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Original Article

Determination of Some Nutrient Contents of Endemic Plant *Verbascum yurtkuranianum* (Schrophulariaceae)

Ferrin Ferda Aşık [1] ✉

[1] Nature Conservation and National Parks 2nd Regional Directorate

[1] https://orcid.org/0000-0003-4961-6925

✉: ferrinferda.asik@milliparklar.gov.tr

ABSTRACT

Verbascum yurtkuranianum (Schrophulariaceae) has been identified in the Ericek Neighborhood area of Bursa Province and requires very different ecological and physiological conditions. This study determined the elemental content of the aerial parts and root organs of the locally endemic Gök Sığırkuyruğu (*V. yurtkuranianum)* plant. The average macro nutrient contents obtained from the aerial parts of the locally endemic plant were found to be: nitrogen (N) 33.4 g kg^{-1}, phosphorus (P) 04.79 g kg^{-1}, potassium (K) 48.1 g kg^{-1}, calcium (Ca) 06.79 g kg^{-1} and magnesium (Mg) 06.07 g kg^{-1}. The micro nutrient contents were determined as and sodium (Na) 1350 mg kg^{-1}. iron (Fe) 107.2 mg kg^{-1}, copper (Cu) 4.75 mg kg^{-1}, manganese (Mn) 11.66 mg kg^{-1}, zinc (Zn) 58.7 mg kg^{-1}, and boron (B) 22.9 mg kg^{-1}. The average macro nutrient contents obtained from the root part were found to be: N 33.3 g kg^{-1}, P 07.37 g kg^{-1}, K 47.9 g kg^{-1}, Ca 04.29 g kg^{-1}, Mg 04.80 g kg^{-1}, Na 00.69 g kg^{-1}. The micro nutrient contents were calculated as Fe 450.8 mg kg^{-1}, Cu 13.97 mg kg^{-1}, Mn 11.42 mg kg^{-1}, Zn 128.1 mg kg^{-1}, and B 16.1 mg kg^{-1}.

Key words: Biodiversity, nutrient content, local endemic, *Verbascum yurtkuranianum*, habitat

Endemik Bitki *Verbascum yurtkuranianum* (Schrophulariaceae)'un Bazı Besin Elementi İçeriklerinin Belirlenmesi

ÖZ

Verbascum yurtkuranianum (Gök sığırkuyruğu), Bursa İli, Ericek Mahallesi Mevkii'nden çok farklı ekolojik ve fizyolojik özelliklere ihtiyaç duymaktadır. Çalışma ile, lokal endemik olan Gök sığırkuyruğu (*V. yurtkuranianum)* bitkisinin toprak üstü ve kök organlarının element içeriği belirlenmiştir. Lokal endemik bitkinin toprak üstü kısımlarından elde edilen ortalama makro besin elementi içerikleri; azot (N) %3.34; fosfor (P) %0.479, potasyum (K) %4.81, kalsiyum (Ca) %0.679, magnezyum (Mg) %0.607, olarak bulunurken, mikro element içerikleri sodyum (Na) 1350 mg kg^{-1}, demir (Fe) 107.2 mg kg^{-1}; bakır (Cu) 4.75 mg kg^{-1}, mangan (Mn) 11.66 mg kg^{-1}, çinko (Zn) 58.7 mg kg^{-1}; bor (B) 22.9 mg kg^{-1} olarak tespit edilmiştir. Kök kısmından elde edilen ortalama makro besin element miktarlarından N %3.33; P %0.737, K %4.79, Ca %0.429, Mg %0.480, Na %0.069 olarak, mikro besin element miktarları ise; Fe 450.8 mg kg^{-1}; Cu 13.97 mg kg^{-1}, Mn 11.42 mg kg^{-1}, Zn 128.1 mg kg^{-1}; B 16.1 mg kg^{-1} olarak hesaplanmıştır.

Anahtar kelimeler: Biyolojik çeşitlilik, besin elementi içeriği, lokal endemik, *Verbascum yurtkuranianum*, yetişme ortamı

INTRODUCTION

Our country harbors 75% of the plant species found in the European continent, with one-third of them being endemic. This high level of endemism places a great responsibility on our country in terms of biodiversity, particularly in the conservation of endemic and rare species (Haspolat et al., 2016; Özdeniz et al., 2017; Yücel et

al., 2023). More than half of the endemic species in Türkiye are struggling to survive due to population declines and reductions, making them species on the brink of extinction (Ekim et al., 2000; Dayan, 2013). In addition, the smuggling of biological resources out of Türkiye leads to the loss of our rare species, over which we have rightful claims. Therefore, identifying and protecting rare species in our country, gaining knowledge about them, preserving their habitats, and ensuring their sustainable use are of great importance (Öztürk and Yiğit, 2013; Anonymous, 2016). The conservation of biodiversity is essential for plants to continue their existence and sustain their life cycles (Bu, 2008). Therefore, understanding the characteristics of a plant intended for cultivation and propagating it accordingly is of great importance for its germination and survival (Öztürk and Yiğit, 2013; Cesur et al., 2017).

One of these endemic species is the *Verbascum yurtkuranianum*, a locally endemic species found in Bursa Province. The *Verbascum* genus is represented worldwide by approximately 360 species (Heywood, 1993) and in Türkiye by 255 species and 130 hybrids, 200 of which are endemic (Duman et al., 2020; Pervin et al., 2024). According to Kaynak et al. (2006), the plant can grow up to 90-107 cm in height, has a sturdy, erect, unbranched or sparsely branched stem, and its basal leaves have serrated edges, with both upper and lower surfaces being hairless and glossy. At the same time, it has been identified as the third *Verbascum* species with purple flowers (Çenil, 2007; Anonymous, 2016). This locally endemic species was discovered in Bursa Province, Gürsu District, on a sloped area along the roadside in the western part of Ericek Neighborhood (Kaynak et al., 2006). The fact that *Verbascum yurtkuranianum* has been identified at a specific altitude and within a limited area indicates that it requires distinct ecological and physiological conditions. The *Verbascum* genus, with an endemism rate of 85%, ranks second in Türkiye in terms of the number of endemic species (Erik and Tarıkahya, 2004). The destruction of natural vegetation for the establishment of settlements and urbanization has led to the formation of ruderal vegetation as plants adapt to new living conditions. Plants that adapt to these habitats are significant due to their ability to flower and complete their vegetation cycle in a short period, even under extremely unfavorable conditions. *Verbascum* species generally prefer regions with harsh living conditions to avoid competition with other species.

The large number of species within the *Verbascum* genus and their distribution across very different geographical regions, along with issues in identification and taxonomy, suggest that examining the structure of these species could contribute to their taxonomic classification (Küçük et al., 2021). In this study, seedlings of the sky Gök sığırkuyruğu (*Verbascum yurtkuranianum*) were planted in pots, and macro- and micronutrient contents of samples collected from both aerial parts and root parts before flowering were analyzed. The obtained data are expected to support the development of *ex situ* conservation strategies for *Verbascum yurtkuranianum* in Ericek Neighborhood, Gürsu District, Bursa Province. Additionally, it is anticipated that this research will contribute to a better understanding of the plant's structural composition and aid in the sustainable conservation of biodiversity.

MATERIALS AND METHODS

In the summer of 2024, seeds of the plant were collected from the area where it naturally occurs in Ericek Neighborhood, Gürsu District, Bursa Province, at the end of August (the plant's seed-setting period). The collected seeds were stored in the refrigerator until the planting date to prevent deterioration. The pots were filled with 10 kg of soil. The soil used has a slightly acidic reaction (pH 6.4), is salt-free (251 µS cm^{-1}), has very little calcareous (0.86%), has sufficient total nitrogen (0.135 %), available P (12.8 mg kg^{-1}) and K (255.0 kg da^{-1}). Microelements (Fe, Cu, Zn and Mn) in the soil were determined to be sufficient. For this reason, basic fertilization was not applied to the pots. The soil was taken as representative of the areas where endemic plant seeds were collected in the Ericek. On March 27, 2024, the seeds were sown in trays (5 trays with 104 cells each) in the greenhouse of the 2nd Regional Directorate of Nature Conservation and National Parks - Bursa Branch, where they were germinated. The seedlings of *Verbascum yurtkuranianum* were transplanted into thirty pots in the Soil Science and Plant Nutrition greenhouse of Uludağ University on June 8, 2024. Ten randomly selected plants were harvested on November 6, 2024.

After the seeds of *Verbascum yurtkuranianum* germinated and reached the seedling stage, they were treated with Maxim XL and Korsilex 50 WP every fifteen days to protect against diseases. Ten plants were randomly selected from thirty pots and harvested by uprooting them, without damaging the roots and stems of the plants. After the samples removed from the pots were washed three times with tap water to clean the soil, they were then rinsed three times with pure water and prepared for drying in the air circulation drying oven at the Soil Science and Plant Nutrition Laboratory of Uludağ University. The root and aerial parts samples of the plants were separated, dried in the oven at 65°C, ground, and treated with a mixture of nitric acid and perchloric acid (4:1 ratio) for analysis preparation. The macro and micronutrient contents of the prepared samples were

analyzed using ICP OES (Perkin Elmer OPTIMA 2100 DV) device (Kacar and İnal, 2010). The nitrogen content of the plant samples was determined by first burning the samples in a furnace according to the Kjeldahl method, and then distilling the burned samples in a distillation apparatus to measure their nitrogen content (Bremmer, 1965). Phosphorus content was determined using the vanadomolybdate-phosphoric acid yellow color method (Lott et al., 1956). The sodium, potassium, and calcium contents of *Verbascum yurtkuranianum* plant samples were determined using the Ependorf Elex 6361 Flame Photometer (Horneck and Hanson, 1998), while the magnesium and micronutrient(copper, iron, manganese, boron, and zinc) contents were determined using ICP OES (Isaac and Johnson, 1998).

RESULTS AND DISCUSSION

As a result of the chemical analyses, the lowest and highest macronutrient contents found in the aerial parts and root organs of *V. yurtkuranianum* were determined and are provided in Table 1.

Table 1. *Some macroelement contents found in the aerial parts and root organs of Verbascum yurtkuranianum*

Plant parts		N, g kg^{-1}	P, g kg^{-1}	K, g kg^{-1}	Ca, g kg^{-1}	Mg, g kg^{-1}
Aerial parts	Minimum	30.4	04.53	46.1	05.53	05.41
	Maximum	35.5	05.05	52.1	07.75	08.06
	Average	33.4	04.79	48.1	06.79	06.07
Root	Minimum	30.0	07.20	39.3	03.81	04.22
	Maximum	40.9	07.76	53.2	05.39	05.64
	Average	33.3	07.37	47.9	04.29	04.80

*: Results are the average of ten plants harvested (n=10).

The average macronutrient contents detected in the aerial parts organs of the plant were: N 33.4 g kg^{-1}, P 04.79 g kg^{-1}, K 48.1 g kg^{-1}, Ca 06.79 g kg^{-1}, Mg 06.07 g kg^{-1}. The average macronutrient concentrations detected in the root organs of the plant were: N 33.3 g kg^{-1}, P 07.37 g kg^{-1}, K 47.9 g kg^{-1}, Ca 04.29 g kg^{-1}, Mg 04.80 g kg^{-1} (Table 1). The average maximum N content found in the aerial parts organs of *Verbascum yurtkuranianum* was 35.5 g kg^{-1}, P content was 05.05 g kg^{-1}, K content was 52.1 g kg^{-1}, Ca content was 07.75 g kg^{-1}, Mg content was 08.06 g kg^{-1}. The average minimum N content of this locally endemic plant was found to be 30.4 g kg^{-1}, P content 04.53 g kg^{-1}, K content 46.1 g kg^{-1}, Ca content 05.53 g kg^{-1}, Mg content 05.41 g kg^{-1}. The maximum macronutrientcontents from the root samples of *V. yurtkuranianum* were: N 40.9 g kg^{-1}, P 07.76 g kg^{-1}, K 53.2 g kg^{-1}, Ca 05.39 g kg^{-1}, Mg 05.64 g kg^{-1}, while the minimum contents were: N 30.0 g kg^{-1}, P 07.20 g kg^{-1}, K 39.3 g kg^{-1}, Ca 03.81 g kg^{-1}, and Mg 04.22 g kg^{-1} (Table 1). It was determined that the average macronutrient contents obtained from the leaf and stem parts of the locally endemic species *V. yurtkuranianum* (Gök Sığırkuyruğu) were higher than those obtained from the root region. Leaves are the primary organs of the plant that best represent its nutrition in terms of photosynthesis, transpiration, and respiration (Bilgin et al., 2016; Yalçın, 2018). Therefore, the amount of nutrients in the leaves is crucial in determining the nutrient content of the plant (Kutbay et al., 2003; Kılıç et al., 2012). N, P, K, Ca, and Mg are macronutrients that need to be absorbed in large amounts from the soil for plant growth and development. The absorption of these nutrient elements from the soil also varies depending on the environment's temperature, soil composition, light availability, and competition with other plants (Özbucak et al., 2022).

As a result of the chemical analyses, the lowest and highest values of the micronutrient contents found in the aerial parts and root organs of *V. yurtkuranianum* were determined and are provided in Table 2.

Table 2. *Some micronutrients contents found in the aerial parts and root organs of Verbascum yurtkuranianum*

Plant Parts		Na, mg kg^{-1}	Fe, mg kg^{-1}	Cu, mg kg^{-1}	Mn, mg kg^{-1}	Zn, mg kg^{-1}	B, mg kg^{-1}
Aerial parts	Minimum	1080	71.3	2.95	10.84	44.8	19.9
	Maximum	1800	169.1	7.91	12.86	83.7	26.7
	Average	1350	107.2	4.75	11.66	58.7	22.9
Root	Minimum	570	199.1	8.87	9.83	97.2	14.8
	Maximum	870	874.8	19.64	13.82	166.1	17.7
	Average	690	450.8	13.97	11.42	128.1	16.1

*: Results are the average of ten plants harvested (n=10).

The average micronutrient contents detected in the aerial parts organs of the plant were: Na 1350 mg kg^{-1}, Fe 107.2 mg kg^{-1}, Cu 4.75 mg kg^{-1}, Mn 11.66 mg kg^{-1}, Zn 58.7 mg kg^{-1}, B 22.9 mg kg^{-1} (Table 2). The average micronutrient contents detected in the root organs of the plant were: Na 690 mg kg^{-1}, Fe 450.8 mg kg^{-1}, Cu 13.97 mg kg^{-1}, Mn 11.42 mg kg^{-1}, Zn 128.1 mg kg^{-1}, B 16.1 mg kg^{-1}. The maximum Na content found in the aerial parts organs of the plant was 1800 mg kg^{-1}, Fe content 169.1 mg kg^{-1}, Cu content 7.91 mg kg^{-1}, Mn content 12.86 mg kg^{-1}, Zn content 83.7 mg kg^{-1}, and B content 26.7 mg kg^{-1}. The minimum Na content detected in the aerial parts of the locally endemic *V. yurtkuranianum* plant was 1080 mg kg^{-1}, Fe content 71.3 mg kg^{-1}, Cu content 2.95 mg kg^{-1}, Mn content 10.84 mg kg^{-1}, Zn content 44.8 mg kg^{-1}, and B content 19.9 mg kg^{-1}. The maximum nutrient contents in the root samples of *V. yurtkuranianum* were: Na 870 mg kg^{-1}, Fe 874.8 mg kg^{-1}, Cu 19.64 mg kg^{-1}, Mn 13.82 mg kg^{-1}, Zn 166.1 mg kg^{-1}, and B content 17.7 mg kg^{-1}. In the study, the minimum nutrient contents in the root region of the plant were obtained as follows: Na 570 mg kg^{-1}, Fe 199.1 mg kg^{-1}, Cu 8.87 mg kg^{-1}, Mn 9.83 mg kg^{-1}, Zn 97.2 mg kg^{-1}, and B content 14.8 mg kg^{-1} (Table 2). In studies determining the relationships between the micronutrients in the soil and the plant, the normal ranges for Cu, Fe, Mn, and Zn elements in plants are defined as 5-30, 2-250, 30-300, 25-150 mg kg^{-1} (dry weight), while the toxic values are determined as 20-100, 400-1000, 300-500, 100-400 mg kg^{-1} (dry weight) (Güleryüz et al., 2010; Hilooğlu and Sözen, 2017; Kabata-Pendias and Mukherjee, 2007; Özdemir and Öztürk, 1996).

When the research results are compared with these values, it is observed that only Cu and Zn remain within the given limits, while the Mn content is below these values, and the average Fe content in the root organ is above the specified range. This indicates that *V. yurtkuranianum* accumulates Fe in its roots. The results are consistent with the studies conducted by researchers.

CONCLUSION

It has been determined that the average macronutrient contents (N, K, Ca, and Mg) in the aerial parts organs of the locally endemic *V. yurtkuranianum* plant are higher than the nutrient contents in the root organs. Only the average P content was higher in the roots than in the aerial parts organs. Among the average micronutrient contents of the plant, Fe, Cu, and Zn values were found to be higher in the roots, while the average Na, Mn and B contents were found to be higher in the aerial parts organs.

This is the first study investigating the macro and micronutrient contents of the locally endemic *V. yurtkuranianum* plant, located in an area of 2 km^2 in Ericek, Gürsu District, Bursa Province. It is believed that this study will provide an important contribution to the conservation of endemic species, which are threatened for various reasons, by identifying new habitats and enhancing the understanding of the species.

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Declaration of interests

The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Ferrin Ferda AŞIK: Conceptualization; data curation; formal analysis; investigation; methodology; writing-original draft; writing-review and editing.

ORCID

Ferrin Ferda AŞIK http://orcid.org/0000-0003-4961-6925

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