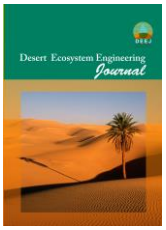
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Investigation of some phytochemical and morphological traits of the medicinal plant *Anvillea garcinii* subsp. *radiata* in the rangeland ecosystem of Darab City

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Extended Abstract

Introduction: Rangelands are vital ecosystems that provide forage and high-value by-products such as medicinal plants. Given population growth and limited forage resources, promoting medicinal plants, beekeeping, ecotourism, and aquaculture is essential. Identifying medicinal plants is a fundamental step toward sustainable development. *Anvillea garcinii* is a perennial shrub from the Asteraceae family, native to southern and southeastern Iran, with traditional uses for wound healing, dysentery, and liver disorders. Its aerial parts contain phenolics, flavonoids, and sesquiterpene lactones, which exhibit anti-diabetic, anti-inflammatory, hepatoprotective, anti-HIV, antifungal, and antioxidant properties. Essential oil analysis has revealed bornyl acetate (33.7%), cis-nerolidol (7.3%), and camphene (6.1%) as major compounds. Despite extensive global research on its phytochemistry, Iranian ecotypes remain understudied. Therefore, this study aims to compare the phytochemical and morphological traits of *A. garcinii* across two natural habitats in Darab, Fars province. The results will provide baseline data for domestication and pharmaceutical exploitation.

Materials and Methods: This study investigated two natural habitats (Dolatabad and Cement Factory) of the medicinal plant *Anvillea garcinii* subsp. *radiata* in Darab County, Iran. Geographic coordinates and altitude were recorded using a GPS device. Along four 100-m transects, 40 plots (2×1 m) were established to measure morphological traits, including canopy cover, plant height, inflorescence length, and number of flowering branches. Soil physicochemical properties (pH, EC, texture, organic matter, calcium carbonate, and CEC) were also analyzed. Chlorophyll fluorescence parameters (Fo, Fm, Fv, Fv/Fm, Tm, and Fv/Fo) were measured using a fluorimeter. Elemental analysis (Fe, Mn, Cu, and Zn) of plant samples was performed by atomic absorption spectrometry after dry ashing. Phytochemical analysis involved methanolic extraction via a Soxhlet apparatus. The extracts were analyzed using GC- FID and GC-MS with an HP- 5MS column to identify chemical constituents. Compounds were characterized based on retention indices and mass spectral comparison with NIST libraries. These comprehensive analyses provide baseline data for domestication and pharmaceutical exploitation of this medicinal plant in Iran's rangelands.

Results and Discussion: Phytochemical analysis of *Anvillea garcinii* from two habitats in Darab (Dolatabad and Cement Factory) revealed 31 distinct compounds. In Dolatabad, the major compounds included 3- Oxatricyclo [4.2.0.0^{24}] octan- 7- one (29.52%), 4- Nonenenitrile (9.009%), and 2- Ethyl- 3- methyl- 4, 6- diphenylpyridine (7.85%). In the Cement Factory habitat, the dominant compounds were Octadecenoic acid (Z)- (17.30%) and Hexadecanoic acid methyl ester (8.73%). Morphological analysis showed an average plant cover of 33.10%, a

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density of 5 bases per unit, a mean height of 28 cm, a crown diameter of 54.50 cm, an inflorescence length of 19.70 cm, and 25 flowering branches. Elemental analysis indicated elevated levels of manganese (632 mg/kg), copper (56 mg/kg), and nickel (95 mg/kg) near the cement factory, suggesting industrial impact and potential phytoremediation capability. Photosynthetic traits showed significant stress-induced differences: Dolatabad exhibited a normal Fv/Fm (0.66) but a very low performance index (PI = 0.01), while the Cement Factory showed a damaged photosystem II (Fv/Fm = 0.34) but higher PI (0.38) and electron sink capacity (Area = 330,655), indicating compensatory mechanisms. Overall, habitat conditions strongly influence phytochemical diversity, fatty acid versus terpenoid profiles, and physiological responses. Dolatabad samples showed superior pharmaceutical potential, with higher diversity (35 compounds) and bioactive terpenes, while Cement Factory samples accumulated more fatty acids as stress responses. The unique compound 3-Oxatricyclo[4.2.0.0²⁴]octan-7-one, a strained bicyclic ketone, shows promise as a synthetic intermediate for pharmaceuticals and materials science. Other identified compounds, such as 4-Nonenenitrile (industrial applications), Z,E-2,13-Octadecadien-1-ol (pheromone/bio-pesticide), and oleic acid derivatives (antimicrobial, antioxidant, and insecticidal activities), highlight the species' diverse biotechnological potential. These findings confirm ecological chemotype plasticity and emphasize the importance of habitat selection for medicinal applications

Conclusion and Suggestions: This study, as the first comprehensive phytochemical investigation of the medicinal plant *Anvillea garcinii* in natural habitats of Iran, represents a fundamental step toward understanding the hidden potential of genetic resources in the country's rangelands. The findings clearly demonstrated that the studied habitats in Darab County, despite plausible environmental stresses (particularly in the cement factory area, evident from photosynthetic indicators), serve as a rich reservoir of secondary metabolites with medicinal and industrial value. The identification of 31 chemical compounds, including predominant and rare compounds such as 3-oxatricyclo[4.2.0.0²,⁴]octan-7-one (29.52%), 4-nonenonitrile (9.00%), and 9-octadecenoic acid (17.30%), not only confirms the chemical richness of this plant but also reveals its potential applications in drug synthesis, biopesticides (pheromones), and the cosmetic-hygiene industry. The qualitative and quantitative differences in essential oil composition between the two studied habitats indicate the significant role of ecological and environmental factors on the chemical composition of the plant. Phytochemical data showed a significant correlation with soil properties, such that nutritional elements and physical parameters of the soil effectively influenced the content of major compounds. These results emphasize that careful habitat selection and intelligent site planning for cultivation and harvesting can be an effective strategy for optimizing the quantity and quality of active compounds in medicinal plants. *Anvillea garcinii*, by demonstrating remarkable metabolic flexibility in response to environmental stresses, represents an outstanding example of biochemical adaptation in plants of arid and semi-arid regions. This plant possesses high potential for producing valuable medicinal and industrial compounds. However, ecological and environmental variations can significantly impact the chemical content of this plant. Therefore, special attention must be paid to habitat conditions and environmental factors when planning for the cultivation and industrial exploitation of this species.

Keywords: Arid ecosystems, GC-MS analysis, Ecophysiological traits, Bioactive compounds, *Anvillea garcinii*, Phytochemical diversity, Secondary metabolites, Habitat selection.