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Anatomical, Micromorphological and Habitat Properties of the Endangered Plant, Gypsum Catmint (*Nepeta eremokosmos* Rech. F.)

Farzane Bahadori[1], Fatemeh Rabizadeh[2]*

[1]Research center of Agricultural and natural resources, Education and Extension Organization (AREEO), Semnan, Iran

[2]Farzanegan Campus, Semnan University, Semnan, Iran

***Corresponding author: f.rabizade@semnan.ac.ir**

Introduction

The *Lamiaceae* family encompasses diverse plant species with medicinal and aromatic properties, predominantly found in the Mediterranean and arid regions. Among them, the genus *Nepeta* holds significant ecological and economic value. *Nepeta eremokosmos* is endemic to central Iran, particularly the gypsum-rich soils of Semnan province, and faces habitat-specific challenges due to its limited geographical distribution and environmental constraints. Previous studies have highlighted the ecological importance of gypsum-adapted species globally. However, detailed investigations into the adaptive traits of *N. eremokosmos* in Iran are scarce. This study focuses on the plant's adaptations to gypsum soils, addressing anatomical and ecological factors influencing its abundance.

Material and Methods

This research was conducted in gypsum habitats of western Semnan, with soil sampling from 30 identified sites ranging from 1580 to 2256 meters above sea level. Soil physicochemical properties, including pH, EC, organic carbon, $CaCO_3$, and essential nutrients, were analyzed. Plant samples were collected during the flowering phase and processed for anatomical and micro-morphological studies using light and electron microscopy. Redundancy Analysis (RDA) was employed to evaluate the correlation between environmental variables and species abundance.

Result and Discussion

Habitat Characteristics: N. eremokosmos was primarily observed in areas with high calcium and potassium levels, gypsum-rich soils, and sandy textures. Factors such as EC, pH, and nitrogen negatively impacted its distribution, whereas gypsum, $CaCO_3$, and elevation positively influenced its abundance.

Anatomical Features: The leaves exhibited idioblasts containing calcium oxalate crystals, suggesting an adaptive mechanism to manage mineral excess and deter herbivory. The plant also showed well-developed trichomes, including glandular and long hairs, aiding in water retention and gypsum detoxification.

Micro-Morphology: The nutlets were smooth and black, with distinct geometric patterns aiding species identification. Trichomes with calcium deposits further underscored the plant's adaptations to arid conditions.

The findings highlight the plant's unique adaptations to gypsum habitats, including specialized anatomical structures and nutrient regulation strategies. Elevation and soil composition were identified as critical factors influencing the plant's ecological niche. These insights provide a foundation for conservation strategies, including habitat protection and potential domestication efforts.

Conclusions

Nepeta eremokosmos demonstrates remarkable adaptability to gypsum-rich soils through unique anatomical and ecological traits. Conservation efforts must prioritize habitat preservation and address threats such as mining activities. This study underscores the significance of integrating ecological and morphological analyses to safeguard endangered species.

Keywords: Nepeta eremokosmos, Gypsum soils, Anatomical adaptation, Micro-morphology, Semnan.

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Declaration of conflict of interest

The authors declare no conflict of interest.