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ARTICLE

Elemental Composition of the *Astragalus Ferganensis* Plant Growing in the Fergana Valley

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Abstract

The elemental composition of the root and aboveground parts of the plant Astragalus ferganensis growing in the Fergana Valley of Uzbekistan was studied using the ICP-OES method. The 30 identified elements were analyzed by classifying them into groups of macro-, micro-, essential, and heavy metals. Among the elements detected in the plant organs, the amounts of Ca, K, Mg, Na, P were relatively high (over 1000 mg/kg), Fe, Si, S were high (50-1000 mg/kg), Mn, Zn, B, Cu were moderate (10-100 mg/kg), Cr, V, Li were low (1-10 mg/kg), Ba, Ni, Pb, Se, As, Co were very low (1-5 mg/kg), while Ag, Bi, Cd, Hg, Sb were not detected. In the underground and aboveground parts of the plants, the predominance of macroelements Ca, K, Mg and microelements Fe, Si was determined.

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1 Introduction

Astragalus is a genus of plants belonging to the Fabaceae family. This genus includes herbaceous species, subshrubs, and occasionally shrubs. According to recent data from The World Checklist of Vascular Plants, the genus comprises about 2,400 species worldwide, of which 223 species have been identified as growing in Uzbekistan.

2 Literature Review and Methodology

One of the species belonging to the genus Astragalus and primarily distributed in the Fergana Valley is Astragalus ferganensis. Commonly referred to as the Fergana astragalus, this plant reaches a height of 10–20 cm. Its stem is slender and white. The leaves are opposite, odd-pinnate, and the leaflets are ovate, measuring 2–6 cm in length. It flowers in May and produces fruit in June. Its distribution is limited to the Fergana Valley, and it was given this name because it was first identified in this region (Figure 1). Astragalus ferganensis is not a widely distributed species; most literature sources more frequently discuss other members of the genus Astragalus [1]. For example, the composition of Astragalus dasyanthus includes macro- and microelements such as iron, sodium, calcium, magnesium, phosphorus, silicon, manganese, and selenium, as well as vitamins A, B, C, and E, organic acids, flavonoids, steroids, and essential oils. It is reported that its stems and branches exude a gum called tragacanth (anzirat, anzarut), which contains 60% bassorin, 8–10% arabin, and carbohydrates [2].

A decoction of Astragalus piletocladus is prescribed as an expectorant and as a remedy for atherosclerosis, liver diseases, myocardial dystrophy, angina pectoris, cancer, kidney diseases, and as a diuretic and anti-inflammatory agent. Its effectiveness in treating tumors such as myomas and uterine fibromyomas has been scientifically confirmed. Its alcoholic extract has been found to be used in the treatment of edema, hypertension, tachycardia, and functional disorders of the liver and kidneys [3].

a) occurrence in nature b) in herbarium form

Figure 1. Fruiting stage of Astragalus ferganensis

Information on the chemical composition and medicinal applications of certain Astragalus species has been presented in the literature. However, no data have been reported regarding the chemical composition of Astragalus ferganensis. In our study, we conducted research specifically on the chemical composition of Astragalus ferganensis and examined the elemental composition of this plant.

3 Results and Discussion

For the purposes of the study, the fruiting stage of the plant was selected, and samples were prepared from the roots, stems, fruits, and fruit peels.

To dry the samples, they were first placed in a drying oven (VWR DRY-line, Germany) and dried until their mass became constant. From the dried samples, 200 mg was weighed using an analytical balance (FA220 4N). The samples were then mineralized using a mineralization system (MILESTONE Ethos Easy, Italy). For this process, each sample was placed into the device's vessel, followed by the addition of 6 ml of nitric acid and 2 ml of hydrogen peroxide (H_2O_2). All mixtures were brought to a mineral state at 180°C for 20 minutes.

After the process was completed, the mixture was transferred into a conical volumetric flask and diluted with distilled water to a final volume of 25 ml.

The solution in the flask was then poured into special tubes in the autosampler section and prepared for analysis. The analysis was performed using an inductively coupled plasma optical emission spectrometer (ICP-OES) (Avio 200, Perkin Elmer, USA). The obtained results reflect the quantitative accuracy of the elements present in the solution, down to 10^{-9} g. (Table 1)

Table 1. Elemental composition identified in the organs of Astragalus ferganensis (mg/10 g)

Plant organ	Al	Ba	B	V	Bi	Fe	Cd	K
Root	0,125	0,019	0,123	0,031	0	1,142	0	215,587
Stem and leaves	0,211	0,008	0,274	0,022	0	2,120	0	154,528
Seed	0,101	0,009	0,212	0,011	0	1,285	0	132,289
Fruit peel	0,288	0,007	0,455	0,012	0	3,811	0	126,120
Plant organ	**Ca**	**Co**	**Si**	**Li**	**Mg**	**Mn**	**Cu**	**As**
Root	96,285	0,011	1,147	0,051	63,325	0,471	0,463	0,003
Stem and leaves	177,412	0,014	2,215	0,066	66,141	0,258	0,410	0
Seed	112,412	0,009	0,285	0,023	71,877	0,142	0,159	0,007
Fruit peel	147,218	0,017	1,258	0,141	79,174	0,425	0,585	0
Plant organ	**Na**	**Ni**	**Pb**	**Se**	**Ag**	**Sr**	**Sb**	**P**
Root	27,412	0,017	0,016	0,008	0	0,169	0	29,336
Stem and leaves	32,258	0,025	0,009	0,003	0	0,124	0	15,362
Seed	10,011	0,044	0,007	0,003	0	0,096	0	9,857
Fruit peel	32,122	0,031	0,021	0,007	0	0,237	0	17,877
Plant organ	**Mo**	**Cr**	**Zn**	**Hg**	**S**			
Root	0,589	0,041	0,289	0	1,258			
Stem and leaves	0,854	0,019	0,369	0	2,119			
Seed	0,089	0,013	0,081	0	0,852			
Fruit peel	0,741	0,048	0,496	0	2,141			

The results obtained for the chemical elements were analyzed across plant organs by dividing them into four groups: macroelements, microelements, vital (essential) elements, and heavy metals.

The quantitative diagram of the macroelements identified in the organs of Astragalus ferganensis is presented in Figure 2.

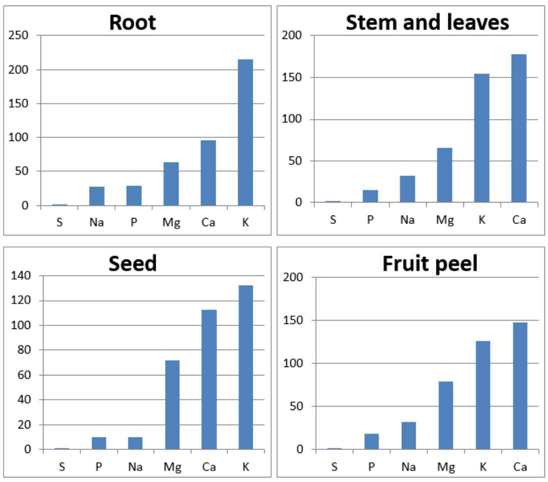

Figure 2. Quantitative diagram of macroelements identified in the plant organs of Astragalus ferganensis

From the diagram above, it can be observed that the highest concentration of Ca is found in the stems and leaves and in the fruit peel (177.412 mg/10 g; 147.218 mg/10 g), while the highest concentration of K is present in the roots and seeds (215.587 mg/10 g; 132.289 mg/10 g). Among all plant organs, S was identified in the lowest concentration. The total amount of macroelements was 369.88 mg/10 g in the roots, 337.3 mg/10 g in the seeds, 404.65 mg/10 g in the fruit peel, and 447.82 mg/10 g in the stems and leaves.

According to published sources, 98 of the potassium in plants is located within tissue cells, where it regulates metabolic processes and maintains pH balance. In medicine, potassium and sodium together influence nervous system function, heartbeat regulation, and muscle tone, playing a key role in the vitality of living organisms [4–5].

Calcium plays a crucial role in human health by ensuring the conduction of nerve impulses, regulating blood pressure, and participating in blood coagulation. It forms the basis of bone tissue and teeth, as the majority of bone minerals consist of calcium [6–7]. Calcium deficiency disrupts metabolic processes, resulting in brittle bones that fracture easily—this condition is known in medicine as osteoporosis. A deficiency of macroelements in the body may lead to arrhythmia, nausea, vomiting, and various digestive disorders [8–9].

Along with this, the concentration of microelements in plant organs is also of great importance. Therefore, the microelement composition of Astragalus ferganensis organs was also analyzed (Figure 3).

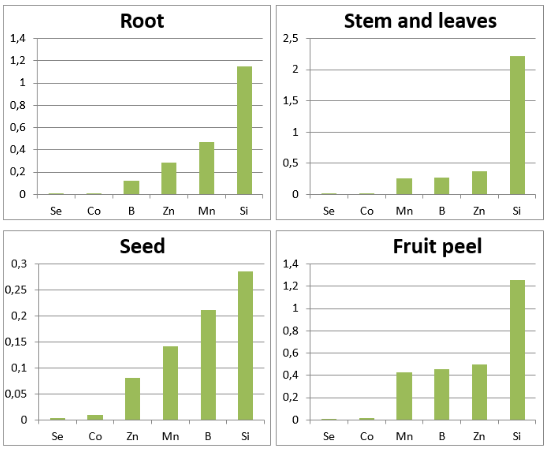

Figure 3. Quantitative diagram of microelements identified in the plant organs of Astragalus ferganensis

Among all plant organs, Si was found in the highest concentration among the microelements, while Se was identified in the lowest amount. The total microelement content was 2.049 mg/10 g in the roots, 0.732 mg/10 g in the seeds, 2.658 mg/10 g in the fruits, and 3.133 mg/10 g in the stems and leaves.

Silicon plays an essential role in the human body by strengthening bones, supporting skin health, preventing nail fragility, and maintaining vascular integrity. It also contributes to detoxification processes and plays a role in combating Alzheimer's disease. Silicon enhances collagen production, thereby improving skin elasticity, preventing cholesterol accumulation on blood vessel walls, and aiding in the removal of toxins from the body [10].

Zinc is a component of insulin and influences carbohydrate metabolism in the body. Zinc deficiency in the diet may slow growth, cause hair loss, and lead to disorders of reproductive function. It is considered an indispensable microelement because it actively participates in fat, carbohydrate, and protein metabolism [11].

The daily requirement of manganese for humans is around 6 mg. This element plays a significant role in the normal growth and development of children. Additionally, manganese, together with iron, copper, and cobalt, participates in the process of blood formation [11].

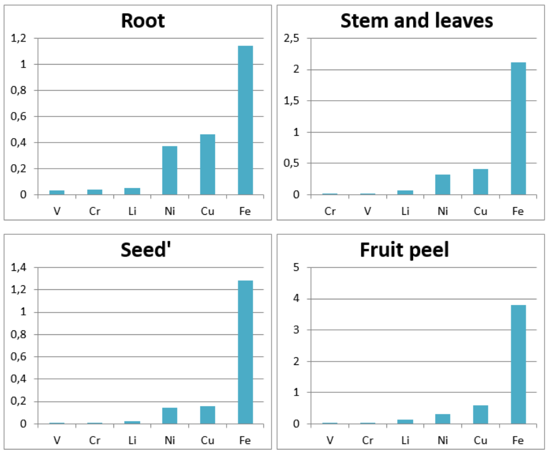

Figure 4. Quantitative diagram of essential elements identified in Astragalus ferganensis

Figure 4 presents the quantitative diagrams of essential elements identified in the organs of Astragalus ferganensis. Among the elements in this group, iron was detected at the highest levels across all plant organs. The highest concentration was found in the fruit peel (3.811 mg/10 g). The total amounts were 1.635 mg/10 g in the seeds, 2.102 mg/10 g in the roots, 2.962 mg/10 g in the stems and leaves, and 4.908 mg/10 g in the fruit peel.

Iron (Fe) belongs to the group of physiologically active and indispensable elements. It performs vital physiological functions in plants, humans, and animals.

Iron deficiency in the body leads to anemia. It also plays an essential role in oxygen transport and is crucial for the respiration process.

According to literature sources and regulatory standards, the total permissible content of Hg, Pb, Co, and As in medicinal plant raw materials must not exceed 7.6 mg/kg. In the organs of Astragalus ferganensis, mercury (Hg) was not detected. Arsenic (As) was found in the roots (0.03 mg/10 g) and seeds (0.007 mg/10 g), while it was absent in the stems, leaves, and fruit peel. Lead (Pb) and cobalt (Co) were detected in small amounts in all plant organs.

4 Conclusion

The results of the study confirm that Astragalus ferganensis is rich in chemical elements. Notably, high concentrations of the macroelements K and Ca, as well as the microelements Si, Zn, and Mn, were identified in the stems and leaves. Additionally, all plant organs contained significant amounts of the essential elements Fe and Cu. These findings suggest that this plant may serve as a valuable natural source for producing medicinal preparations and biologically active supplements aimed at preventing and treating diseases associated with chemical element deficiencies.

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