

Heavy Metal Content Screening in Leaves and Flowers of *Hypericum montbretii* Spach. by Atomic Absorption Spectrometry

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Received: 18 February 2021, **Accept:** 15 March 2021, **Published Online:** 01 June 2021

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 montbretii* Spach. through atomic absorption spectrometry. Mean heavy metal content in the flowers and leaves of *H. montbretii* Spach. was, in descending order, Ca > Mg > K > Mn > Na. Ca was present in higher concentrations in the leaves (10252.75 ppm) and flowers (7321.94 ppm) of titled plant. Our results reveal that flowers are less suitable as target plant parts for metal accumulation than leaves.

Key words: *Hypericum montbretii* Spach., heavy metals, atomic absorption spectrometry.

1. Introduction

The environment in developing countries, pollution in irrigation water, atmosphere, soil, sterilization methods and storage conditions all play an important role in the contamination of medicinal plants by metals. Metals may contaminate a variety of plants causing ensuing serious health hazards such as kidney damage, renal failure and liver damage (Shaw et al., 1997; Andrew et al., 2003; Ajasa et al., 2004). 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*, *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 (Gomez et al., 2004; Kadioğlu et al., 2005; Gomez et al., 2007; Özcan and Akbulut, 2007).

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 (Robson, 1967; Robson, 1977; Robson, 2012; Duman and Çakır-Dindar, 2020). There has been many studies previously conducted on the *Hypericum* species, but very limited studies for *H. organifolium*. According to the literature reviews, only one anatomical study on *H. montbretii* was found (Potoğlu Erkara and Tokur, 2004). 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 (Yaylacı et al., 2013). In the light of phytochemical studies performed on *H. montbretii*, 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 (Mathis and Ourisson, 1964; Kitanov and Nedialkov, 1998; Makovests'ka, 1999; Sirvent et al., 2002; Çırak et al., 2007; Öztürk et al., 2009; Bertoli et al., 2015).

Data available on the biological activity of *H. montbretii* is also limited to a few previous reports that have demonstrated their cytotoxic, antiproliferative, antimicrobial, antibacterial, antiyeast and antioxidant activities (Sakar et al., 1988; Sakar and Tamer, 1990; Güzey, 2007; Çırak et al., 2007; Öztürk et al., 2009; Güzey et al., 2011; Yaşar et al., 2013; Bertoli et al., 2015; Boran, 2018). In the light of literature data, any studies on the heavy metal content of *H. montbretii* 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. montbretii* by atomic absorption spectrometry. We hope that the relationship between the heavy metal amounts in *H. montbretii* leaves and flowers will be reference for future studies.

2. Material and Methods

H. montbretii Spach. was collected around of Eskişehir, Turkey. *H. montbretii* Eskişehir: Kalabak village and its surrounding area, 1300 m. under the forest, June 2003 (OUFE: 10332). Eskişehir: Kirazlı village, Springs, 1500 m., alongside the road, June 2003 (OUFE: 10333). The plant was identified according to Flora of Turkey and the East Aegan Islands (Robson, 1967, 1988; Dönmez, 2000).

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. montbretii* were extracted for the solution phase as described previously (Que Hee and Boyle, 1988). and analyzed for Fe, Zn, Ca, Mg, Cu, K, Mn, Na (Merck AAS standard solutions), using Hitachi (180-70) Polarized Zeeman flame atomic absorption spectrometry. All precautions were taken to prevent metal contamination, i.e. samples were cleaned with 2% HNO₃, 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 1.

Table 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 ₂ H ₂	7.5	248.3	0.2	10	2.3
Zn	Air-C ₂ H ₂	7.5	213.8	1.3	10	2.0
Ca	Air-C ₂ H ₂	12.5	422.7	2.6	7.5	2.6
Mg	Air-C ₂ H ₂	7.5	285.2	2.6	7.5	1.6
Cu	Air-C ₂ H ₂	7.5	324.8	1.3	7.5	2.3
K	Air-C ₂ H ₂	7.5	766.5	2.6	10	2.3
Mn	Air-C ₂ H ₂	7.5	279.5	0.4	7.5	2.3
Na	Air-C ₂ H ₂	7.5	589.0	0.4	10	2.2

3. Results and Discussion

In this study, the heavy metal contents of the leaves and flowers of *Hypericum montbretii* Spach. 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. montbretii* were found to be 68.096, 38.991, 10252.750, 6463.236, 5.570, 2019.217, 166.759 and 86.687 ppm; and in flower of *H. montbretii* were found to be 150.617, 41.564, 7321.943, 9503.734, 13.312, 4694.398, 105.095 and 93.040 ppm for iron, zinc, calcium, magnesium, copper, potassium, manganese, sodium, respectively (Table 2, Figure 1).

Fe, Zn, Mg, Cu, K and Na concentrations were recorded as higher in the flower than in the leaf, 150.617 > 68.096 ppm, 41.564 > 38.991 ppm, 9503.734 > 6463.236 ppm, 13.312 > 5.570 ppm, 4694.398 > 2019.217 ppm, 93.040 > 86.687 ppm, respectively. Ca and Mn concentrations were observed to be higher in the leaf than in the flower 10252.750 > 7321.943 ppm, 166.759 > 105.095 ppm, respectively (Figure 1, Table 2).

Table 2. Element concentrations of *H. montbretii* (ppm).

Elements	<i>H. montbretii</i>	
	leaf	flower
Fe	68.096	150.617
Zn	38.991	41.564
Ca	10252.750	7321.943
Mg	6463.236	9503.734
Cu	5.570	13.312
K	2019.217	4694.398
Mn	166.759	105.095
Na	86.687	93.040

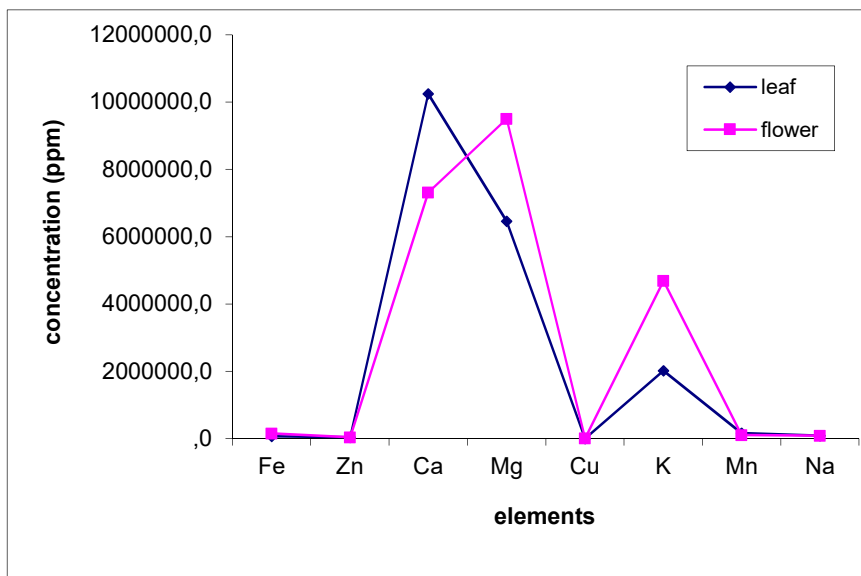


Figure 1. Relationship between leaf and flower metal concentrations of *H. montbretii*.

The mean heavy metal content in the flowers and leaves of *H. montbretii* was, in descending order, Ca > Mg > K > Mn > Na. Ca was present in higher concentrations in the leaves (10252.750 ppm) and flowers (7321.943 ppm) of the titled plant. Gomez et al. indicated that the Ca concentration in *Hypericum perforatum* was 100-500 ppm for the dried herb, as indicated in table (Gomez et al., 2004). This situation shows that the Ca concentration of the leaf and flower of *H. montbretii* is higher than *Hypericum perforatum*. Kadioğlu et al. (2005) found the concentrations to be 495, 62.6, 11.1, 19,5 ppm for iron, manganese, copper, zinc, respectively (Özcan and Akbulut, 2007). In this study, the concentrations of Mn and Zn were higher, while that of Fe was lower than in the *Hypericum perforatum* concentrations reported by Kadioğlu et al. (2005).

Elemental studies of the plants revealed that they contained large amounts of nutrients and were rich in Mg, Ca, Na and K (Ajasa et al., 2004). The results above indicated that the herbal plants contain large amounts of nutrients and are rich in Mg, Ca and K. The abundance of K, Mg and Ca, demonstrated as a result of this analysis, was in agreement with previous findings that these three metals represent the most abundant metal constituents of many plants. Variations in the metal concentration of plants from different sites are related to their condition. These differences might be due to growth conditions, genetic factors, geographical variations and analytical procedures in the locale from which the samples are collected. 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. Deficiency or excess of Cu, Mn, Zn, Ca, Mg and K may cause a number of disorders (Ajasa et al., 2004). These elements also play a part in neurochemical transmission, as well as serving as constituents of biological molecules, as a cofactor for various enzymes, 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 an important element for the human body and plays a role in oxygen and electron transfer, as well as being essential for the formation of haemoglobin. Copper and Zinc

are required in our diet because they exhibit a wide range of biological functions, such as being components of the enzymatic and redox systems (Özcan and Akbulut, 2007). The results also show that many of these plants contain elements of vital importance to man's metabolism, and that they are also needed for growth and development, as well as in the prevention and healing of diseases.

While many investigations into the quality values of medicinal plants are being reported in the current literature (Gomez et al., 2007), 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.

4. Conclusion

The classification of biological species in relation to their chemical composition, which of course includes metal species, is also important in the area of chemotaxonomy. Heavy metal levels are important pollutants for soil, water, plant, the environment and human health. Some species can be used as biomonitors in the determination of trace heavy metal levels. Therefore, further investigations are also needed to determine interactions between the leaves and flowers in terms of heavy metals.

Conflicts of Interests

Authors declare that there is no conflict of interests

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