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Physiological and phytochemical responses of *Matthiola incana* L. to salinity stress: insights into biochemical and metabolic adaptation

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Abstract

Matthiola incana L. is an ornamental plant with recognized phytochemical and antioxidant potential. However, limited information is available regarding its integrative physiological and metabolic responses to salinity stress. Therefore, this study investigated the effects of increasing salinity levels on growth performance, biochemical traits, antioxidant activity, and metabolite profiles of *M. incana*.

Methods: Plants were exposed to four irrigation salinity levels (2, 4, 6, and 8 dS m⁻¹). Growth characteristics, photosynthetic pigments, soluble carbohydrates, proline accumulation, anthocyanin content, and DPPH radical scavenging activity were evaluated. Metabolic alterations induced by salinity stress were further analyzed using LC-MS and GC-MS techniques.

Results: Moderate salinity (6 dS m⁻¹) significantly increased biomass and fresh weight by 11.58% and 38.99%, respectively, compared with the baseline salinity treatment (2 dS m⁻¹). Soluble carbohydrate and proline contents also increased markedly under moderate salinity conditions, indicating osmotic adjustment responses. Anthocyanin accumulation was highest at 4 dS m⁻¹, whereas DPPH radical scavenging activity progressively increased with increasing salinity. In contrast, high salinity (8 dS m⁻¹) significantly reduced chlorophyll a, chlorophyll b, total chlorophyll, and carotenoid contents. Metabolomic analyses revealed salinity-induced changes in organic acids, phenolic compounds, flavonoids, and antioxidant-related metabolites, including scopoletin, hydroxycaffeic acid, ferulic acid, and ascorbic acid.

Conclusion: The results demonstrate that *M. incana* exhibits physiological and metabolite-associated responses under moderate salinity conditions through osmotic regulation and enhanced antioxidant-related metabolism. These findings provide new insights into salinity-responsive biochemical metabolic in ornamental Brassicaceae species.

Keywords Ornamental plant, Salt stress, Tolerance, Scavenging activity, LC-MS

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