



Elemental Composition and Health Risk Assessment of *Smyrniium erfoliatum* (L.): A Medicinal Plant with Therapeutic Potential

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p-ISSN: 1608-9391

e-ISSN: 2664-2786

Article information

Received: 3/9/2025

Revised: 22/11/2025

Accepted: 2/12/2025

DOI:

10.33899/rsci.v35i3.49409

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ABSTRACT

Smyrniium perfoliatum (L.) is a biennial plant that originated in the Mediterranean and southwestern Asia. Still, it has been widely naturalized in Western Europe since ancient times for its medicinal value. Some *Smyrniium* species have been used for their diuretic and depurative properties as well as aperient and antiscorbutic action, different species have been used traditionally for conditions such as indigestion, cystitis, urinary tract infections and gynecological problems. Minerals are necessary for metabolic processes and tissue function, which are necessary for human health as micronutrient deficiency leads to severe health problems. In this study trace and heavy metals, Target Hazard Quotient (THQ), total target hazard quotient (TTHQ) and estimated daily intakes (EDIs) were investigated.

Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) was employed. The contents of the trace elements Mn, Fe, Cu and Zn were 16.730, 41.628, 4.195 and 13.376 (ppm), respectively.

These elements are important for biological systems in minimal amounts, since they participate in redox processes and/or function as enzyme cofactors. The concentrations of heavy metals Cr and Ni were measured at 1.753 and 0.834 ppm, respectively. As a result of the fact that the quantities of heavy and toxic metals were discovered to be below the acceptable limits for medical use, the plant is regarded as safe and is recommended for collecting for the purposes of pharmaceuticals.

Keywords: *Smyrniium perfoliatum* (L.), Minerals, Estimated Daily Intake, Total Target Hazard Quotient.

INTRODUCTION

Perfoliate alexanders, the biennial umbellifer *Smyrniium perfoliatum* (L.), known as perfoliate alexanders, is a relatively easily distinguished member of the Apiaceae by its large golden-yellow flowers and leaves that completely enclose the stem (perfoliate). Native to the Mediterranean region and western Asia, it has been widely naturalized in Western Europe but is not extant as a wild plant (having certainly escaped from cultivation) over much of its range outside Southwest Asia (Bermejo and León, 1994). The genus *Smyrniium* has received increasing attention in recent years from phytochemical and pharmacological viewpoints, thus contributing to the clarification of its complex composition and activity. Traditionally, different species of *Smyrniium* have been important in folk medicine in different cultures. *Smyrniium* roots are also popular as diuretics, depuratives and aperients.

Also, the fruit has been used for its carminative actions and effects on gastrointestinal and different species have been used in traditional medicine to heal discomforts like indigestion, cystitis and urinary tract infections, as well as gynecological conditions (Amiri and Joharchi, 2016). The tonic, antihelmintic and antipyretic properties of the plant are also described. Its use is still being recorded in recent ethnobotanical surveys, highlighting the retention of its space in traditional medicine (Ayaz *et al.*, 2022). Contemporary scientific studies have since started to corroborate and investigate the chemical foundations of these historical applications. Phytochemical investigations on *Smyrniium* species in the recent past revealed diverse bioactive compounds. For example, phytochemical studies in *Smyrniium cordifolium* corroborated the existence of isofuranodiene, curzerene, thymol and (E,E)-germacrone as part of its essential oil composition, which might be responsible for their biological properties (Doodman *et al.*, 2023). Also, the phytochemical study of *Smyrniium olusatrum* showed that it is rich in furanocoumarins and essential oils, which are characterized by antimicrobial and antioxidant activity (Merad *et al.*, 2021). These results are in agreement with the use of these plants in traditional medicine and demonstrate a high potential for medicinal application. Furthermore, its essential oil is also studied and dominated by germacrene B and β -elemene – both with a potential anti-inflammatory impact – and cytotoxicogenic effects (Cherif Hamida *et al.*, 2020). This current study of the volatile compounds and non-gaseous metabolites from the plant renders it a potential candidate for drug discovery programmes. In view of this revitalized scientific interest toward its phytochemistry and the ongoing importance of traditional uses, a profile on safety and efficacy is required. Accordingly, the purpose of this study is to add to the present perspective of pharmacological characterization for *Smyrniium perfoliatum* (L.) by performing a comprehensive elemental composition and human health risk assessment. Through assessing the content of macro elements and toxic metals, this study is intended to offer valuable information for its safe use and rational use as future evidence based phytomedicines.

MATERIALS AND METHODES

Reagents and standards

All solutions were made with ultra-pure water (specific resistance: 18 M Ω cm) from a Milli-Q purification system, made by the firm Millipore Corporation, MA, USA. Working standard solutions were prepared from stock solutions of the analyte to a concentration of 1000 mg L⁻¹, which were obtained from Merck. All glassware was cleaned with ultrapure water (nitric acid washed for 24 h) and washed thoroughly with ultra-pure: water. HNO₃ and H₂O₂ were purchased from Sigma-Aldrich.

Sample collection

The samples used in this study were collected from the Akre area of Duhok city, Iraq, in April 2025. In the biochemistry research lab at the College of Science, Duhok University, leaf segments of the samples were cleaned with a cleaning procedure, dried in shade at 30 to 40°C, and macerated until a fine powder was obtained for analyses. The ground plant materials were maintained in a cool, dark room, free from direct sunlight. The Akre district near Dohuk, Iraq, has fertile soils that are good for growing crops, but it faces challenges like topsoil erosion and water pollution from pesticides.

Microwave digestion

The resultant powder was employed for the intended analysis. Microwave-Facilitated Digestion Utilizing a microwave digestion apparatus, 9 mL of HNO₃ and 1 mL of H₂O₂ were employed to decompose approximately 0.25 g of the sample. A vessel engineered for microwave bomb applications was employed to encapsulate the mixture. After undergoing a heating procedure at 210 °C for a duration of 45 minutes with a power output of 1800 W, the solutions were then cooled and diluted with ultra-pure water to reach a final volume of 50 mL (Ali *et al.*, 2023).

Apparatus

Sample digestion is performed using the ETHOS EASY Advanced Microwave Digestion System and Milestone Connect. The ICP-OES was conducted using a Thermo Scientific ICAP 7000 Series Spectrometer ICP-OES (CID86 resolution of 540*540 pixels). By means of this process it is now possible to measure a metal, quickly and accurately, for any application.

ICP-OES has a broad dynamic calibration range, due to which there is not the limitation of different elements at different wavelengths and working ranges. The multielement ICP QC standard solution of 100 mg/L was diluted with 0.5% (v/v) HNO₃ for preparing the calibration standards.

Analysis of elements was performed by radial and axial measurements at selected wavelengths: Barium (radial only) and other elements (axial). The selected wavelengths for each element were as follows: Fe (259.940 nm), Cu (219.958 nm), Zn (213.856 nm), Mn (260.569 nm), Cr (205.560 nm), Ni (241.476 nm), Mo (202.030 nm), V (309.311 nm), As (189.042 nm), Se (196.090 nm), Cd (226.502 nm), Pb (220.353 nm), Hg (194.277 nm), Be (313.042 nm), Al (167.079 nm), Mg (280.270 nm), Ca (184.006 nm), Na (588.995 nm), K (224.641 nm), Ag (224.641 nm), and Ba (455.403 nm).

Calibration curves for all elements were between 2.5 and 70 ppt. The argon for the plasma torch was 99.99% pure. The generated calibration curves had correlation coefficients; $R^2 \geq 0.98$. Each measurement was repeated three times, and the mean value is calculated by Microsoft Excel.

Health risk assessment

The consumption of *Smyrniium perfoliatum* (L.) was evaluated with the use of the estimated daily intake (EDI), which was used to determine the potential dangers to one's health. A daily intake of one gram of *Smyrniium perfoliatum* (L) per seventy kilogrammes of body weight was used to calculate the EDI value (Dokht *et al.*, 2024).

$$EDI = \frac{MS * C}{BW} \dots\dots\dots 1$$

C is the quantity of metal in *Smyrniium perfoliatum* (L.) in mg/kg, MS is the amount of consumed *Smyrniium perfoliatum* (L.) daily (g/person × day), and BW is the average weight of adult housing intakes believed to be = 70 kg. We could successfully evaluate the non-carcinogenic hazard of metals, and predict their health risk by means of the sample *Smyrniium perfoliatum* (L.) followed by using the formula.

A potential human health risk assessment was performed, and the factors that were considered in conducting it are as follows. The default assumption was applied by the United States Environmental Protection Agency (US-EPA) in the course of calculating as part of an integrated risk assessment. In fact, the value of the target hazard quotient (THQ) is precisely the exposure to reference dose ratio. If the target hazard quotient risk is greater than one, as defined by US EPA in 1989, there may be potential for adverse effects on structures. To determine the THQs, the following equation was used in the calculation process: (Dadar *et al.*, 2017).

$$THQ = \frac{EF * ED * EDI}{RfD * AT} \dots\dots\dots 2$$

EF stands for the frequency of exposure (number of days per year). ED is the exposure time during seventy years. RfD is the acronym given to the reference intake dose of the element in mg/kg/day. (AT) is determined by the formula $(EF \cdot ED) / (365 \text{ days/year} \times 70 \text{ years})$, determining an average life span (Ali *et al.*, 2023).

The total target hazard coefficient, which is more commonly known as TTHQ, is calculated by adding up the values of the target hazard quotient for all metals (Kortei *et al.*, 2020).

Statistical analysis

Based on the results of three separate replicates, the mean values and standard deviation of the parameters that were measured were computed with the help of Microsoft Excel 2016 (version 16.0, 2015).

RESULTS AND DISCUSSION

Food should contain certain things if it is to feed the body and maintain health: much of this is mineral salts, which are quite indispensable to the economy, while salt of some kind simply controls the activities. Elements occur in various natural states and are essential to many bodily mechanisms; trace elements are particularly necessary to cellular mechanisms which take place at the molecular, chemical, and biological scales. They also function as basic entities that can stabilize the molecular structure of enzymes as well as proteins (Matthewman and Costa-Pinto, 2023). Inorganic minerals as shown in (Table 1) have an important function even in minute amounts, usually less than 1 and 2500 milligrammes per day. The mineral requirements of feeding varies within animal species: Just as the differences among variety types of foods are observed, (Godswill *et al.*, 2020). A variety of metabolic processes rely on the presence of magnesium, copper, selenium, zinc, iron, manganese, and molybdenum, which are crucial co-factors in the creation of particular enzymes (Mohammed *et al.*, 2025). Since the pigment haemoglobin transports oxygen in blood cells throughout the human body, it should contain iron. Similarly, iron is found in cellular respiration vital components known as cytochromes (Obeagu, 2025). High intake of iron may impair the liver's normal function (Liu *et al.*, 2023). In human nutrition, chromium, a dietary supplement, is used in cases of the disturbed metabolism of carbohydrates characterized by reduced tolerance of glucose and insulin decompensation, weight reduction and, most importantly, to prevent plaque, known as atherosclerosis, formation within vessels (Dwivedi *et al.*, 2023). Nickel has been suggested to function as a cofactor in the activation of some enzymes which participate in glucose metabolism or oxidation. Nickel is also involved in the formation of prolactin. However, it is plausible that high exposure to nickel could be hazardous (Zhu *et al.*, 2011). Barium is not an essential nutrient for terrestrial plants and can be toxic when present at sufficiently high levels (Supriya *et al.*, 2020).

Inorganic arsenic has been considered a carcinogen, which may induce skin, lung, liver and bladder cancer (Palma-Lara *et al.*, 2020). Cadmium could induce epigenetic alterations which play a critical role in the etiology of various cancers, chronic diseases, and other disease conditions. Human exposure to cadmium may result in cancer (Charkiewicz *et al.*, 2023). The nervous system is highly sensitive to many forms of mercury. Chronic exposure to high levels could cause brain, kidney and developing foetal damage (Chamoli and Karn, 2024). When aluminium accumulates in the kidney, it is harmful to tubular cells lining the kidney.

Several studies find that using underarm deodorants, especially those containing aluminium salts, increases the risk of breast cancer (Peto, 2010). Respiratory issues, lung and throat irritation, and stomach pain can be caused by the inhalation of high amounts of airborne silver (Rosário *et al.*, 2022). Although more than 4000 patents relating to vanadium compounds have been published for applications against parasites, viruses, bacteria, thrombosis, high blood pressure and atherosclerosis, many subject matters of these patents were for anti-HIV as well as anti-TB agents, but the majority of them were for anti-cancer and anti-diabetic drugs (Treviño *et al.*, 2019). Lead is among the most hazardous toxic metals. It causes degeneration of nerves and is toxic to many other tissues, including

lungs, liver, blood vessels and the reproductive system. Women who are exposed to lead are at increased risk of a number of pregnancy complications, such as miscarriage (Mandal *et al.*, 2023).

Beryllium and its compounds are extremely toxic, especially when inhaled as dust; the poison can cause a chronic life-shortening chronic granulomatous lung disease with a relatively high percentage possibility of fatality if the dose is sufficient to cause berylliosis. (Vaessen and Szteke, 2000). Sodium, potassium and chloride are important in the regulation of osmotic pressure in interstitial fluid and within cells (Preuss, 2020). Plants' pigment chlorophyll is bound with magnesium (Ye *et al.*, 2019).

The interrelationship between nutrition and drug metabolism and nutrition and diseases also had interrelated effects. The excessive intake of individual minerals can upset the body's harmony and result in damage. High salt intake is associated with high levels of blood pressure (Hunter *et al.*, 2022). In order to maintain bone health, as well as enable the correct functioning of muscles and nerves, vertebrates, which include humans, require loads of calcium (Vieira *et al.*, 2025). The body is a delicate machine that must be held in balance for its normal function and health, and when minerals are deficient or they're haphazardly self-prescribed, this balance can be disrupted. Patients with chronic health conditions or those on medications that affect mineral uptake must be aware of the biochemistry of mineral elements (Ali, 2023).

Table (1): The concentrations (n=3) of certain elements and the corresponding RDA, RfD, EDI, THQ, and TTHQ values determined for elements in the *Smyrniium perfoliatum* (L.) sample.

Element	Conc. PPM	SD	RSD	EDI $\mu\text{g/kg/day}$	THQ	RfD $\mu\text{g/kg/day}$	RDA $\mu\text{g/day}$
Zn	13.376	1	7.48	0.1911	0.063700	3.0	11,000
Cu	4.195	0.1	2.38	0.0599	0.001498	40.0	900
Fe	41.628	1.528	3.67	0.5947	0.000849	700.0	8,000
Se	0.001	0	0	0.0000	0.000000	5.0	55
Mn	16.730	0.477	2.85	0.2390	0.001700	140.0	2,300
Cr	1.753	0.03	1.71	0.0250	0.008330	3.0	30
Mo	0.234	0.02	8.55	0.0033	0.000660	5.0	45
Ni	0.834	0.03	3.60	0.0119	0.000595	20.0	5.0
Ba	5.712	0.1	1.75	0.0816	0.000408	200.0	
As	2.432	0.103	4.2	0.0348	0.116000	0.3	
Cd	0.001	0	0	0.0000	0.000000	1.0	
Hg	0.002	0	0	0.0000	0.000000	3.0	
Al	57.743	1.1	1.9	0.8249	0.000825	1,000.0	
Ag	9.429	0.577	6.12	0.1347	0.026940	5.0	
V	0.002	0	0	0.0000	0.000000	1.0	
Pb	0.003	0	0	0.0000	0.000000	3.4	
Be	0.001	0	0	0.0000			
Mg	0.002	0	0	0.0000			420,000
K	0.006	0	0	0.0000			4,700,000
Na	0.004	0	0	0.0000			2,300,000
Ca	1704.969	8.548	0.5	24.3567			1,300,000
TTHQ					0.221505		

Note: (Relative Standard Deviation) RSD is less than 5%: High level of precision, RSD 5–10%: High precision and a Zero RSD % suggest extremely low concentrations.

The leaves of *Smyrniium perfoliatum* (L.) were observed to have trace quantities of non-essential heavy metals apart from the important elements like zinc, iron, and copper, as revealed by elemental

analysis. The content of all elements, including possibly harmful ones such as cadmium, lead and aluminium, should not exceed the levels specified for medicinal plants. This safety is also supported quantitatively by the health risk assessment, which indicated that the estimated daily intake of all elements was far below one, and both individual THQs and total THQ were lower than one. From this study, it could reasonably be argued that eating the plant won't increase the risk of cancer in humans. However, it is important to consider the total quantity of those elements that patients get via their diet, which includes all sources, such as food and supplements, even if the plant itself has a minimal risk relative to the whole population. Further examination of repeated exposure to low concentration heavy metals is necessary to avoid potential toxicity and body burden accumulation.

It's the equivalent of the situation you have when you eat too many vitamins, like iron or zinc. Thus, the results of this study show that *S. perfoliatum* (L.) is a safe mineral source; however, intake values must be assessed in terms of a specific dietary table.

Research by Mohsen Jalali and Rosa Fakhri reported the Calcium, Potassium, Magnesium, Sodium, Cadmium, Cobalt, Copper, Iron, Manganese, Nickel and Zinc, content of *Smyrniun cordifolium* Boiss (L.) were 9202200, 78303100, 7700200, 405200, 800, 600, 4000, 90000, 8000, 6900 and 14000 ppm dry weight respectively. While the value of estimated daily intake for Cadmium, Cobalt, Copper, Iron, Manganese, Nickel and Zinc found to be 0.1, 0.0, 0.2, 4.6, 0.6, 0.1 and 0.1 µg/kg/day respectively (Jalali and Fakhri, 2021).

Comparison with literature revealed that the elemental constituents of medicinal plants in the same genus could largely differ. These variations are due to a combination of species traits and notably the geochemical context of the plant habitat. *Smyrniun cordifolium* accumulates some elements in very high concentrations; it also accumulates dangerous levels of cadmium. The results for *Smyrniun perfoliatum* from this study, the essential element to toxic heavy metal ratio for *Smyrniun perfoliatum* was well balanced, and these low contents of toxic heavy metal clearly indicate that this species is a safe and attractive candidate as a pharmaceutical industry source. This difference calls for element-wise health risk assessments relevant to every plant species on a per-geographical-source basis.

CONCLUSION

According to the elemental content's values and health risk indices, *Smyrniun perfoliatum* L. can be considered as a safe medicinal plant that is rich in favorable minerals and has low health risks the contents of major and trace elements like Zn, Fe, Cu, Mn, Cr and Ni fall within permissible levels, and all the non-carcinogenic hazard quotients (THQs/TTHQs) as well as estimated daily intakes (EDIs) are much lower than the maximum acceptable limits. The plant looks particularly promising as a major natural calcium source. These findings provide useful information for the safe use of this compound in pharmaceutical and traditional medicines.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to the Directorate of Ibrahim Khalil International Entry Complex, New Standard Company Complex Lab, for making it possible for them to carry out this study by using ICP-EOS for mineral testing.

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تقدير المعادن وتقييم المخاطر الصحية لنبات سمريونيون محيطي الأوراق: نبات طبي ذو امكانات علاجية

بشير شوكت عيسى

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الملخص

سمريونيون محيطي الاوراق (*Smyrniun perfoliatum* (L.) نبات ثنائي الحول، الموطن الاصلي له حوض البحر الابيض المتوسط واجزاء من جنوب غرب اسيا ويتواجد ايضا في مناطق اوربا الغربية حيث ان النبات له تاريخ في الزراعة ويعتبر من النباتات الطبية، ويستخدم كمدرر للبول كما ان له تأثيرات مهدئة وكذلك يستخدم للتطهير ويعمل كمضاد لداء الاسقربوط، وهو مفيد للجهاز الهضمي، طارد للغازات وقد استخدمت انواع منه لعلاج حالات عسر الهضم والتهاب المثانة والتهاب المسالك البولية وامراض النساء، اضافة الى امتلاكه لخصائص منشطة ومضاد للديدان وخافض للحرارة. من المعلوم ان المعادن ضرورية لعمليات الابيض المختلفة ووظائف الانسجة وهي ضرورية للحفاظ على صحة الانسان. ان نقص المعادن النزرة يؤدي الى مشاكل صحية خطيرة، لذلك هدفت هذه الدراسة الى تقييم مستويات المعادن الاساسية اضافة الى قياس بعض العناصر الثقيلة المؤذية لصحة الانسان الموجودة في نبات السمريونيون بيرفولياتوم. تم تقدير عنصر الزنك، النحاس، الحديد، السيلينيوم، المنغنيز، الكروم، النيكل، المغنيسيوم، البوتاسيوم، الصوديوم، الكالسيوم، البريليوم، الفناديوم، الفضة، الزئبق، الرصاص، الألمنيوم، الزرنيخ، المولوبوديوم، الكاديوم والباريوم. كما تم حساب نسبة المخاطر المستهدفة (THQ) وكذلك اجمالي نسبة المخاطر المستهدفة (TTHQ) والكميات اليومية المقدرة (EDI) والكميات الغذائية الموصى بها (RDA).

استخدمت تقنية مطيافية الانبعاث البصري البلازمي المقترن بالحث (ICP-OES) وجد ان تراكيز العناصر النزرة لكل من المنغنيز، الحديد، النحاس والزنك بلغت 16.730، 41.628، 4.195 و 13.376 جزء من المليون على التوالي. تعد هذه العناصر مهمة للأنظمة البيولوجية بكميات ضئيلة، اذ تشارك في عمليات الاكسدة والاختزال وتعمل ايضا كعوامل مساعدة للإنزيمات. تراكيز المعادن الثقيلة كالكروم والنيكل كانت 1.753 و 0.834 جزء من المليون على التوالي. نظرا لان كميات المعادن الثقيلة والسامة اقل من الحدود المقبولة للاستخدام الطبي، يعتبر النبات آمنا طبيا ويوصى به لأغراض المستحضرات الصيدلانية.

الكلمات الدالة: سمريونيون محيطي الأوراق، المعادن، كميات الغذاء الموصى بها، اجمالي نسبة المخاطر المستهدفة.