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Heavy metal content screening in leaves and flowers of *Hypericum origanifolium* by atomic absorption spectrometry

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Abstract

Atomic absorption spectrometry facilitates the reliable determination of mineral content during pharmaceutical quality control of medicinal plants. In the present work, measurable amounts of Fe, Ca, Cu, K, Mg, Mn, Na and Zn were detected in the leaves and flowers of *Hypericum origanifolium* Willd. through atomic absorption spectrometry. Mean heavy metal content in the flowers and leaves of *H. origanifolium* was, in descending order, Ca > Mg > K > Na > Fe. Ca was present in higher concentrations in the flowers (11157.24 ppm) and leaves (20132.24 ppm) of titled plant. Our results reveal that flowers are less suitable as target plant parts for metal accumulation than leaves.

Keywords: *Hypericum origanifolium,* heavy metals, atomic absorption spectrometry

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Hypericum origanifolium'un yaprak ve çiçeklerindeki ağır metal içeriğinin atomik absorpsiyon spektrometresi ile belirlenmesi

Özet

Atomik absorpsiyon spektrometresi, tıbbi bitkilerin farmasötik kalite kontrolü sırasında mineral içeriğinin güvenilir bir şekilde belirlenmesini kolaylaştırmaktadır. Bu çalışmada, *Hypericum origanifolium* Willd'un yaprak ve çiçeklerinde atomik absorpsiyon spektrometresi ile ölçülebilir miktarda Fe, Ca, Cu, K, Mg, Mn, Na ve Zn bulunduğu tespit edilmiştir. *H. origanifolium*'un yaprak ve çiçeklerindeki ortalama ağır metal içeriği sırasıyla Ca> Mg> K> Na> Fe olarak belirlenmiştir. Kalsiyum, çiçek (11157,24 ppm) ve yapraklarda (20132,24 ppm) en yüksek konsantrasyonda tespit edilmiştir. Elde edilen sonuçlar çiçeklerin yapraklara kıyasla çok daha düşük seviyede ağır metal birikimi gösterdiğini ortaya koymaktadır.

Anahtar kelimeler: *Hypericum origanifolium,* ağır metaller, atomik absorpsiyon spektrometresi

1. Introduction

Especially in developing countries, environmental pollutants which are released to nature in an uncontrolled manner reach the structure of plants through water, soil and air. Metals have an important place among these pollutants. The use of metal based pollutant exposed plants by humans causes serious health problems such as kidney damage, renal failure and liver damage [1; 2; 3]. Iron, zinc, calcium, magnesium, copper, potassium, manganese, sodium were chosen as representative metals whose levels in the environment represent a reliable index of environmental pollution and human health. Some plants like as *Hypericum perforatum*, *Avena sterilis*, *Bifora radians*, *Chenopodium album*,

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Consolida regalis, *Humulus lupulus*, *Reseda lutea*, *Solanum nigrum*, *Sorghum halepense* and *Xanthium strumarium* can then be used as biomonitors for the determination of trace element levels [4; 5; 6; 7].

Hypericum L., which is a member of the Hypericaceae (Guttiferae) family, is represented approximately 500 species all around to world. About 108 of these species are naturally distributed in Turkey [8; 9; 10; 11]. There has been many studies previously conducted on the *Hypericum* species, but very limited studies for *H. origanifolium.* According to the literature reviews, only one anatomical study on *H. origanifolium* was found [12]. One of the most important features of *Hypericum* taxa is their unique secondary metabolites. *Hypericum* taxa and their metabolites are widely used in traditional and modern medicine today [13]. In the light of phytochemical studies performed on *H. origanum*, flavonoids (myrcetin, rutin, quercetin, hyperoside), xanthones (iso-magniferin and mangiferin), naphthodiantrones (frangulin, emodin, proto-pseudohypericin, psudohypericin and phenolicin) and phenolic acids have been determined at the aerial parts of the plant [14; 15; 16; 17; 18; 19; 20].

Data available on the biological activity of *H. origanifolium* is also limited to a few previous reports that have demonstrated their cytotoxic, antiproliferative, antimicrobial, antibacterial, antiyeast and antioxidant activities [18; 19; 20; 21; 22; 23; 24; 25; 26]. In the light of literature data, any studies on the heavy metal content of *H. origanifolium* not determined.

The main purpose of this study is to determine the heavy metal content in extracts obtained from the flowers and leaves of *H. origanifolium* by atomic absorption spectrometry. We hope that the relationship between the heavy metal amounts in *H. origanifolium* leaves and flowers will be reference for future studies.

2. Materials and methods

H. origanifolium Willd. was collected around of Eskişehir, Turkey. *H. origanifolium* Willd. Sivrihisar, Tekören village, 1100 m. June 2003 (OUFE 10334). The plant was identified according to Flora of Turkey and the East Aegan Islands [8; 27; 28].

For the solid samples with a nitric acid (Merck, Darmstadt, Germany)–perchloric acid (Merck, Darmstadt, Germany) digestion was used for mineralizing. The dried flowers and leaves of *H. origanifolium* were extracted for the solution phase as described previously and analyzed for Fe, Zn, Ca, Mg, Cu, K, Mn, Na (Merck AAS standard solutions), using Hitachi (180-70) Polorized Zeeman flame atomic absorption spectrometry [29; 30]. All precautions were taken to prevent metal contamination, i.e. samples were cleaned with 2% HNO_3, rinsed in distilled water and baked at 600°C. All samples were analyzed in triplicate and the mean values were calculated. In order to increase the reliability of the measurements during the study, the instrument was calibrated at every 10 readings.

The flame atomic absorption spectrometry (FAAS) instrumental and operating conditions that provided the best sensitivity for the determination of metal content are detailed in Table 2.1.

Table 2.1. FAAS instrumental parameters employed to determine metals

Elements	Flame type	Burner height (mm)	Wavelength (nm)	Slit width (nm)	Lamp Current (mA)	Fuel gas (1 min^{-1})
Fe	Air-C_2H_2	7.5	248.3	0.2	10	2.3
Zn	Air-C_2H_2	7.5	213.8	1.3	10	2.0
Ca	Air-C_2H_2	12.5	422.7	2.6	7.5	2.6
Mg	Air-C_2H_2	7.5	285.2	2.6	7.5	1.6
Cu	Air-C_2H_2	7.5	324.8	1.3	7.5	2.3
K	Air-C_2H_2	7.5	766.5	2.6	10	2.3
Mn	Air-C_2H_2	7.5	279.5	0.4	7.5	2.3
Na	Air-C_2H_2	7.5	589.0	0.4	10	2.2

3. Results

In this study, the heavy metal contents of the leaves and flowers of *Hypericum origanifolium* Willd. were investigated. These levels were obtained through flame atomic absorption spectrometry. Fe, Zn, Ca, Mg, Cu, K, Mn and Na were determined to be present in the samples. Metal concentrations in the leaves of *H. origanifolium* were found to be 130.25, 30.99, 20132.24, 7775.84, 7.60, 3361.53, 48.40, and 145.02 ppm; and in flower of *H. origanifolium* were found to be 93.64, 26.26, 11157.23, 5768.23, 11.37, 2454.99, 36.12, and 184.94 ppm for iron, zinc, calcium, magnesium, copper, potassium, manganese, sodium, respectively (Table 3.1. and Figure 3.1.).

Table 3.1. Element concentrations of *H. origanifolium* (ppm)

Elements	*H. origanifolium* (leaf)	*H. origanifolium* (flower)
Fe	130.25	93.64
Zn	30.99	26.26
Ca	20132.24	11157.23
Mg	7775.84	5768.23
Cu	7.60	11.37
K	3361.53	2454.99
Mn	48.40	36.12
Na	145.02	184.94

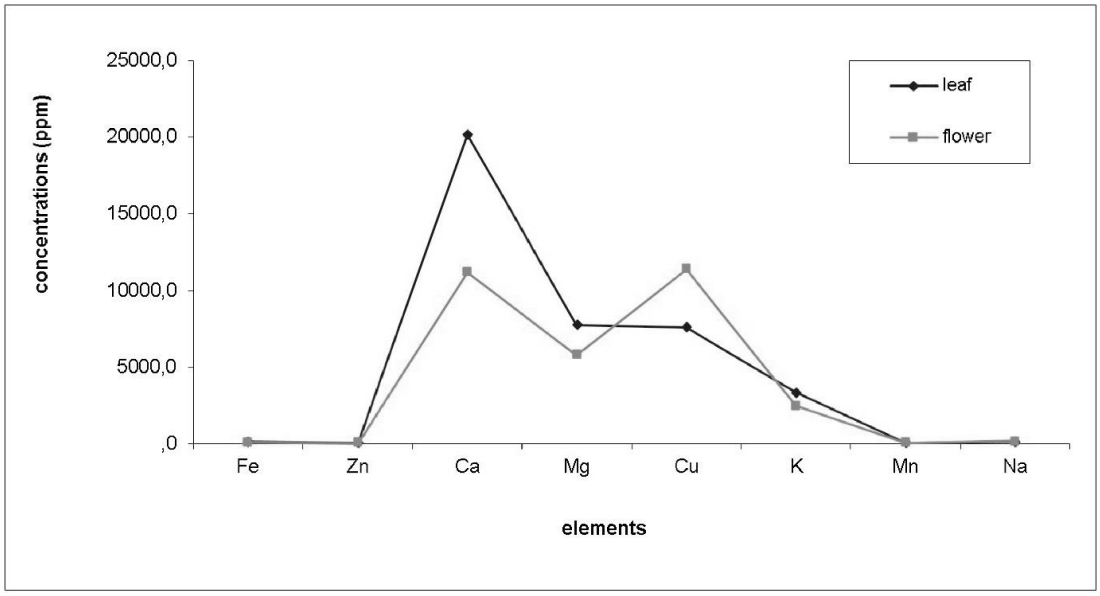

Figure 3.1. Relationship between leaf and flower metal concentrations of *H. origanifolium*

4. Conclusions and discussion

In the light of obtained data from flame atomic absorption spectrometry analysis of the leaves and flowers of *Hypericum origanifolium*, Fe, Zn, Ca, Mg, K and Mn concentrations were recorded as higher in the leaf than in the flower, 130.25 > 93.64 ppm, 30.99 > 26.26 ppm, 20132.24> 11157.23 ppm, 7775.84> 5768.23 ppm. 3361.53> 2454.99 ppm, 48.40> 36.12 ppm, respectively. Cu and Na concentrations were observed to be higher in the flower than in the leaf 11.37> 7.60 ppm, 184.94 > 145.02 ppm, respectively (Figure 1, Table 2).

The mean heavy metal content in the flowers and leaves of *H. origanifolium* was, in descending order, Ca > Mg > K > Na > Fe. Ca was present in higher concentrations in the flowers (11157.24 ppm) and leaves (20132.24 ppm) of the titled plant. Gomez *et al*. (2004) indicated that the CA concentration in *H. perforatum* was 100-500 ppm for the dried herb, as indicated in table 3.1. [4]. This situation shows that the Ca concentration of the leaf and flower of *H. origanifolium* is higher than *H. perforatum.* Kadıoğlu *et al*. found the concentrations to be 495, 62.6, 11.1, 19,5 ppm for iron, manganese, copper, zinc, respectively [5]. In this study, the concentrations of Fe and Mn were higher, while that of Zn was lower than in the *H. perforatum* concentrations reported by Kadıoğlu *et al*. (2005).

Findings obtained from elemental analysis studies on plants reveal that herbal foods are rich in especially Mg, Ca, Na and K [3]. The data obtained in our study coincide with the above findings. K, Mg and Ca which are represent the most abundant metal constituents of many plants were identified as the most abundant metals in *H. origanifolium* extracts. Internal and external factors have direct and indirect effects on the different metal concentrations of distinct parts of plants. These regional differences in metal content can occur due to many different reasons, such as genetic factors, growth conditions, analytical procedures and geographical variations. These factors are directly affected by the location differences where the plant samples are collected. Hence, there is an indirect relationship between sample locations and metal content can be mentioned. Though much is known about the functional role of a number of elements, the best foreseeable benefit for human health, mineral nutrition, lies in obtaining the correct amount of supplementation in the right form at the right time. High or low levels of Ca, Cu, Zn, Mn, K and Mg may invite many disorders [3]. These elements also play a part in neurochemical transmission, as well as serving as constituents of biological molecules, as a cofactor for various enzymes such as NAD(P)H oxidase, Ferroxidase, Alcohol dehydrogenase and in a variety of different metabolic processes.

High amounts of Ca are expected one way or another, as it is one of the most common minerals of the soil, from where it is readily absorbed into the plants. Iron is one of the important elements for the human body and is involved in vital activities such as hemoglobin formation, oxygen and electron transfer. Zinc and Copper, on the other hand, are involved in many different vital processes such as being important components of enzymatic and redox systems. For this reason, they have an important place among the elements that should be found regularly in the diet [6]. Also, the consequences show that most of these herbal plants contain vital elements for human metabolism and are also essential for growth and development as well as for the prevention and cure of diseases.

While many investigations into the quality values of medicinal plants are being reported in the current literature [7], less emphasis has been made on the metal content of herbal products. Metallic elements are constituent plant compounds demonstrating biological activity as essential or toxic agents in metabolism. Thus, the application of metal monitoring as a pattern recognition method in medicinal herbs is a promising tool for their characterization.

Chemotaxonomy is one of the most important tools that help classify plant taxa. The field of study of chemotaxonomy is to reveal the chemical content similarities and differences between different taxonomic groups. In this context, determining the metal content of plants is extremely valuable for chemotaxonomic researches. Heavy metal levels are important pollutants for soil, water, plant, the environment and human health. Especially the accumulation of heavy metals in some plant taxa makes them a valuable tool in determining heavy metal pollution. Therefore, further investigations are also needed to determine interactions between the leaves and flowers in terms of heavy metals.

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