics, along with reduced levels of inflammatory and oxidative stress markers.

Aljohani (2022) isolated salicylalazine from *Micromeria biflora* and evaluated its analgesic, muscle relaxation, sedative, and anti-inflammatory properties. Salicylalazine exhibited significant analgesic potential, muscle relaxation, and sedation, along with anti-inflammatory activity in both initial and late phases of edema.

Abdur Rauf (2024) explored the synthesis and characterization of iron nanoparticles (NPs) using *Micromeria biflora* extract. The NPs exhibited significant inhibitory effects against urease, CA-II, and XO, along with superior anti-inflammatory and analgesic effects compared to the extract.

CONCLUSION

Micromeria biflora demonstrates a wide range of pharmacological activities, including antimicrobial, anti-inflammatory, analgesic, antinociceptive, cytotoxic, and antioxidant effects. The extensive phytochemical investigations have revealed the presence of various bioactive compounds, such as monoterpenes, sesquiterpenes, flavonoids, tannins, and saponins, contributing to its therapeutic potential. The plant's ability to treat arthritis, along with its significant anticancer and insecticidal properties, further underscores its value in modern medicine. Continued research and exploration of *Micromeria biflora* may yield new compounds of remarkable interest for drug discovery and development.

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