MANSOURA JOURNAL OF BIOLOGY
Official Journal of Faculty of Science, Mansoura University, Egypt
E-mail: scimag@mans.edu.eg ISSN: 2974-492X

Proximate composition and secondary metabolites of *Reichardia tingitana* (L.) Roth under coastal and desert habitats

Nazar Ali Khalaf, Ghada A. El-Sherbeny, Ibrahim A. Mashaly, and Mohamed Abdelaal*

Botany Department, Faculty of Science, Mansoura University, Mansoura 35516, Egypt
**** Correspondence to:** Email, mohamed_eco@mans.edu.eg, Tel: 01117370673*

Received:11/6/2025
Accepted: 23/6/2025

Abstract : Reichardia tingitana (L.) Roth is a wild edible and medicinal plant widely distributed across coastal and arid regions of North Africa and the Mediterranean basin. This study investigated and compared the proximate composition and secondary metabolite profiles of R. tingitana collected from coastal and desert habitats to assess its ecological adaptability and bioactive potential. Coastal specimens exhibited significantly higher moisture (10.15%), ash (6.88%), fibers (22.19%), protein (16.44%), and lipid content (3.5%) compared to desert plants, which showed elevated carbohydrate levels (55.1%), reflecting physiological adjustments to arid conditions. Phytochemical analysis revealed that coastal plants had greater concentrations of total phenolics (135.23 mg GAE/g) and flavonoids (56.14 mg CE/g), whereas desert samples accumulated more alkaloids (15.36%) and tannins (4.8 mg TAE/g). Saponin levels were relatively consistent across both habitats. These findings highlight the species' biochemical plasticity in response to environmental stress and underline its potential value as a source of nutraceutical and therapeutic compounds. The study supports the ecological significance and pharmacological promise of R. tingitana across contrasting habitats.

keywords: Phytochemistry, coastal habitat, arid conditions

1.Introduction

In order to deal with abiotic stresses including dryness, excessive salt, and temperature variations, plants that live in harsh environments—such as saline and desert habitats—have developed amazing adaptation mechanisms [1,2]. The generation of secondary metabolites is one of these adaptations that is essential for improving plant fitness and survival. Although they are not directly engaged in primary growth and development, secondary metabolites including total phenols, flavonoids, alkaloids, and tannins are essential for defense against pathogen attacks, herbivory, and environmental stresses [3,4]. These substances are a focus of study in plant biology and natural product chemistry due to their substantial ecological and pharmacological significance [5,6].

Reichardia tingitana (L.) Roth is an annual herbaceous plant belonging to the Asteraceae family, widely distributed across Mediterranean and arid regions including North Africa, the Middle East, and parts of southern Europe **(Figure 1)**. Adapted to saline and disturbed soils, it plays a role in soil stabilization and is commonly found in coastal and arid habitats. Morphologically, it is recognized by its rosette-forming leaves and bright yellow, dandelion-like flowers. Phytochemical analyses reveal that R. tingitana contains flavonoids, phenolic acids, tannins, and sesquiterpene lactones, which contribute to its notable antioxidant and antimicrobial activities. The plant also demonstrates allelopathic effects and potential for phytoremediation in saline soils. Recent pharmacological studies suggest that extracts from *R. tingitana* exhibit promising anticancer and hepatoprotective effects, supporting its use in traditional medicine and its growing importance in drug discovery research [[7–9].

The current study provides a comprehensive comparison of the secondary metabolites profile of *R. tingitana* across two habitats: coastal and arid habitats.

2. Materials and methods

2.1 Plant collection

The investigation was conducted in two different ecosystems in Egypt: saline and desert. Saline coastal habitat stretches along the deltaic Mediterranean coastline area, which is characterized by high salinity, and arid habitat extends along the interior desert in Egypt's Eastern Desert.

Figure 1. Morphology of *Reichardia tingitana*.

2.2. Proximate composition

The proximate composition of *Reichardia tingitana* was determined following standard [10] methods. Moisture content was measured by oven drying at 105°C until a constant weight was achieved, while ash content was obtained by incinerating samples at 550°C in a muffle furnace. Crude fiber was estimated through sequential acid and alkali digestion, and crude lipid was extracted using a Soxhlet apparatus with petroleum ether. Protein content was determined using the Kjeldahl method and calculated by multiplying total nitrogen by a factor of 6.25. Carbohydrate content was obtained by difference from the sum of other components [10].

2.3. Phytochemical analysis

The total phenols were measured using the Folin-Ciocalteu assay [11]. The flavonoid content was evaluated using the aluminum chloride assay [12]. For tannins, the vanillin-hydrochloride technique was employed [13]. The amount of alkaloids was measured using an ammonium hydroxide solution [14]. The quantity of saponins was determined by means of consecutive solvent extractions.

3. Results and Discussion

3.1. Proximate Composition of *R. tingitana*

The proximate composition of *Reichardia tingitana* varied significantly between coastal and desert habitats (Figure 2). Moisture content was significantly higher in coastal samples (10.15 ± 1.05%) compared to desert samples (5.66 ± 0.44%). Similarly, the ash content was greater in coastal plants (6.88 ± 0.90%) than in desert ones (4.57 ± 0.67%). Coastal plants also exhibited higher fiber content (22.19 ± 1.16%) than desert plants (10.56 ± 2.10%). Lipid and protein contents followed the same trend, with coastal samples containing 3.5 ± 0.46% lipids and 16.44 ± 1.09% proteins, while desert samples had 1.8 ± 0.02% and 12.5 ± 1.46%, respectively. In contrast, carbohydrate content was higher in desert plants (55.1 ± 1.44%) compared to coastal plants (45.7 ± 1.18). The observed variations in the proximate composition and secondary metabolite profiles of Reichardia tingitana between coastal and arid habitats provide insights into the species' ecological adaptability and physiological responses to environmental stress. These differences are consistent with known patterns in halophytes and xerophytes, which modulate their biochemical makeup in response to abiotic pressures such as drought, salinity, temperature fluctuations, and nutrient availability [15,16]. The significantly higher moisture content in coastal R. tingitana plants (10.15%) compared to desert plants (5.66%) reflects the relative water abundance and higher soil water retention capacity typical of coastal ecosystems. In contrast, the reduced moisture in desert specimens is a typical xerophytic adaptation to aridity, where plants maintain lower tissue water content to minimize transpirational loss [17]. The elevated ash content in coastal plants suggests higher uptake of minerals, possibly due to better soil fertility or increased ion availability in coastal saline soils [18].

Conversely, the higher carbohydrate content observed in desert plants (55.1%) may indicate a physiological adaptation to osmotic stress. Accumulation of soluble carbohydrates under arid conditions has been widely documented as a strategy to maintain cellular osmotic balance and protect macromolecules against desiccation [19]. These sugars also serve as an energy reserve for stress recovery and contribute to ROS scavenging [20]

3.2. Secondary metabolites of *R. tingitana*

Secondary metabolite profiling of *R. tingitana* also revealed habitat-based variation **(Figure 2)**. Coastal plants exhibited significantly higher levels of total phenolic compounds (135.23 mg GAE/g) and flavonoids (56.14 mg CE/g) than desert plants (90.1 mg GAE/g and 30.15 mg CE/g, respectively), suggesting enhanced antioxidant potential in the coastal habitat. In contrast, alkaloid content was greater in desert plants (15.36%) compared to coastal ones (12.1%). Tannin content was slightly elevated in desert samples (4.8 mg TAE/g) relative to coastal ones (4.55 mg TAE/g), while saponin content remained relatively stable across habitats (2.1% in coastal and 2.0% in desert samples).

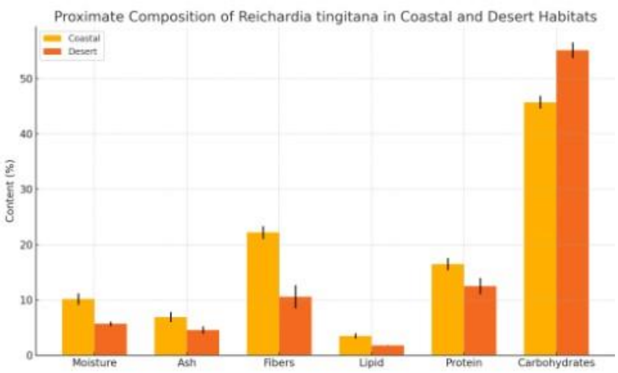

Figure 2. Proximate composition of *R. tingitana.*

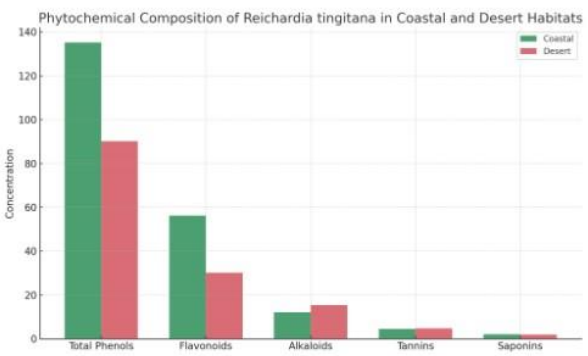

Figure 3. Secondary metabolites (mg/g) of *R. tingitana*.

The secondary metabolite profile of *R. tingitana* also revealed habitat-linked differences, which are likely driven by abiotic stress conditions. Coastal plants exhibited significantly higher levels of total phenols (135.23 mg GAE/g) and flavonoids (56.14 mg CE/g) compared to their desert counterparts (90.1 mg GAE/g and 30.15 mg CE/g). These phenolic compounds are key antioxidant molecules that contribute to the scavenging of reactive oxygen species (ROS), UV protection, and defense against herbivory [21]. The higher accumulation in coastal habitats may be linked to high salinity and light intensity, both of which are known to stimulate phenolic biosynthesis [22].

Interestingly, desert plants showed higher alkaloid content (15.36%) than coastal ones (12.1%), which may reflect an adaptive response to harsher abiotic stressors such as drought and high temperature. Alkaloids are nitrogenous compounds involved in plant defense and stress resistance, particularly in nutrient-poor environments where nitrogen allocation is tightly regulated [23]. Tannins, although relatively stable across habitats, were slightly elevated in desert plants, supporting their role in oxidative stress mitigation and herbivore deterrence [24].

Saponin levels remained relatively unchanged, which may indicate that their biosynthesis is constitutive rather than strongly inducible by environmental conditions. However, saponins also contribute to plant defense and membrane stabilization under stress, and their consistent presence in both habitats confirms their functional importance in *R. tingitana's* chemical ecology [25].

Collectively, the chemical variability observed between coastal and desert populations of *R. tingitana* suggests a high degree of metabolic plasticity, allowing this species to thrive under diverse and challenging ecological conditions. These biochemical traits not only reflect environmental adaptation but also highlight the species' potential as a source of bioactive compounds with pharmacological applications.

In conclusion, this study demonstrates that Reichardia tingitana exhibits significant variation in both proximate and secondary metabolite composition between coastal and arid habitats, reflecting its adaptive biochemical plasticity. Coastal plants showed higher levels of moisture, proteins, lipids, fibers, and antioxidant-related compounds such as phenolics and flavonoids, indicating favorable growth conditions and enhanced metabolic activity. In contrast, desert plants accumulated higher carbohydrates and alkaloids, likely as a response to water scarcity and environmental stress. These findings underscore the ecological resilience of R. tingitana and highlight its potential as a nutritionally and pharmacologically valuable plant species. Further research is recommended to explore its bioactive constituents and their functional applications in food, health, and environmental biotechnology.

4. References

1. Hasegawa, P.M., et al. (2000). Plant cellular and molecular responses to high salinity. Annual Review of Plant Biology, **51**:463–499.
2. Zhu, J.K. (2001). Plant salt tolerance. Trends in Plant Science, **6(2)**:66–71.
3. Akula, R., & Ravishankar, G.A. (2011). Influence of abiotic stress signals on secondary metabolites in plants. Plant Signaling & Behavior, **6(11)**:1720–1731.
4. Sharma, A., et al. (2022). Role of flavonoids and phenolics in plant resistance to abiotic stress. Biologia Plantarum, **66(3)**:1–15.
5. Dixon, R.A. (2001). Natural products and plant disease resistance. Nature, **411(6839)**:843–847.
6. Wink, M. (2003). Evolution of secondary metabolites from an ecological and molecular phylogenetic perspective. Phytochemistry, **64(1)**:3–19.
7. El-Amier, Y.A., et al. (2020). Evaluation of the allelopathic activity and ecological role of Reichardia tingitana. *Egyptian Journal of Botany*, **60(1)**:1–12.
8. Khafagi, I.K., et al. (2022). Antioxidant and anticancer activity of Reichardia tingitana extracts. *Journal of Applied Pharmaceutical Science,* **12(3)**:87–94.
9. Kamel, M.M., et al. (2023). Phytochemical screening and hepatoprotective activity of R. tingitana. Pharmaceutical Biology, **61(1)**:12–21.
10. AOAC (2005). Official Methods of Analysis (18th ed.). Association of Official Analytical Chemists.
11. Wolfe, K.L., et al. (2003). Antioxidant activity of apple peels. *Journal of Agricultural and Food Chemistry,* **51(3):**609–614.
12. Zhishen, J., et al. (1999). Determination of flavonoid contents. Food Chemistry, **64(4)**:555–559.
13. Burlingame, B. (2000). Food composition data. FAO/INFOODS Guidelines.
14. Harborne, J.B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd Ed., Springer.
15. Ashraf, M., & Harris, P.J.C. (2013). Photosynthesis under stressful environments. Photosynthetica, **51(2):**163–190.
16. Ksouri, R., et al. (2007). Ecophysiological and phytochemical variability in Tunisian halophytes. Acta Physiologiae Plantarum, **29(5)**:439–449.
17. Chaves, M.M., et al. (2003). How plants cope with water stress. Functional Plant Biology, **30(3)**:239–264.
18. Wang, B., et al. (2020). Mineral nutrition of halophytes in saline environments. Ecological Indicators, 110:105903.
19. Tardieu, F. (2012). Any trait or trait-related allele can confer drought tolerance. *Journal of Experimental Botany*, 63(1):25–31.
20. Bolouri-Moghaddam, M.R., et al. (2010). Sugars and plant stress. *Journal of Experimental Botany***,** **61(2)**:3987–4006.
21. Michalak, A. (2006). Phenolic compounds and oxidative stress. Polish *Journal of Environmental Studies*, **15(2)**:523–530.
22. Khan, N.A., et al. (2011). Salinity-induced changes in phenolics. Plant Physiology and Biochemistry, **49(6)**:684–692.
23. Züst, T., & Agrawal, A.A. (2017). Trade-offs between plant growth and defense. Current Biology, **27(17)** 34-44.
24. Barbehenn, R.V., & Constabel, C.P. (2011). Tannins in plant–herbivore interactions. Phytochemistry, **72(13)**:1551–1565.
25. Augustin, J.M., et al. (2011). Saponins: biosynthesis and role in plant defense. Phytochemistry, **72(13)**:1409–1424.