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Research Article

Antioxidant potential of flowers of *Moringa oleifera* Lam.: a solvent-based comparative study

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Abstract: *Moringa oleifera* is a widely cultivated medicinal tree known for its rich phytochemical composition and diverse therapeutic properties. While leaves, pods and seeds have been extensively studied, limited information is available regarding the antioxidant potential of its flowers. Present study aimed to evaluate the *in vitro* antioxidant activity of hydroethanolic, methanolic and ethanolic extracts of *M. oleifera* flowers using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay. Extracts were tested at varying concentrations and the percentage inhibition of DPPH radicals was determined spectrophotometrically. Among them, the methanolic extract showed comparatively higher radical scavenging potential, followed by the ethanolic and hydroethanolic extracts. The observations point that the flowers of *M. oleifera* possess appreciable antioxidant properties and warrant further phytochemical investigation.

Keywords: Antioxidants, medicinal plants, *Moringa*, therapeutics

Introduction

Medicinal plants have played a fundamental role in traditional healthcare systems across cultures for centuries and continue to serve as valuable sources of therapeutic agents (Wachtel-Galor and Benzie, 2011). Among them, domestically cultivated plants hold particular importance, as they are readily available in household gardens and local surroundings, making them practical and sustainable options for preventive and curative uses (Ofosu-Bamfo et al., 2023). Many of these plants are rich in bioactive secondary metabolites such as phenolics, flavonoids, alkaloids and terpenoids, which contribute to their pharmacological properties (Riaz et al., 2023). One of the key therapeutic attributes of medicinal plants is their antioxidant potential. Oxidative stress, resulting from an imbalance between reactive oxygen species (ROS) and the body's antioxidant defence mechanisms, is implicated in the development of various chronic diseases, including diabetes, cardiovascular disorders, neurodegenerative conditions and cancer (Pizzino et al., 2017). Plant-derived antioxidants, particularly polyphenols and flavonoids, can scavenge free radicals, donate hydrogen atoms or electrons, and chelate metal ions, thereby mitigating oxidative damage and supporting cellular health (Bas, 2026). Consequently, the exploration of natural antioxidants from plant sources has gained significant scientific interest as per recent trends (Rahaman et al., 2023).

Figure 1: Inflorescence of *Moringa oleifera*

Moringa oleifera (Figure 1), often called as the 'drumstick tree', 'miracle tree' or the 'tree of life', is a multipurpose, versatile, drought-resistant and nutrient-rich tree native to the Indian subcontinent (Panova et al., 2025). Every part of the tree, including leaves, seeds, pods, bark and flowers, has potential and proven pharmacological (Shil, 2021), nutritional and fodder value because of which, it is a popular and frequently cultivated species among both the domestic and commercial sectors (Alavilli

et al., 2022). It is widely recognized as a rich source of natural antioxidant metabolites. Various parts of the plant have been reported to contain diverse polyphenolic compounds, particularly flavonoids such as quercetin, kaempferol, myricetin, rutin and isorhamnetin, along with phenolic acids including gallic acid, caffeic acid, ferulic acid, protocatechuic acid and sinapic acid (Alam et al., 2022). The presence of such bioactive secondary metabolites focuses on the therapeutic importance of *M. oleifera* and justifies further investigation of its less explored parts, including the flowers, for antioxidant activity.

Plate 1: a) Flowers of *Moringa oleifera*; b) Collected sample and c) Ethanolic, hydroethanolic and methanolic extracts of the sample

Methodology

Flowers of *Moringa oleifera* were collected from nearby Mahanadi areas of Cuttack district, Odisha, India (Figure 1). The plant species was identified by the authors, followed by published literature (Saxena and Brahmam, 1994). The flowers were carefully washed with tap water to remove dust and adhering particles. Further, they were dried in shade to remove excess water content and then were subjected to maceration using different solvents, such as hydroethanol (1:1), methanol and ethanol

(Plate 1). The antioxidant activity of *Moringa oleifera* flower extracts was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay following Baliyan et al., (2022) with minor modifications. A 0.1 mM DPPH solution was prepared in methanol and wrapped in aluminium foil to protect from light. Various concentrations of hydroethanolic, ethanolic and methanolic extracts were prepared in their respective solvents. 1 mL of DPPH solution was mixed with the required volume of extract and the final volume was adjusted to 3 mL. 1 mL DPPH mixed with 2 mL methanol was used as a control. Sample blanks containing extract and solvent (without DPPH) were used to correct for background absorbance. The reaction mixtures were incubated in the dark at room temperature for 20 minutes and the absorbance was measured at 517 nm using a UV-Visible spectrophotometer. The percentage of radical scavenging activity was calculated using the formula. A percentage inhibition versus concentration graph was plotted using the resultant data.

$$\% \text{ Inhibition} = \frac{A_0 - A_s}{A_0} \times 100$$

Where, A_0 is the absorbance of the control and A_s is the absorbance of the sample after blank correction.

Results and discussion

Antioxidants are responsible for protecting the cells against oxidative damage caused by the accumulation of free radicals (Pham-Huy et al., 2008). Polyphenols, mainly flavonoids and phenolic compounds, are responsible for the antioxidant production and potent activity by neutralizing the free radicals (Pandey and Rizvi, 2009). They can be found abundantly in flower parts playing roles of natural pigments, UV filters and antioxidants (Ciupei et al., 2024). The antioxidant activity of *Moringa oleifera* flower extracts was evaluated using the DPPH radical scavenging assay as a preliminary screening method. Among the three tested extracts, the methanolic extract exhibited the highest radical scavenging activity, followed by the ethanolic and hydroethanolic extracts. The results of the assay are presented in Figure2. All the extracts showed concentration-dependent radical scavenging activity, with percentage inhibition increasing as concentration increased.The methanolic extract showed 51.29 % inhibition at 0.5 mg/mL, which increased to 69.40 % at 1 mg/mL and reached 99.94 % at 50 mg/mL. Similarly, ethanolic extract demonstrated 48.13 %, 50.84 % and 94.54 % inhibition at 0.5, 1.0 and 50 mg/mL concentration. In comparison, the hydroethanolic extract showed relatively lower activity at lower concentrations, with 12.93 % and 25.81% inhibition at 0.5 and 1 mg/mL, although inhibition increased substantially to 80.53 % at 50 mg/mL. The standard antioxidant quercetin (Figure 3), exhibited consistently high radical scavenging activity within the tested range (8.33 - 66.67 µg/mL), showing inhibition values between 96.85 % and 97.50 %. The high activity of quercetin confirms the validity and sensitivity of the assay system. Differences observed among the extracts may be attributed to variations in solvent polarity, which influence the extraction efficiency of antioxidant phytoconstituents such as phenolics and flavonoids (Chandimali et al., 2025). The higher inhibition observed in the methanolic and ethanolic extracts suggested facilitation of better extraction of compounds in polar solvents. The findings indicated that *Moringa oleifera* flowers possess

measurable antioxidant potential and the extraction solvent plays a vital role in determining the extent of activity.

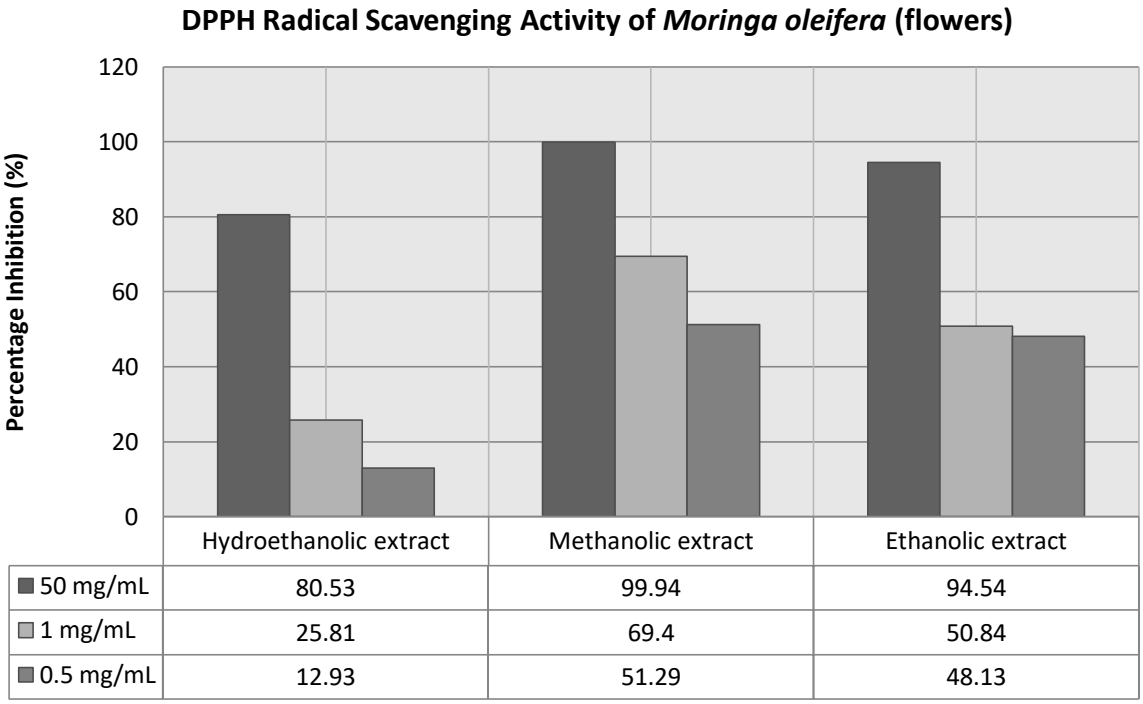

Figure 2: Percentage inhibition against concentration showing DPPH free radical scavenging activity of different extracts of *Moringa oleifera* (flowers)

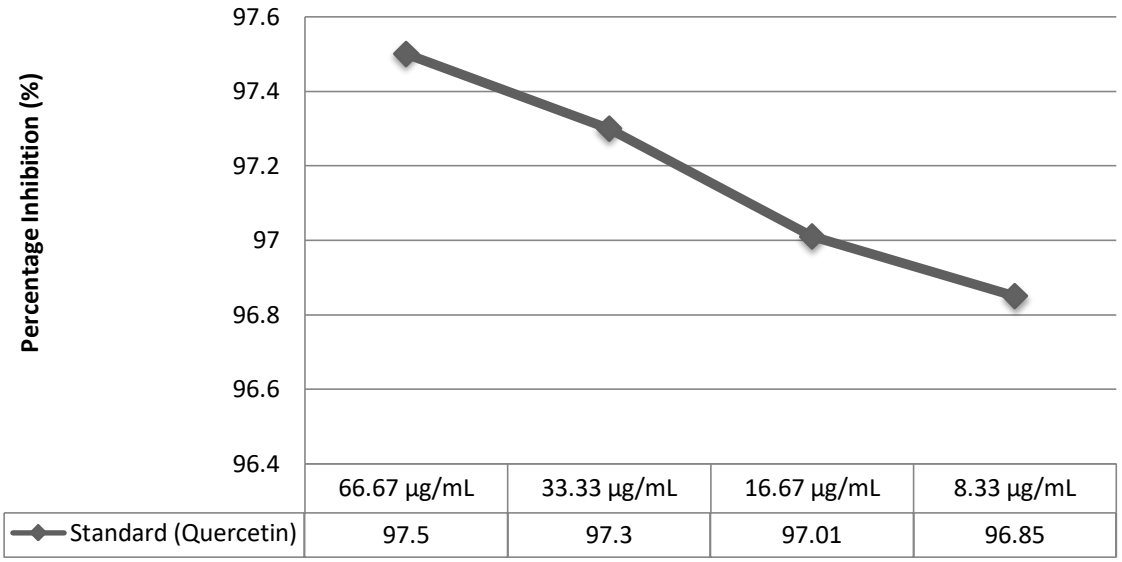

Figure 3: Percentage inhibition against concentration showing DPPH free radical scavenging activity of standard (Quercetin)

Research gaps

As this study represents a preliminary evaluation, further investigations using a broader range of concentrations and detailed phytochemical analysis are warranted to better characterize the antioxidant properties of the flower extracts.

Conclusion

Moringa oleifera flower extracts possess measurable antioxidant activity as determined by the DPPH radical scavenging assay. All the tested extracts in present study exhibited concentration-dependent inhibition of DPPH radicals, indicating the presence of bioactive compounds capable of donating hydrogen atoms or electrons to neutralize free radicals. Among the evaluated solvents, the methanolic extract showed comparatively higher radical scavenging activity, followed by the ethanolic extract. The hydroethanolic extract showed relatively lower activity at the tested lower concentrations. These findings suggest that solvent polarity influences the extraction of antioxidant constituents from *M. oleifera* flowers. Further exploration in the context of its antioxidant potential can help better understand its chemistry, use in pharmacology and green medicine.

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