The International Journal of Engineering and Science (IJES)
|| Volume || 15 || Issue 11 || November || Pages || PP 50-53 || 2026 ||
ISSN (e): 2319-1813 ISSN (p): 2319 – 1805

Investigation of the Trace Element Content of St. John's Wort Oil by ICP-OES

Sukru Kalayci[1*], Mina Erkoyuncu[1], Elif Hayat Başak[1], Osman Bahadir Hamzaoglu[1]

[1]*Gazi University, Faculty of Technical Sciences, Department of Chemical Technology, Ankara, Türkiye*

----------ABSTRACT----------

St. John's wort oil (Hypericum perforatum L.), which originates in Turkey and plays a significant role in wound healing, was analyzed for its mineral content using the inductively coupled plasma optical emission spectrometry (ICP-OES) method. The instrument was first calibrated by employing appropriate determination methods for each element. Subsequently, the elements present in the St. John's wort oil were analyzed. The concentrations of potassium, calcium, magnesium, and sodium were found to be high, while the concentrations of zinc, manganese, copper, iron, aluminum and barium were low. The same sample was also measured using ion chromatography, and the results were found to be consistent with one another.

KEYWORDS; *St. John`s wort oil, Trace elements, ICP-OES, Analysis.*

Date of Submission: 11-11-2026 Date of acceptance: 23-11-2026

I. INTRODUCTION

St. John`s wort (Hypericum perforatum L.) is one of the most interesting medicinal plants with a long history of use in traditional medicine all over Europe; principally for external use in the treatment of burns, bruises, swelling and shingles [1-2]. An area that is receiving more attention is the monitoring of elements for the quality control of medicines including herbal products [3].

Elements have a greater stability in comparison to molecular constituents and many herbs of medicinal interest are known accumulators or hyper-accumulators of metals [4]. The elemental profile of a herbal medicine can also be affected by processing and formulation. In recent years, a number of studies have reported on the presence of toxic elements such as As, Cd, Hg and Pb in herbal products [5]. Consequently, manufacturers are required to ensure concentrations of heavy metals in their products fall within recommended safety limits before they can be sold.

Nowadays, there are a large number of available analytical techniques allowing for trace and ultratrace analysis of elemental composition. For the trace elements that are present in parts per million concentration range, the most widely used technique is probably atomic absorption spectrometry with flame atomization. For ultra trace elements present in concentration of parts per billion and below, the number of suitable techniques drops due to the required analytical sensitivity. The determination of trace elements is commonly held with potentiometry, voltammetry, atomic spectrometry, X-ray, and nuclear methods. Electrochemical methods can measure either free ions in solution (potentiometry) or free ions together with ions bound in labile complexes (voltammetry), and they can also provide analysis of the oxidation state of some of the elements. A large number of samples that need to have determined the concentration of essential and toxic elements belong to food [6-7], environmental [8-9], clinical and biological [10-11] samples.

In this study, the elements present in an oil preparation derived from St. John's wort (Hypericum perforatum L.) grown in the Denizli region were analyzed. The elements within the sample were transferred into an aqueous phase through an appropriate extraction process. The quantities of trace elements in this sample were then measured using the ICP-OES (Inductively Coupled Plasma Optical Emission Spectroscopy) method. The concentrations of potassium, calcium, magnesium, sodium zinc, manganese, copper, iron, aluminum and barium were found. The role of these trace elements in wound healing was also examined.

II. EXPERIMENT

Materials and apparatuses

All chemicals used throughout the experiments were of analytical-reagent grade (Merck, Germany). HNO3 (65%), H_2O_2 (30%) and HCI (37%) were of analytical pure quality (Merck, Germany). Samples of St. John's wort oil produced in the Denizli region were brought in.Milestone microwave digestion device was used

to dissolve the samples.All determinations were performed by Perkin Elmer Optima 5300 DV model inductively coupled plasma optical emission spectrometry (ICP- OES).

Samples

The digestion procedure was as follows: 0.5 g of sample was placed in a polytetrafluoethylene (PTFE) digestion vessel, 2 mL of nitric acid and 2 mL of hydrogen peroxide were added. The samples were then kept at room temperature for 6 hours for homogenization and slow digestion. Afterwards, the containers were closed and the digestion process was carried out by applying a temperature program of 170 °C for 18 minutes to the samples inside [12].

After the digestion procedure, all digestion vessels were left closed overnight for cooling. The next day, container contents were transferred to vials and the final volume adjusted to 10 mL with ultrapure. The appropriate measurement conditions for the analysis of each element using an ICP-OES instrument are provided in Table 1.

ELEMENT	WAVELEİGNT (nm)
K	766,494
Na	589,592
Mg	279,553
Ca	393,366
Zn	213.857
Mn	257,610
Cu	324,354
Fe	238,204
Al	396,152
Ba	455,403

Table 1 Wavelength value of elements in ICP-OES

III. RESULT VIEW

Determination of the optimum conditions of ICP-OES for trace elements

Prior to trace element quantification, conditions for sample preparation and for ICP-OES analysis were carefully chosen, in order to define the optimal settings for the analysis. After optimization, the selected method demonstrated to be the most selective and sensitive.Quantification limits were obtained through the signal/noise (10×S/N) method. Correlation coefficient (R^2), detection limits (LOD) and quantity limits (LOQ) of each element are shown in Table 2. According to these measurements, it was seen that the sensitivity of the method was high and the detection limit could be used easily in the quantitative analysis of metals with very low concentrations.

ELEMENT	R^2	LOD (mgL^{-1})	LQD (mgL^{-1})
K	0,9965	1,01	3,04
Na	0,9986	1,02	3,05
Mg	0,9978	1,05	3,12
Ca	0,9991	1,03	3,09
Zn	0,9989	0,07	0,22
Mn	0,9993	0,08	0,25
Cu	0,9994	0,09	0,29
Fe	0,9988	0,09	0,29
Al	0,9979	0,11	0,33
Ba	0,9987	0,07	0,22

Table 2 Figures of merit of ICP-OES method showing correlation coefficient (R2), limits of detection (LOD) and limits of quantitation (LOQ) of each element.

Analytical performance

Validation of the proposed method was carried out using certified reference material NIST-SRM 1515-Apple Leaves. The comparison of the metal content of the certified reference material with the values measured

by our method is shown in Table 3. Here, it was determined that the accuracy of our method was high. Therefore, it was decided that the metal amounts in our real sample can now be analyzed with our method.

ELEMENT	CERTİFİED VALUE	MİCROWAVE DİGESTION	RECOVERY (%)
Fe	83 ± 5	82 ± 4	97,2
Cu	5,64 ± 0,24	5,51 ± 0,27	99,5
Zn	12,5 ± 0,3	12,1 ± 0,4	98,3

Table 4 The results of analysis with microwave digestion procedures of NIST SRM 1515 Apple Leaves certified reference material (µg/g), N = 4.

Trace elements in St. John's wort

The concentrations of trace elements (K, Na, Ca, Mg, Zn, Cu, Mn, Fe, Al, and Ba) found in three different St. John's wort oil samples obtained from the Denizli region are presented in Table 4. Samples with concentrations exceeding the highest standard were diluted and re-analyzed.At this stage, it was determined that the method employed possesses a high degree of accuracy. Consequently, it was concluded that the metal content in actual samples could be reliably analyzed using this method. Trace elements can easily enter various food products through contaminated ecosystems; therefore, the determination of trace and toxic elements has become significant in the context of human biology [13-14]. An examination of the results obtained from the samples revealed that the levels of trace elements in the St. John's wort oil are slightly higher compared to similar samples from other parts of the world. Nevertheless, the values obtained remain within the limits permitted by relevant regulations. It is estimated that this may be attributed to the climatic conditions in our country [15]

Element	Sample 1	Sample 2	Sample 3
K	520 ± 5	516 ± 4	521 ± 5
Na	51 ± 3	50 ± 3	52 ± 3
Mg	47 ± 2	46 ± 3	48 ± 2
Ca	2,5 ± 0,3	2,4 ± 0,3	2,5 ± 0,3
Zn	18,6 ± 0.6	18,1 ± 0.5	19,1 ± 0.7
Mn	1,82 ± 0,02	1,78 ± 0,01	1,84 ± 0,03
Cu	0,96 ± 0,01	0,93 ± 0,01	0,96 ± 0,01
Fe	1,51 ± 0,01	1,51 ± 0,01	1,57 ± 0,02
Al	9,05 ± 0,22	9,11 ± 0,23	9,08 ± 0,22
Ba	1,13 ± 0,02	1,14 ± 0,03	1,12 ± 0,01

Table 5 Trace element contents (µg/g) in St Tohn`s wort samples after microwave digestion. N= 4.

IV. CONCLUSION

The analysis of trace elements in St. John's wort oilused as a medicinal remedywas conducted using the ICP-OES method. The levels of K, Na, Ca, Mg, Zn, Cu, Mn, Fe, Al, and Ba were found to be identical across all three samples. To obtain a realistic picture of human intake, it is necessary to evaluate the total elemental concentration present in the plants. It has been shown that only a very small fraction of the total elemental content in plants is bioavailable, typically representing less than 1% of the total daily intake for humans.It is known that heavy metals present in St. John's wort oil hinder the plant's development and diminish its biochemical properties. Consequently, the presence of heavy metals also reduces the plant's wound-healing efficacy.

REFERENCE

[1]. Maisenbacher, P., Kovar, K.A. (1992). "Analysis and Stability of Hyperici Oleum", Planta Med., 58, 351-354.
[2]. Crockett S.L. (2010). "Essential oil and volatile components of the genus Hypericum (Hypericaceae)", Natural Product Communications, 9, 1493 – 1506.
[3]. Rascio, N., Navari-Izzo, F. (2011). "Heavy metal hyperaccumulating plants: how and why do they do it? And what makes them so interesting?", Plant Sci., 180 (2), 169-181.
[4]. E. Masarovičová, K. Kráľová, M. Kummerová. Principles of classification of medicinal plants as hyperaccumulators or excluders. Acta Physiol. Plant., 32 (5) (2010), pp. 823-829
[5]. E. Ernst. "Toxic heavy metals and undeclared drugs in Asian herbal medicines", Trends Pharmacol. Sci., 23 (3), 136-139.
[6]. Orecchio S, Amorello D, Raso M, Barreca S, Lino C, Di Gaudio F. (2014). "Determination of trace elements in gluten-free food for celiac people by ICP-MS", Microchem J, 116, 163–172.

[7]. Nowak S, Gesell M, Holtkamp M, Scheffer A, Sperling M, Karst U, Buscher W. (2014). "Low gas flow inductively coupled plasma optical emission spectrometry for the analysis of food samples after microwave digestion", Talanta, 129, 575–578.
[8]. Badocco D, Lavagnini I, Mondin A, Tapparo A, Pastore P. (2015). "Limit of detection in the presence of instrumental and non-instrumental errors: study of the possible sources of error and application to the analysis of 41 elements at trace levels by ICP-MS technique", Spectrochim Acta Part B, 107, 178–184.
[9]. Butler O, Cairns WRL, Cook J, Davidson CM. (2013). "Atomic spectrometry update Environmental analysis", J Anal At Spectrom, 28, 177–216.
[10]. Taylor A, Branch S, Day M, Patriarca M, White M. (2008). "Atomic spectrometry update. Clinical and biological materials, foods and beverages" J Anal AtSpectrom, 2008, 23, 595–646.
[11]. Sun, H., Luo, J., Xie, C. A. (2026). "Study on the serum trace element concentration in patients with androgenetic alopecia", Arch Dermatol Res, 318, 486-491.
[12]. Vinodkumar, T., Dinesh, T., Ghosh, K. Ilavarasan, R. A. (2025). "Comprehensive analysis of minerals in Moringa oleifera leaves, seeds, stem bark, and ash using inductively coupled plasma-optical emission spectroscopy (ICP-OES)", Discov. Chem., 2, 36-42.
[13]. Afridi H.I., Kazi T.G., Jamali M.K., Arain M.B., Jalbani N., Baig J.A. (2008). "Distribution of Zinc, Copper and Iron in Biological Samples of Pakistani Myocardial Infarction (1st, 2nd and 3rd Heart Attack) Patients and Controls" Clin. Chim. Acta, 389(1–2), 114–119.
[14]. Kazi T.G., Memon A.R., Afridi H.I., Jamali M.K., Arain, M.B., Jalbani, N., Sarfraz, R.A. (2008). "Determination of Cadmium in Whole Blood and Scalp Hair Samples of Pakistani Male Lung Cancer Patients by Electro Thermal Atomic Absorption Spectrometer", Sci. Total Environ, 389 (2–3), 270–276.
[15]. Kalayci, S. (2025). "Investigation of the ascorbic acid content of cold-pressed orange and pomegranate juice using electroanalytical methods", The International Journal of Engineering and Science (IJES), 14 (12), 431-434.