Ethnobotany, medicinal utilization and analysis of biogenic elements and flavonoids of *Apium graveolens* and *Tussilago farfara* from Uzbekistan

Saidaxon Islomova, Ibrahimjon Asqarov, Rainer W. Bussmann, Olim K. Khojimatov, Muhammad Zafar, and Trobjon Makhkamov

Correspondence

Saidaxon Islomova[1], Ibrahimjon Asqarov[2], Rainer W. Bussmann[3,4]*, Olim K. Khojimatov[5], Muhammad Zafar[6] and Trobjon Makhkamov[7]*

[1]Andijan State Medical Institute, Andijan 170100, Uzbekistan
[2]Andijan State University, Andijan 170127, Uzbekistan
[3]Institute of Botany, Ilia State University, Tbilisi 0105, Georgia
[4]Department of Botany, State Museum of Natural History, 76135 Karlsruhe, Germany
[5]Tashkent Botanical Garden named after Academician F.N. Rusanov at the Institute of Botany of the Academy of Sciences of the Republic of Uzbekistan, st. Bogishamol, 232 B, Tashkent, 100140, Uzbekistan
[6]Quaid-i-Azam University, Islamabad 45320, Pakistan
[7]Tashkent State Agrarian University, Tashkent region 100700, Uzbekistan

*Corresponding Author: mturobzhon@mail.ru; rainer.bussmann@iliauni.edu.ge

Ethnobotany Research and Applications 26:36 (2023) - http://dx.doi.org/10.32859/era.26.36.1-12
Manuscript received: 24/08/2023 – Revised manuscript received: 08/09/2023 - Published: 09/09/2023

Notes on Ethnobotany

Abstract

Background: Plants are a rich source of both organic and inorganic substances that play a crucial role in determining their therapeutic effects. Within each medicinal plant, a diverse array of chemical compounds and trace elements can be found, contributing to its wide spectrum of healing properties. It is important to highlight that certain chemical element found in medicinal plants are essential for sustaining life processes. Elements such as calcium (Ca), potassium (K), sodium (Na), sulfur (S), iron (Fe), silicon (Si), manganese (Mn), magnesium (Mg), and zinc (Zn) are involved in nearly all biochemical processes within the body. They play crucial roles in regulating energy metabolism, primary and secondary metabolism, as well as hormonal regulation occurring within cells. This article examines the ethnobotany, medicinal utilization and analysis of biogenic elements and flavonoids of *Apium graveolens* and *Tussilago farfara* from Uzbekistan.

Methods: The determination of biogenic elements in food products has been carried out using the plasma inductively coupled mass spectrometry method (ICP-MS). The reagents employed in the process included Standard No. 3, which contains multiple elements (29 elements for mass spectrometry). Additionally, the standards encompassed mercury, nitric acid, hydrogen peroxide, bi-distilled water, and argon gas (with a purity of 99.995%). The samples were subjected to analysis using the Agilent-1200 HPLC method with a diode detector, operating in the isocratic elution mode. The mobile phase consisted of a mixture of acetonitrile and buffer solution in a ratio of 70:30. The eluent flowed at a volumetric flow rate of -1.0 ml/min, and 10 µl of the sample was injected. Detection was performed at a wavelength of 254 nm. The chromatographic column used was the Eclipse XDB-C18, with dimensions of 5.0 microns and 4.6×250 mm. The thermostat temperature was maintained at 300°C.

Results: Analyzing the study results we observed that all samples contained more than 18 elements: Highest concentration of Sodium, Magnesium, Potassium, Calcium, Iron, Copper, Zinc in the seeds of *Apium graveolens*, followed by *Tussilago farfara* and *A. graveolens* leaves. As a result of the analysis conducted on extracts of Tussilago farfara and Apium graveolens, six phenolic flavonoid compounds were successfully isolated. One particular flavonoid, apigenin, exhibits a retention time shift during analysis, indicating its presence. The relatively high concentrations of flavonoids such as rutin, quercetin, and dihydroquercetin further contribute to the significance of studying these plants.

Conclusion: The conducted studies focused on the analysis of nutrients and flavonoids present in plants such as *Tussilago farfara* and *Apium graveolens*. Additionally, these medicinal plants were found to be rich in essential elements such as calcium, magnesium, potassium, and iron. Building upon these findings, the proposal was made to develop novel dietary supplements aimed at providing relief in the treatment of bone-related disorders, cardiovascular issues, and anemia.

Key words: celery**,** coltsfoot, ethnobotany, medicinal utilization, biogenic elements, flavonoids.

Background.

Folk medicine has long relied on the utilization of plant and animal components known for their healing properties, as well as the therapeutic benefits offered by various minerals. This traditional approach to treating diseases and ailments is deeply rooted in communities worldwide. Building upon centuries of empirical knowledge, it is essential to recognize and harness the potential of these natural resources to improve healthcare practices.

Over the course of many years, extensive experiments have demonstrated that natural remedies have a remarkable ability to positively impact the human body without causing adverse effects. This has led to their recognition as a safe and reliable option for various treatments. In the realm of patient care, it is crucial to acknowledge and integrate the benefits of both modern medicine and folk medicine. By combining these two approaches, we can effectively prevent numerous health issues and promote overall well-being.

Uzbekistan boasts an impressive natural diversity, with approximately 4500 species of high plants naturally distributed throughout the country. Among these plant species, around 1200 have been identified to possess medicinal properties, highlighting the rich potential for traditional medicine. At present, the Republic of Uzbekistan officially permits the use of 112 types of medicinal plants in the field of modern medicine (Khojimatov, 2021). Notably, a remarkable 80% of these approved plants are naturally occurring and grow abundantly within the country (Khaydarov & Khozhimatov 2002).

Plants are a rich source of both organic and inorganic substances that play a crucial role in determining their therapeutic effects. Within each medicinal plant, a diverse array of chemical compounds and trace elements can be found, contributing to its wide spectrum of healing properties. These chemical constituents are responsible for the plant's medicinal efficacy and have been the subject of extensive research and exploration (Karimov 2003).

It is important to highlight that certain chemical element found in medicinal plants are essential for sustaining life processes. Elements such as calcium (Ca), potassium (K), sodium (Na), sulfur (S), iron (Fe), silicon (Si), manganese (Mn), magnesium (Mg), and zinc (Zn) are involved in nearly all biochemical processes within the body. They play crucial roles in regulating energy metabolism, primary and secondary metabolism, as well as hormonal regulation occurring within cells (Askarov & Ashuraliyeva 2012).

Folk medicine represents an ancient and time-honored approach to treating diseases. Rooted in traditional knowledge and practices, this method relies on the utilization of healing plants, animals, minerals, and various other natural elements for therapeutic purposes (Tayjanov et al. 2021). Folk medicine embodies a holistic perspective, considering the interconnectedness of the human body with nature and recognizing the innate healing properties present in the natural world (Askarov 2021).

In recent years, the number of ethnobotanical studies in Uzbekistan is increasing (Khojimatov, 2021; Tayjanov et al. 2021; Boboev et al. 2023; Makhkamov et al. 2023). This scientific research work can serve as a basis for effective use of medicinal plants.

Flavonoids, being biologically active substances found abundantly in plants, have demonstrated their efficacy in numerous medicines used in the field of medicine. Recognizing the potential of these compounds, we have undertaken a research study aimed at investigating the biogenic elements and flavonoid profiles of *Tussilago farfara* and *Apium graveolens*. To achieve this, we employ advanced instrumental analysis techniques, which enable us to delve deeper into the composition and properties of these plants. Through our research, we aim to enhance our understanding of the biologically active components present in these plant species and contribute valuable insights to the development of novel therapeutic approaches based on flavonoids.

Materials and Methods

Study objects

***Apium graveolens* L.**

Synonyms: *Apium celleri* Gaertn., *Apium decumbens* Eckl. & Zeyh., *Apium dulce* Mill., *Apium graveolens* var. bashmensis Hosni, *Apium graveolens* var. *butronensis* D.Gómez & G.Monts., *Apium graveolens* var. *butronensis* D. Gómez & G. Monts., *Apium graveolens* subsp. *butronensis* (D. Gómez & G. Monts.) Aizpuru, *Apium graveolens* var. *dulce* (Mill.) DC., *Apium graveolens* var. *lusitanicum* (Mill.) DC., *Apium graveolens* f. lusitanicum (Mill.) J. Helm, *Apium graveolens* var. *maritimum* Dumort., *Apium graveolens* subsp. *rapaceum* (Mill.) P.D. Sell, *Apium integrilobum* Hayata, *Apium lusitanicum* Mill., *Apium maritimum* Salisb., *Apium palustre* Thore, *Apium rapaceum* Mill., *Apium vulgare* Bubani, *Carum graveolens* (L.) Koso-Pol., *Celeri graveolens* (L.) Britton, *Libanotis graveolens* G. Don, *Selinum graveolens* (L.) E.H.L. Krause, *Seseli graveolens* (L.) Scop., *Sium apium* Roth, *Sium graveolens* (L.) Vest

Local names: Uzbek: Kafs; Russian: Сельдерей (celderei); Azeri: кэревюз (kerevjuz); Armenian: нехур (nekhur); Georgian: ნიახური (Niakhuri), დიდი ნიახური (didi niakhuri) (Grossheim 1952; Ketskhoveli et al., 1971-2011; Makashvili, 1991; Sokolov 1988); Persian: Karafs کرفس; English: Celery (Bussmann et al. 2021).

Kafs, commonly known as celery (*Apium graveolens* L.), is a versatile plant distributed across various regions of the world. In its wild form, celery was found in Western Europe, Asia, India, North and South America, Australia, New Zealand, and predominantly in the southern parts of the European region of the Russian Federation. The cultivation of celery has expanded worldwide, including in Uzbekistan (Bussmann et al. 2021; Khaydarov & Khozhimatov 2002; Tayjanov et al. 2021; Scott Cunningham 2014).

Annual or biennial; root fusiform, branching, lignifying in second year, cultivated forms with fleshy, cylindrical-turnip- shaped root; stem erect, 30-100 cm high, furrowed, often hollow, strongly branching, with spreading branches; leaves long-petioled (petioles sometimes fleshy), the lowermost leaves trifid, becoming pinnate, resembling cauline leaves; upper cauline leaves sometimes opposite, subsessile, on short sheaths with white- scarious margins; in lower leaves first-order lobes rounded, obtuse at base, 3-lobate or tripartite, incised-dentate with acute teeth, these of cauline leaves cuneate at base, with acute whitish-cartilaginous teeth. Umbels numerous, small, on short peduncles or subsessile, of 6-12 glabrous rays; involucre and involucels none; petals white, ca. 0.5 mm long; fruit 1.5-2 mm long, nearly as wide. Flowering July-September. Ural, Caucasus, along creeks, often as a weed in wet places., widely cultivated (Bussmann et al. 2021).

Apium is originally endemic to the Mediterranean region and was already cultivated in ancient times In Europe it was known in the Middle Ages, but its widespread cultivation began only in the 18th century. Celery occurs wild in Europe, the Mediterranean region and in Asia west of the Himalayas. The ancient Greeks and Egyptians already cultivated celery. It was probably first grown as a medicinal plant, later for the leaves as flavoring. Celery has a long history in China, dating back to at least the 6thcentury AD. In Central Europe cultivated celery was recorded in 1623 in France. (Bussmann et al. 2021; Shishkin 1950).

The plant thrives in environments that provide ample moisture and exhibits impressive resilience to frost. The seeds possess a remarkable ability to germinate even at low temperatures, with an optimal range of 3°C to 15°C. As the seedlings emerge, they display a remarkable tolerance to frost, enduring temperatures as low as -5°C without significant damage (Bussmann et al. 2021).

Phytochemistry

Carbohydrates (mannitol), organic acids (amber, apple, lemon, tartar, oxalic), essential oils (4-ethylhexane, a-pinene, 3-pinene, camphen, sabinene, myrcene, limonene, cis-ocimene, y-terpene, trans-ocimene, terpinolene, npentylcyclohexadiene, allo-cymene, alimene, pentyl benzene, terpinol, caryophyllene, humylen, a-terpineol, 3-selenene, butylidenaphthalide, 3-n-butyl-phthalene, ligustilide), phthalides (butylphthalide, butylidene, butylidenephthalide, sidanonic acid, clodidyl, neocyanidyl, senkiunolide), phenylcarboxylic acids (chlorogenic), organic acids (oxalic, acetic), coumarins (bergapten, zoopinelline), flavonoids (luteoline, apigenine, apiine, apion, quercetine), anthocyanins (feruloyl, synapoyil, cyanidine), vitamins (K), coumarins (bergapten, xanthatexine, isopimpinelline, apiometine, retine, selerine, seleroside) (Bussmann et al. 2021; Sokolov 1988).

***Tussilago farfara* L.**

Synonyms: *Cineraria farfara* (L.) Bernh.; *Farfara radiata* Gilib.; *Petasites farfara* Baill.; *Tussilago alpestris* Hegetschw.; *Tussilago generalis* E.H.L.Krause; *Tussilago radiata* Gilib.; *Tussilago ruderalis* Salisb.; *Tussilago rupestris* Wall.; *Tussilago umbertina* Borbás; *Tussilago vulgaris* Lam.

Local names: Russian: Мать-и-мачеха обыкновенная (Mat'-i-machekha obyknovennaya); Uzbek: Okkaldirmok, Ottuyoq; Kygyz: Кадимки огой Эне (Kadimki ogoy ene); Tadjik: Поиасб (Poiasb) (Dadabaeva 1996); English: Coltsfoot (Khojimatov et al. 2023; Sokolov 1993).

Perennial. Rhizome long, creeping; flowering shoots 10-25 cm high, covered with scaly, appressed, ovate-lanceolate, acute leaves, mostly purple-violet. Basal leaves appear after anthesis, long-petiolate, roundish-cordate, 10-25 cm wide, angular, with irregular teeth, coriaceous, floccose on both sides, but later glabrous above, whitish-tomentose with soft hairs. Capitula solitary, 2.0-2.5 cm in diameter, drooping. Florets golden yellow; pappus 4-5 times as long as achenes. Flowering April to May Ural, Caucasus, Altai, Middle Asia, widely distributed; found on young alluvial deposits, both clayey and sandy, or leached soils, on slopes along bottoms of ravines and on railroad embankments; also distributed in middle mountain zone on rock outcrops and along banks of mountain streams and rivers. (Khojimatov et al. 2023; Shishkin and Boborov 1961). These flowers add a splash of color to the plant and attract pollinators (Putyrskiy & Prokhorov 2000).

Phytochemistry: Carbohydrates (inuline, raffinose, sucrose, mukopectine, pectine), latex, steroids (sitosterol, stigmasterine), alkaloids (tussilagine, senesionine, senkirkine, petazitenine, symphitine), essential oils, vitamins (C), tannins, sesquiterpenoids (tussilagon, hydroxytussilane), flavonoids (kaempferol, quercetine, rutine, hyperoside), fatty acids (caprylic, pelargonic, capric, undecano, lauric, myristic, palmitic, stearic, arachine, dodecene, tridecanoic, tridecene, tetradecene, pentadecene, pentadecanoic, hexadecene, heptadecanoic, heptadecene, octadecene, octadecadiene, octadecatriene), phenolcarboxylic acids (ferulic, p-hydroxybenzoic, coffee). (Khojimatov et al. 2023; Sokolov 1993).

Analysis of biogenic elements.

The determination of biogenic elements in food products has been carried out using the plasma inductively coupled mass spectrometry method (ICP-MS). In this method, precise measurements of calcium, phosphorus, magnesium, iron, and iodine content are obtained. The procedure involves weighing 0.0500 - 0.500 g of the sample on an analytical scale and transferring it into a Teflon container within an autoclave. Next, a corresponding volume of purified concentrated mineral acids, such as nitric acid and hydrogen peroxide, is added to the sample. The autoclave is then sealed and placed in a Berghof programmed microwave shredder (MWS-3+). This technique ensures efficient digestion of the sample, enabling accurate analysis of the biogenic elements present.

To enhance the clarity and readability of the paragraph, you can consider the following revision: The selection of the appropriate program depends on the type of substance under examination. Following the breakdown of the substances within the autoclave, a 50- or 100-ml meter is utilized to transfer the samples into flasks. These flasks are then filled to the desired mark using 0.5% nitric acid. Subsequently, the substances are detected using an argon plasma emission spectrometer, which is bound in an ISPMS or a similar inductive state instrument.

When conducting the aforementioned analyses, the following equipment was utilized: an ISPMS NEXION-2000 mass spectrometer or a similar instrument, microwave separators from Germany or similar Teflon autoclaves, and flasks of various sizes. The reagents employed in the process included Standard No. 3, which contains multiple elements (29 elements for mass spectrometry). Additionally, the standards encompassed mercury, nitric acid, hydrogen peroxide, bi-distilled water, and argon gas (with a purity of 99.995%).

Analysis of flavonoids.

The samples were subjected to analysis using the Agilent-1200 HPLC method with a diode detector, operating in the isocratic elution mode. The mobile phase consisted of a mixture of acetonitrile and buffer solution in a ratio of 70:30. The eluent flowed at a volumetric flow rate of -1.0 ml/min, and 10 µl of the sample was injected. Detection was performed at a wavelength of 254 nm. The chromatographic column used was the Eclipse XDB-C18, with dimensions of 5.0 microns and 4.6×250 mm. The thermostat temperature was maintained at 300°C.

To determine the flavonoids in the samples, 5-10 g of the sample was weighed on an analytical scale and placed in a 300 ml flat flask. Subsequently, 50 ml of a 70% ethanol solution was added to the flask. The mixture was heated under vigorous stirring at a temperature of 70-80°C for 1 hour using a magnetic stirrer and reflux condenser. Afterward, it was stirred at room temperature for 2 hours. The mixture was then cooled and filtered. The remaining portion was re-extracted twice by adding 25 ml of 70% ethanol each time. The filtrates were combined and filled up to the mark with 70% ethanol in a 100 ml volumetric flask. The resulting solution was centrifuged at a speed of 6000-8000 rpm for 20-30 minutes, and the top portion of the solution was collected for analysis.

The analysis commenced by introducing working standard solutions followed by prepared working solutions into the chromatograph.

Results and Discussion.

Ethnobotany and medicinal utilization.

***Apium graveolens* L.**

In the Northern Caucasus the roots are used as diuretic and antiscorbutic, and against rheumatism. Celery seed extract aids in the elimination of uric acid and is often used for the relief of symptoms of arthritis, rheumatism and inflammation of the joints. Its diuretic properties assist in relieving fluid retention. Celery seeds also relieve pain. (Bussmann et al. 2021; Sokolov 1988).

Aerial parts of *A. graveolens* help to relieve asthma, headache and low back pain (Hooper & Field 1937; Ghorbani 2005; Mahdavi Meimand & Mirtajadini, 2010). This species is used as carminative, diuretic, sedative and general tonic (Hooper & Field 1937, Amin 2005, Mahdavi Meimand and Mirtajadini 2010). It is also used to treat rheumatic diseases and to stimulate menstruation (amenorrhea) (Amin 2005, Amiri et al. 2014). These plants were thought to be efficient remedies for urinary tract infection (Mahdavi Meimand and Mirtajadini 2010). The roots are used as diuretic (Bussmann et al. 2014; 2016a,b; 2017a,b; 2018, 2021).

The leaves of the celery plant are rich in various beneficial compounds, including carotene, vitamins, and the glycoside apinin. In traditional Central Asian folk medicine, celery has been utilized for its medicinal properties in treating a range of ailment (Bussmann et al. 2021).

One of its notable uses is in the treatment of respiratory conditions such as pneumonia and bronchial asthma. The plant's properties are believed to help alleviate symptoms associated with these respiratory disorders, providing relief and promoting better breathing (Bussmann et al. 2021).

Celery has also been used in folk medicine to address hepatitis, a condition affecting the liver. The plant's medicinal components are thought to possess properties that aid in liver health and promote its proper functioning (Bussmann et al. 2021).

Celery roots are known to have a dry matter content ranging from 10 to 20%, consisting of various beneficial components. Among these are approximately 2-4% sugar and 1-2.5% raw protein. Additionally, celery roots are a good source of essential minerals such as potassium, calcium, and phosphorus. (Khalmatov 2002). Celery leaves also contain a significant amount of dry matter, typically ranging from 10 to 18%. They are known to contain around 1% sugar and approximately 2-3% raw protein. The leaves of celery are particularly notable for their high content of ascorbic acid, also known as vitamin C, with levels reaching up to 110 mg% in leaves. Other essential vitamins such as B1 (thiamine), B2 (riboflavin), and vitamin PP (niacin). These vitamins are involved in various metabolic processes and contribute to overall well-being. (Encyclopedia of Chinese Medicine). (Bussmann et al. 2021).

Celery is packed with biogenic elements and biologically active substances that offer numerous benefits to the body. These components have a positive impact on metabolism, promoting healthy bodily functions and contributing to overall well-being (Bussmann et al. 2021).

The biogenic elements and antioxidants present in celery play a crucial role in slowing down the aging process. Antioxidants help protect cells from oxidative damage caused by free radicals, reducing the signs of aging and promoting healthier-looking skin (Bussmann et al. 2021).

Apium graveolens L. is a plant with various medicinal properties. In the case of osteochondrosis, a condition affecting the joints and cartilage, consuming 2 teaspoons of celery root juice three times a day is recommended for potential relief (Bussmann et al. 2021).

To prepare the celery root juice, you can start by adding a tablespoon of the root to two glasses of boiling water. Allow this mixture to steep for approximately four hours. Afterward, strain the liquid and consume 50 ml (about half a glass) of the juice three times a day, preferably half an hour before meals (Asqarov 2021; Bussmann et al. 2021).

During the summer months, the leaf is carefully harvested, removing approximately half of the leaf band. This selective cutting technique ensures optimal quality. Afterwards, the collected flowers and leaves are spread thinly on a cool surface to undergo a thorough drying process. This drying method helps preserve the plant's beneficial properties (Bussmann et al. 2021).

The young stems are pickled, the seeds used as spice. The most common use of celery is for its thick, succulent leaf stalks that are used, often with a part of the leaf blades, in soups, cooked dishes and salads. Celery seeds can be used as flavoring or spice either as whole seeds or, ground and mixed with salt. Celery salt can also be made from an extract of the roots. Roots used as soup spice; leaves as spice for various dishes. (Grossheim 1952; Sokolov 1988). Young leaves of celery are commonly used as a vegetable (Mozaffarian 2013). Leaves and stems are eaten, added while cooking or fresh after cooking. The roots are eaten raw or cooked. (Bussmann et al. 2014; 2016a,b; 2017a,b; 2018); (Bussmann et al. 2021).

All parts of celery, including the roots, stems, leaves, and rhizome, can be utilized in a variety of culinary preparations. They can be incorporated into first and second courses, salads, drinks, sauces, and even used as spices. celery stems are often recommended as a substitute for salt in dishes. This recommendation is particularly beneficial for individuals with kidney or gallbladder conditions, as excessive salt intake may exacerbate these conditions (v; Zokirov 2000).

***Tussilago farfara* L.**

Originally included in a large number of official herbal pharmacopoeiae. More recently removed due to possible toxicity and carcinogenic activity. Traditionally used in the whole region as expectorant and suppressant for cough, respiratory diseases, bronchial asthma, emollient, anti-inflammatory, for tracheitis, laryngitis, bronchopneumonia, bronchial asthma, bronchitis. Topically as poultice for infected wounds, skin ulcers, burns, periodontitis, treat tumors, abscesses, and furuncles. Juice from fresh leaves and roots is used to treat tuberculosis and malaria, and as a choleretic and diaphoretic. The decoction is used to treat tracheitis, kidney and bladder diseases, the gastrointestinal tract, loss of appetite, fever, erysipelatous skin inflammation, scrofula, hair loss, and abscesses. Fresh juice from the leaves is inhaled into the nostrils to eliminate sinus colds. The juice of leaves is also mixed with powdered sugar to treat tuberculosis. (Sokolov 1993). Leaves are used as an expectorant and emollient. It is used inside in the form of decoctions, as well as in the composition of thoracic and sweating teas for bronchitis, laryngitis and bronchiectasis. It is also used in abscesses and gangrene of the lungs. Externally used in the form of solders as a soft, disinfectant and anti-inflammatory agent (Khojimatov 2021). In modern traditional medicine widely used, especially for colds and cough, bronchitis, as expectorant, but also for lung problems and as vasodilator, for flu treatments, and for wounds (Bussmann et al. 2014; 2016a,b; 2017a; 2018). Often sold in local medicinal plant markets (Bussmann et al. 2017b) (Khojimatov et al. 2023).

Folk recipes: Infusion of Coltsfoot leaves against bronchitis: It is necessary to pour 1 tablespoon of leaves of Coltsfoot with a glass of boiling water, insist for half an hour, then strain. The resulting infusion is taken three to four times a day for 1 tablespoon. Infusion of Coltsfoot leaves in skin diseases, furuncles: It is necessary to pour 1 tbsp. l of mother-and-stepmother leaves with a glass of boiling water, insist for an hour, then strain and squeeze out the raw materials (https://planta-medica.uz/tussilago-farfara-l-mat-i-macheha-obyknovennaya/). The resulting infusion is lubricated several times a day by sick places. Decoction from the leaves of Coltsfoot, used as an expectorant. You need to pour 1 tablespoon of Coltsfoot leaves with a glass of hot water, hold for fifteen minutes in a water bath. Cool the resulting mixture for 45 minutes at room temperature, and then squeeze out the feed. Add the resulting decoction with boiled water so that the initial volume is obtained. Take decoction two or three times a day for half a glass before eating (https://lektrava.ru/encyclopedia/mat-i-machekha-obyknovennaya/) (Khojimatov et al. 2023).

In veterinary medicine for diseases of the gastrointestinal organs, tract, urinary tract, to stimulate appetite and improve digestion, as expectorant respiratory diseases, and for wound care. Good fodder for cattle. (Sokolov 1993). The plant possesses an array of valuable components, including tuscilyagin, a potent compound, alongside bitter glycosides, saponins, carotene, vitamin C, organic acids, essential oils, mucus, and enhancers. These substances work in synergy to provide numerous health benefits (Botanical-pharmacognostic dictionary 2000; Khojimatov et al. 2023).

Its leaves are widely utilized in the treatment of various ailments, including coughs, colds, and even tuberculosis. The cabbage-like juice and aphids derived from these leaves have been employed as remedies with positive results. Moreover, the dried leaves are often smoked similarly to papyrus, providing significant relief. The herbal leaves are frequently included in tea blends. This tea serves as a key component in the production of galenic drugs, further enhancing their therapeutic properties (Khojimatov et al. 2023).

This plant contains a variety of valuable compounds, including tannides, glucosides, saponins, tusilagin, phytostrins, inulin, starch, carotenoids, and vitamin C, ranging from 5 to 12% in concentration. Additionally, its flowers are rich in essential oil, with levels averaging 0.08-0.12%. The flowers also contain tannides and a dye substance called taraxanthin (Khojimatov et al. 2023; Putyrskiy I. & Prokhorov 2000).

Analysis of biogenic elements.
The following table illustrates the biogenic element analysis of *Tussilago farfara* and *Apium graveolens*.

Table 1. Amount of biogenic elements contained in samples

Name of elements	Leaf of *Tussilago farfara*	Semen of *Apium graveolens*	Leaf of A*pium graveolens*
mg / kg			
Lithium	5,759	7,885	3,864
Beryllium	1,125	1,515	0,704
Borum	98,798	49,787	12,943
Sodium	5567,833	7696,909	3512,106
Magnesium	7263,450	4190,606	1207,662
Aluminum	554,667	308,072	349,776
Silicon	507,361	714,670	345,962
Phosphorus	962,435	1959,484	663,105
Sulfur	564,070	806,453	394,393
Potassium	6239,638	7041,953	3571,074
Calcium	4596,258	6606,747	3248,513
Chromium	79,958	142,493	44,254
Manganese	197,762	125,658	68,204
Iron	3565,287	4836,392	2354,057
Cobalt	21,918	27,204	14,309
Nickel	6,937	8,095	4,048
Copper	311,216	417,611	223,034
Zinc	35,764	55,179	14,065

Analyzing the study results we observed that all samples contained more than 18 elements:

Sodium: Highest concentration in the seeds of *Apium graveolens*, followed by *Tussilago farfara* and *Apium graveolens* leaves.
Magnesium: Highest concentration in *Tussilago farfara*, followed by seeds of *Apium graveolens* and *Apium graveolens* leaves.
Potassium: Highest concentration in the seeds of *Apium graveolens*, followed by *Tussilago farfara* and *Apium graveolens* leaves.
Calcium: Highest concentration in the seeds of *Apium graveolens*, followed by *Tussilago farfara* and *Apium graveolens* leaves.

Iron: Highest concentration in the seeds of *Apium graveolens*, followed by *Tussilago farfara* and *Apium graveolens* leaves.
Copper: Highest concentration in the seeds of Apium graveolens, followed by *Tussilago farfara* and *Apium graveolens* leaves.
Zinc: Highest concentration in the seeds of *Apium graveolens*, followed by *Tussilago farfara* and *Apium graveolens* leaves.

Relative abundance of these elements in the analyzed samples.

Magnesium plays a crucial role in reducing the level of irritability in the nervous system, while also normalizing the activity of the heart muscle and its blood supply. In terms of bone health, significant quantities of calcium, magnesium, and phosphorus are present.

Potassium, on the other hand, is found in higher amounts in the muscles, brain, and kidneys compared to sodium. In fact, the concentration of sodium in the plasma is approximately 20 times higher than that of potassium, whereas the cell has a higher potassium content (Asqarov & Ashuraliyeva 2012).

Iron is an indispensable element closely associated with critical bodily functions and serves as a vital component of hemoglobin and myoglobin. It is an integral part of red blood cells, enabling their proper function. Iron actively participates in cellular gas exchange and facilitates the oxidation process of substances through its ability to bind with oxygen (Anvar 2004; Askarov et al. 1988; Ganieva et al. 1994; Mamarakhmonov et al. 2017).

Potassium, an essential mineral, plays a crucial role in enhancing the function of the heart muscle. It also regulates the activity of muscle tissue throughout the body. Disruptions in potassium metabolism primarily stem from irregularities in heart tissue function. Consequently, these imbalances can result in various symptoms such as cardiac colic, fatigue, dizziness, heart rhythm disturbances, and edema (Asqarov & Ashuraliyeva 2012).

Sodium is an essential element crucial for sustaining life, as it actively participates in mineral exchange within the human and animal bodies. It can be found in various bodily fluids, including blood plasma, red blood cells, whey, and gastric juice. Sodium plays a vital role in maintaining the balance of water and salt in the body, as well as regulating acid-base levels. Furthermore, it contributes to the regulation of blood pressure, ensuring it remains within the healthy range, and aids in maintaining the proper buffering capacity of the blood (Anvar 2004).

Analysis of flavonoids

The resulting chromatograms are depicted in figures 1, 2, and 3.

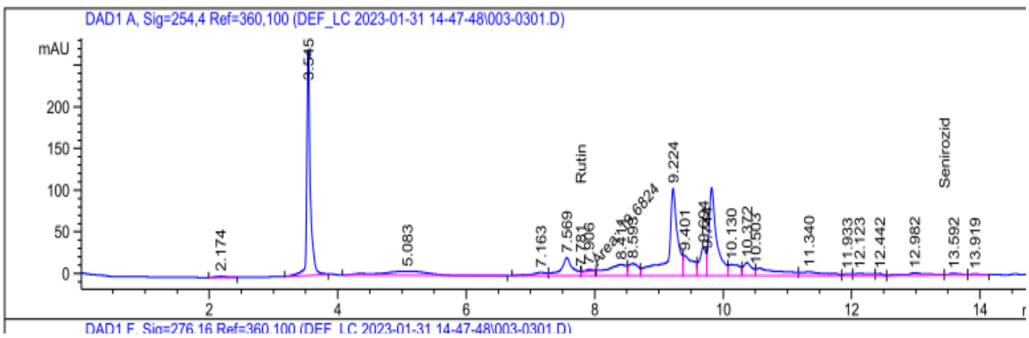

Figure 1. Chromatogram of an extract from seeds of *Apium graveolens*

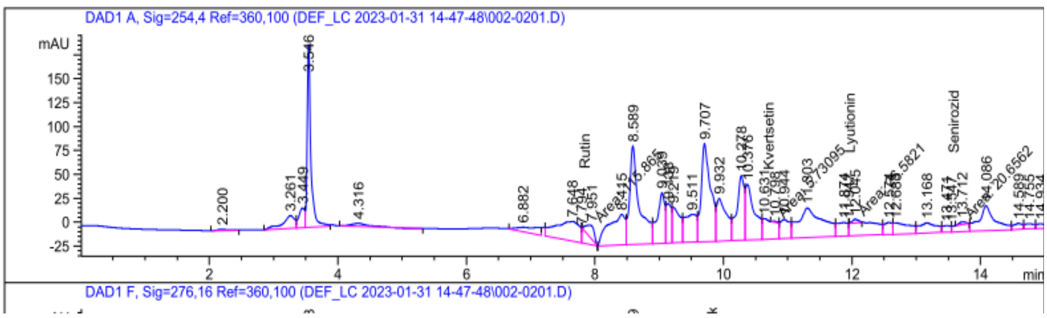

Figure 2. Chromatogram of an extract from leaves of *Apium graveolens*

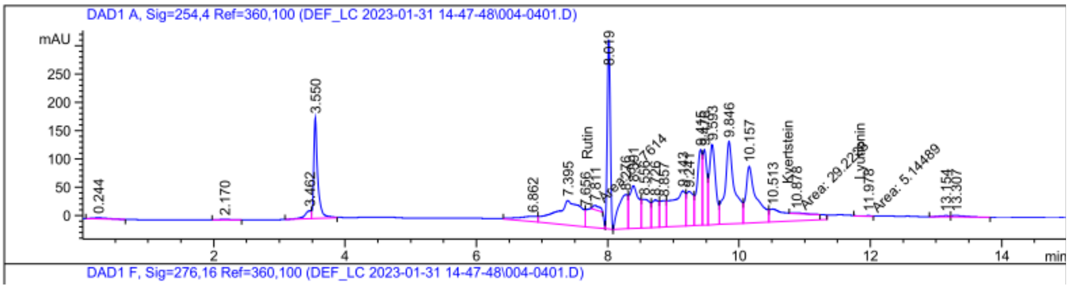

Figure 3. Chromatogram of an extract from the leaves of *Tussilago farfara*

As a result of the analysis conducted on extracts of *Tussilago farfara* and *Apium graveolens*, six phenolic flavonoid compounds were successfully isolated. The qualitative and quantitative analysis results are presented in Table 2.

Table 2. Qualitative and quantitative analysis

Amount of flavonoids in plants	leaves of *Apium graveolens*	seeds of *Apium graveolens*	leaves of *Tussilago farfara*
	Concentration mg/g		
Apigenin	0	0	0
Luthione	0,62	0,24	1,12
Rutine	2,32	1,52	2,65
Quercetin	1,65	0,95	3,25
Dihydroquercetin	3,97	1,64	2,98
Senneroside	1,59	0,69	0

The analysis of flavonoid content in *Tussilago farfara* and *Apium graveolens* plants has revealed the presence of several notable flavonoids. One particular flavonoid, apigenin, exhibits a retention time shift during analysis, indicating its presence. The relatively high concentrations of flavonoids such as rutin, quercetin, and dihydroquercetin further contribute to the significance of studying these plants.

Quercetin, found in notable quantities, is recognized for its inclusion in various biologically active additives (BAA) and preparations, as well as its use in alternative medicine. Rutin, specifically, demonstrates a higher concentration (mg/g) in *Tussilago farfara* compared to celery seeds and leaves. Rutin is known to protect against the degradation of hyaluronic acid molecules, stimulate the production of synovial lubrication, and activate the synthesis of collagen proteins, which form the basis of articular cartilage. Additionally, Rutin, along with other flavonoids, effectively strengthens vascular walls and improves their elasticity, which is crucial for enhancing vascular conductivity and facilitating blood flow. In conditions such as arthritis, arthrosis, and osteochondrosis, where blood flow is pathologically impeded, the nutrition of joints and the spine is compromised. Rutin's presence can potentially address these issues.

Dihydroquercetin (DHA) plays a role in normalizing the production of collagen and elastin in connective tissues, which are vital for the strength of cartilage and bones. Furthermore, DHA's ability to accelerate blood flow contributes to improved joint and spine conditions, as well as increased range of motion. The anti-inflammatory effects of dihydroquercetin can be attributed to its remarkable ability to enhance microcirculation, eliminate free radicals from the body, establish an abundance of healthy particles, and enhance overall immunity.

Conclusion

The conducted studies focused on the analysis of nutrients and flavonoids present in plants such as *Tussilago farfara* and *Apium graveolens*. Additionally, these medicinal plants were found to be rich in essential elements such as calcium, magnesium, potassium, and iron. Building upon these findings, the proposal was made to develop novel dietary supplements aimed at providing relief in the treatment of bone-related disorders, cardiovascular issues, and anemia.

Declarations

List of abbreviations: Not applicable.

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and materials: All the data are presented in tables and figures in the manuscript and are available with the corresponding authors.

Competing interests: The authors declare that they have no competing interests.

Funding: Ministry of Innovative Development of the Republic of Uzbekistan supported this research project (no. AL 2021090820).

Authors' contributions: SI and TM collected, analyzed the data and drafted the manuscript. RB, IA, MZ and TM advised, reviewed, and approved the final manuscript.

Acknowledgements

SI and TM would like to thank Ministry of Innovative Development of the Republic of Uzbekistan. We are also indebted to thank the anonymous reviewer for reading the manuscript and providing important comments.

Literature Cited

Amin G. 2005. The most common medicinal plants in Iran. Tehran, Medical ethics and history of medicine research center.

Amiri MS, Joharchi MR, Taghavizadeh Yazdi ME 2014. Ethno-medicinal plants used to cure jaundice by traditional healers of Mashhad, Iran. Iranian Journal of Pharmaceutical Research 13(1):157.

Anvar Sobirjon. About medicinal plants. 2004, Mehnat, Tashkent. (in Uzbek)

Askarov IR, Kirgizov SM, Nurimdinova GT. 1988. Synthesis and study of the antianemic activity of p-ferrocenylphenol. Pharmaceutical Chemistry Journal 22(5):372-376.

Askarov I, Ashuralieva M. 2012. Chemical elements in the human body: study guide. Tafakkur, Tashkent. 64 pages. (in Uzbek)

Askarov IR. 2021. Mysterious Medicine. Science and Technology Publishing House, Tashkent. 888 pages. (in Uzbek)

Blinova KF, Yakovlev GP. (eds). 2000. Botanical-pharmacognostic dictionary: Higher school, Moscow. 237 pages. (in Russian)

Boboev S, Makhkamov T, Bussmann RW, Zafar M, Yuldashev A. 2023. Anatomical and phytochemical studies and ethnomedicinal uses of *Colchicum autumnale* L. Ethnobotany Research and Applications 25:1-9.

Bussmann R.W, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Batsatsashvili K, Hart RE. 2017a. Ethnobotany of Samtskhe-Javakheti, Sakartvelo (Republic of Georgia), Caucasus. Indian Journal of Traditional Knowledge 16(1):7-24.

Bussmann RW, Batsatsashvili K, Kikvidze Z, Khutsishvili M, Maisaia I, Sikharulidze S, Tchelidze D, Paniagua Zambrana NY. 2017b. Ethnobotany of the Caucasus – Georgia. In: Bussmann RW. (ed.) Ethnobotany of the Caucasus, Springer International Publishing, Cham.

Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Khutsishvili M, Batsatsashvili K, Hart RE. 2016a. A comparative ethnobotany of Khevsureti, Samtskhe-Javakheti, Tusheti, Svaneti, and Racha-Lechkhumi, Republic of Georgia (Sakartvelo), Caucasus. Journal of Ehnobiology and Ethnomedicine 12:43. doi: 10.1186/s13002-016-0110-2.

Bussmann R.W, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Khutsishvili M, Batsatsashvili K, Hart RE. 2016b. Medicinal and food plants of Svaneti and Lechkhumi, Sakartvelo (Republic of Georgia), Caucasus. Medicinal and Aromatic Plants 5:266. doi: 10.4172/2167-0412.1000266.

Bussmann R.W, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Khutsishvili M, Batsatsashvili K, Hart RE. 2016c. Plant and fungal use in Tusheti, Khevsureti and Pshavi, Sakartvelo (Republic of Georgia), Caucasus. Acta Societatis Botanicorum Poloniae 86(2):3517. doi: 10.5586/asbp.3517.

Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Batsatsashvili K, Hart RE. 2017c. Plants in the spa – the medicinal plant market of Borjomi, Sakartvelo (Republic of Georgia), Caucasus. Indian Journal of Traditional Knowledge 16(1):25-34.

Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Batsatsashvili K, Hart RE. 2018. Unequal brothers – Plant and fungal use in Guria and Racha, Sakartvelo (Republic of Georgia), Caucasus. Indian Journal of Traditional Knowledge 17(1):7-33.

Bussmann RW, Paniagua-Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Jinjikhadze T, Shanshiashvili T, Chelidze D, Batsatsashvili K, Bakanidze N. 2014. Wine, Beer, Snuff, Medicine and loss of diversity – Ethnobotanical travels in the Georgian Caucasus. Ethnobotany Research and Application 12:237-313.

Bussmann RW, Batsatsashvili K, Kikvidze Z, Paniagua-Zambrana NY, Moazzami Farida SH, Ghorbani A, Khutsishvili M, Maisaia I, Sikharulidze S, Tchelidze D. 2020. *Apium graveolens* L. In: Batsatsashvili, K; Kikvidze, Z; Bussmann, RW (Eds.) Ethnobotany of Mountain Regions Far Eastern Europe. Springer International Publishing, Cham. doi: 10.1007/978-3-319-77088-8_13-2

Dadabaeva O. 1996. Dikorastushie lekarstvennie rastenia flori Tadjikistana – Khujand: Rakhim Djalil. 585 pages. (In Russian).

Encyclopedia of Chinese Medicine: 2004 Healing Powers. St. Petersburg. 448 pages. (in Russian)

Ganieva,MG, Chukanin NN, Askarov IR. 1994. A method of determination of serum iron and total iron binding capacity of capillary blood in children. Klinicheskaia Laboratornaia Diagnostika 4:54-55. (in Russian)

Ghorbani A. 2005. Studies on pharmaceutical ethnobotany in the region of Turkmen Sahra, north of Iran: (Part 1): General results. Journal of Ethnopharmacology 102(1):58-68.

Grossheim AA. 1952. Plant richness of the Caucasus. Moscow, Akademia Nauk.. (in Russian).

Hooper D, Field H, Dahlgren BE. 1937. Useful plants and drugs of Iran and Iraq, Field Museum of Natural History Chicago.

https://lektrava.ru/encyclopedia/mat-i-machekha-obyknovennaya/

https://planta-medica.uz/tussilago-farfara-l-mat-i-macheha-obyknovennaya/

Karimov VA, Shomakmudov A. 2003. Medicinal plants used in folk medicine and modern medicine. 2003, Publishing-printing association named after Ibn Sina, Tashkent. 320 pages. (in Uzbek)

Ketskhoveli N, Kharadze A, Gagnidze R. 1971-2011. Flora of Georgia, 16 vols., Tbilisi, Metsniereba. (in Georgian).

Khalmatov Kh. 2002. Medicinal plants. Tashkent publishing house, Tashkent. (in Uzbek)

Khaydarov K, Khojimatov K. 2002. Plants of Uzbekistan: Handbook for secondary school biology teachers. Second revised and updated edition. Teacher, Tashkent. 248 pages. (in Uzbek)

Khojimatov OK. 2021 Medicinal plants of Uzbekistan (properties, use and sustainable use. Ma'naviyat, Tashkent, 328 pages. (in Russian).

Khojimatov OK, Kosimov ZZ, Bussmann RW. 2023. *Tussilago farfara* L. in: Khojimatov, OK; Gaffrov, Y; Bussmann, RW. (eds). Ethnobiology of Uzbekistan, Springer Nature Publishing, Cham, pp. 735-739. doi: 10.1007/978-3-031-23031-8_75

Mahdavi Meimand Z, Mirtajadini M. 2010. Collection and identification of some plant species in Kerman province for the herbarium of medicinal plants Faculty of Pharmacy (stage 1). Journal of Herbal Drugs 2:1-24.

Makashvili A. 1991. Botanical Dictionary. Metsniereba, Tbilisi. (in Georgian).

Makhkamov T, Sotiboldiyeva D, Mamarakhimov O, Yuldashov Y, Botirova L. 2022. Morphogenesis and Seasonal Developmental Rhythm Under the Conditions of Introduction of *Curcuma longa* L.. International Scientific Conference on Agricultural Machinery Industry "Interagromash". Cham: Springer International Publishing. pp. 1460-1469.

Mamarakhmonov MK, Belenkii LI, Djurayev AM, Chuvylkin ND, Askarov IR. 2017. Quantum chemical study of ferrocene derivatives 1. Arylation reactions with aminobenzoic acids. Russian Chemical Bulletin, 66, 721-723.

Mozaffarian V. 2013. Identification of medicinal and aromatic plants of Iran. Tehran, Farhang Moaser.

Putyrskiy I, Prokhorov V. 2000. Universal Encyclopedia of Medicinal Plants. Maxaon, Moscow. 605 pages. (in Russian)

Scott C. 2014. The magic of herbs from A to Z. The complete encyclopedia of magical plants. Ves, St. Petersburg. 314 pages. (in Russian)

Shishkin BK. 1950 (English 1973). Flora of the USSR, Volume 16: Umbelliflorae; Akademia Nauk, Leningrad. 478 pages, 37 b/w plates, 2 maps.

Shishkin BK, Boborov EG. 1961 (English 1995). Flora of the USSR, Volume 26: Compositae Giseke (altern. Asteraceae Dumort); Akademia Nauk, Leningrad. 1072 pages.

Sokolov PD. (ed.) 1988. Plant Resources of the USSR: Flowering plants, their chemical composition, use; Volume 4. Families of Rutaceae-Elaeagnaceae. Akademia Nauk, Leningrad, 357 p. (in Russian).

Sokolov PD. (ed.) 1993. Plant Resources of the USSR: Flowering plants, their chemical composition, use; Volume 7. Family Asteraceae (Compositae). Akademia Nauk, Leningrad, 352 p. (in Russian).

Tayjanov K, Khojimatov O, Gafforov Y, Makhkamov T, Normakhamatov N, Bussmann RW. 2021. Plants and fungi in the ethnomedicine of the medieval East-a review. Ethnobotany Research and Applications 22(46):1-20. doi: 0.32859/era.22.46.1-20

Zakirov KZ. 2000. Plants of Uzbekistan. Teacher, Tashkent. (in Uzbek)