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Phytochemical and pharmacological profiling of *Nymphoides hydrophylla* leaves, flowers, and roots

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The increasing demand for novel, plant-based therapeutics has led to the exploration of bioactive compounds in medicinal plants. This study investigates the antioxidant, antidiabetic, cytotoxic, and phytotoxic activities of methanolic extracts obtained from the leaves, flowers, and roots of *Nymphoides hydrophylla* (locally known as Kumudu), an aquatic medicinal plant. Standardized bioassays were employed, including the Ferric Reducing Antioxidant Power (FRAP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays for antioxidant activity, the α-glucosidase inhibition assay for antidiabetic potential, the brine shrimp lethality assay for cytotoxicity, and the lettuce seed (*Lactuca sativa*) germination assay for phytotoxicity. Plant materials were cleaned, shade-dried, powdered, and extracted with methanol using ultrasonication. The resulting extracts were filtered, concentrated via rotary evaporation, and vacuum-dried. FRAP analysis revealed that the leaf extract exhibited the highest antioxidant activity (683.38 ± 0.03 µmol $FeSO_4$ g^{-1}), followed by the flower (641.95 ± 0.08 µmol $FeSO_4$ g^{-1}) and root extracts (65.62 ± 0.01 µmol $FeSO_4$ g^{-1}), in comparison to the standard Trolox (1692.19 ± 0.10 µmol $FeSO_4$ g^{-1}). In the DPPH assay, the floral extract demonstrated the strongest radical scavenging activity ($IC_{50} = 123.95 \pm 8.56$ mg L^{-1}), followed by leaves (213.05 ± 4.17 mg L^{-1}) and roots (553.28 ± 3.48 mg L^{-1}), all less effective than the positive control, ascorbic acid ($IC_{50} = 7.90 \pm 0.10$ mg L^{-1}). The leaf extract showed moderate α-glucosidase inhibitory activity ($53.94 \pm 1.22\%$), compared to the reference inhibitor, acarbose ($76.67 \pm 0.46\%$). In the brine shrimp lethality assay, both the leaf ($LC_{50} = 654.26 \pm 27.21$ mg L^{-1}) and floral ($LC_{50} = 159.19 \pm 28.81$ mg L^{-1}) extracts demonstrated low cytotoxicity relative to potassium dichromate ($LC_{50} = 7.97 \pm 0.97$ mg L^{-1}). Phytotoxicity testing at 1000 mg L^{-1} revealed that the floral extract exerted the strongest inhibitory effect on lettuce seedling growth, with root and shoot inhibition rates of $84.23 \pm 2.24\%$ and $47.98 \pm 9.67\%$, respectively. The leaf extract inhibited root and shoot growth by $73.17 \pm 8.66\%$ and $21.34 \pm 0.40\%$, while the root extract showed limited activity, with $24.09 \pm 4.30\%$ root inhibition and no significant effect on shoot growth. The minimum inhibitory concentration (MIC) of the positive control, abscisic acid, was effective at concentrations as low as 5–10 ppm. These findings suggest that *N. hydrophylla*, particularly its leaves and flowers, exhibits antioxidant, antidiabetic, and phytotoxic properties, encouraging further investigation into its bioactive constituents for pharmaceutical and agrochemical applications.

Keywords: *α-glucosidase inhibition, DPPH assay, FRAP assay, Phytotoxicity, Cytotoxicity*