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Research Article

HEAVY METAL CONTENT SCREENING IN LEAVES AND FLOWERS OF *Hypericum perforatum* L. 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 perforatum* L. through atomic absorption spectrometry. Mean heavy metal content in the flowers of *H. perforatum* L. was, in descending order, Ca>Mg>K>Fe>Na>Mn>Zn>Cu and in the leaves of *H. perforatum* L. was, in descending order, Mg>Ca>K>Na>Fe>Mn>Zn>Cu. Ca was present in higher concentrations in the leaves (18028.345 ppm) and flowers (10955.625 ppm) of titled plant. Our results reveal that flowers are less suitable as target plant parts for metal accumulation than leaves.

Keywords: *Hypericum perforatum* L., *heavy metals, atomic absorption spectrometry*

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 onsuing serious health hazards 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 can then be used as biomonitors for the determination of trace element levels [4, 5, 6, 7].

The genus *Hypericum* L., a member of the Guttiferae (Hypericaceae) family, contains about 450 species in the world, represented by approximately 80 species in Turkey, and are all small herbaceous perennials [8, 9, 10]. There has been many studies previously conducted on the *Hypericum* species, but few heavy metal content studies for *H. perforatum* [5]. Although only one anatomical study on it exists [11]. Several phytochemical studies have been previously performed to elucidate its constituents. According to the results of phytochemical studies, the aerial parts of *H. perforatum* contain naphthodiantrones (hypericin, psudohypericin, proto-pseudohypericin, emodin and frangulin), flavonoids (rutin, quercetin, myrcetin, hyperoside), xanthones (mangiferin and iso-magniferin), and phenolic acids [12, 13, 14, 15, 16].

Data available on the biological activity of *H. perforatum* is also many previous reports that have demonstrated their antioxidant, antimicrobial, antibacterial and antiyeast activities [16, 17, 18]. To the best of our knowledge, there is no previous study indicating their heavy metal contents.

Hence, the primary aim of this study was to investigate the contents of heavy metals of the extracts of *H. perforatum* to determine the relationship between the leaf and flower through atomic absorption spectrometry.

MATERIALS AND METHODS

Hypericum perforatum L. was collected around of Eskişehir, Turkey. *H. perforatum* Eskişehir: Türkmen Mountains, upper parts of Kalabak, 1300 m., June 2003 (OUFE: 10336). Eskişehir: the country road to Kızılinler, alongside the road to Kütahya, 900 m., June 2003 (OUFE: 10337). Eskişehir: Sarıcakaya, Sakarılıca, Mayıslar, Dağküplü, Muttalip, 1300 m., alongside the road, June 2003, İ.Potoğlu (OUFE: 10338). The plant was identified according to Flora of Turkey and the East Aegan Islands [8, 9, 10].

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. perforatum* 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 [19]. 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_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

RESULTS AND DISCUSSION

In this study, the heavy metal contents of the leaves and flowers of *H. perforatum* L. 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. perforatum* were found to be 248.453, 42.810, 18028.345, 8695.878, 14.768, 2345.542, 78.706 and 281.221 ppm; and in flower of *H. perforatum* were found to be 187.295, 47.320, 10955.625, 7328.300, 13.772, 3958.755, 63.561 and 75.971ppm for iron, zinc, calcium, magnesium, copper, potassium, manganese, sodium, respectively (Table 2, Figure 1). Fe, Ca, Mg, Cu, Mn and Na concentrations were recorded as higher in the leaf than in the flower, 248.453> 187.295 ppm, 18028.345> 10955.625 ppm, 8695.878> 7328.300 ppm, 14.768> 13.772 ppm. 78.706> 63.561 ppm, 281.221> 75.971 ppm, respectively. Zn and K concentrations were observed to be higher in the flower than in the leaf 47.320> 42.810 ppm, 3958.755> 2345.542 ppm, respectively (Figure 1, Table 2).

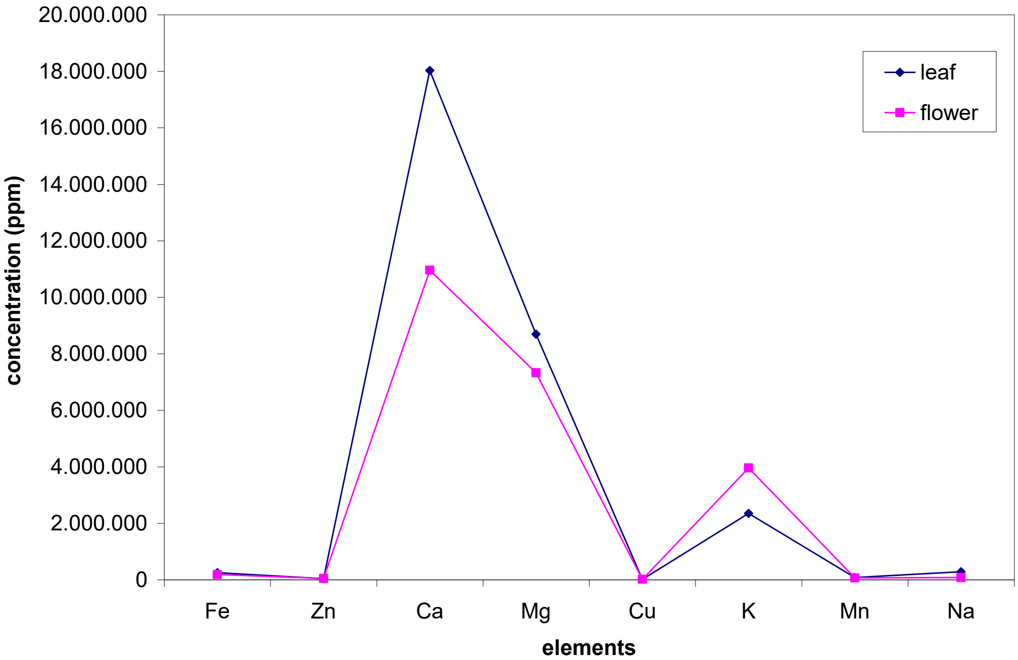

Fig. 1. *Relationship between leaf and flower metal concentrations of H. perforatum*

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

Elements	***H. perforatum***	
	leaf	**flower**
Fe	248.453	187.295
Zn	42.810	47.320
Ca	18028.345	10955.625
Mg	8695.878	7328.300
Cu	14.768	13.772
K	2345.542	3958.755
Mn	78.706	63.561
Na	281.221	75.971

The mean heavy metal content in the flowers of *Hypericum perforatum* L. was, in descending order, Ca>Mg>K>Fe>Na>Mn>Zn>Cu and in the leaves of *H. perforatum* was, in descending order, Mg>Ca>K>Na>Fe>Mn>Zn>Cu. Ca was present in higher concentrations in the leaves (18028.345 ppm) and flowers (10955.625 ppm) of titled plant. Gomez et al. indicated that the Ca concentration in *H. perforatum* was 100-500 ppm for the dried herb, as indicated in table. This situation shows that the Ca concentration of the leaf and flower of *H. perforatum* is higher than that study. Kadioglu et al. found the concentrations to be 495, 62.6, 11.1, 19,5 ppm for iron, manganese, copper, zinc, respectively. In this study, the concentrations of Mn, Cu and Zn were higher, while that of Fe was lower than in the *H. perforatum* concentrations reported by Kadioglu et al. [5].

Elemental studies of the plants revealed that they contained large amounts of nutrients and were rich in Mg, Ca, Na and K [3]. 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 [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, 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 [7]. 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 [6], 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.

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.

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