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CONTENT OF THE PLANT CISTANCHE MONGOLICA GROWN IN KHOREZM SOIL CLIMATIC CONDITIONS

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Abstract.

A detailed examination of the chemical composition of Cistanche mongolica, a plant species indigenous to the Khorezm oasis, has been conducted for the first time. This investigation was undertaken to assess the plant's adaptability to the region's extreme climatic conditions by analyzing the distribution of macro- and microelements, flavonoids, vitamins, and amino acids across its root, shoot, and flower systems. A comparative analysis with Cistanche mongolica specimens from other regions of the republic and China identified both significant similarities and distinct differences in their chemical profiles. Comparative phytochemical analysis of Cistanche specimens collected from northwestern regions of our country and China revealed substantial compositional similarities, as well as distinct differences in their chemical profiles.

The elemental analysis identified potassium, sodium, calcium, and iron as the predominant elements in the plant, with concentrations measuring 245.7×10^4 µg/g, 45.15×10^4 µg/g, 14.65×10^4 µg/g, and 1.43×10^4 µg/g, respectively. Elemental analysis revealed that potassium, sodium, calcium, and iron were the predominant elements in the plant material, with concentrations of 2.457×10^6 µg/g, 4.515×10^5 µg/g, 1.465×10^5 µg/g, and 1.43×10^4 µg/g, respectively. These elements exhibited significantly higher concentrations compared to other detected elements. The plant's flavonoid profile included apigenin, hypolaetin, rutin, and gallic acid. Additionally, vitamins B2, B6, B9, B12, and PP were detected.

Amino acid analysis across the shoot, flower, and root systems revealed a complex composition, with 20 different amino acids identified. Of these, serine, glutamine, cysteine, proline, valine, methionine, leucine, and tryptophan were found in significant quantities, ranging from 1.173151 µg/g to 6.87511 µg/g. These findings indicate that Cistanche mongolica is a nutrient-dense plant species, with a chemical composition that is comparable to, or even superior to, other species. The study's results enhance our understanding of the plant's nutritional value and its potential applications.

Key words: *Cistanche mongolica*, phytochemical analysis, composition of amino acids and fatty acids, macro and micro elements, vitamins, flavonoids.

Introduction

The genus Cistanche, comprising holoparasitic desert plants, exhibits wide distribution across North Africa, Arabia, and Asia. Several species, including C. deserticola, C. tubulosa, and C. salsa, have been integral components of traditional Chinese medicine for centuries, addressing various health conditions such as kidney deficiency, female infertility, and senile constipation [15]. Despite this historical significance, the phytochemical properties and potential therapeutic applications of these species remain underexplored in Uzbekistan, particularly within the Khorezm region, where nine species, including Cistanche mongolica and the rare Cistanche salsa, have been documented.

Recent regulatory developments in China have led to the official recognition of Cistanche as both a food and medicinal substance. In 2016, the China National Center for Food Safety Risk Assessment conducted a comprehensive safety evaluation of Alxa Desert Cistanche, confirming its adherence to food safety standards [6]. Subsequently, Cistanche was incorporated into the Catalog of Substances That Are Both Food and Chinese Medicinal Materials, sanctioning its use as a dietary supplement for general health maintenance [7]. In 2020, the National Health Commission, in collaboration with the

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State Administration of Market Supervision, issued regulatory guidelines for the management of dual-purpose substances, including Cistanche [32].

The formal approval of Cistanche as both a medicinal and dietary ingredient in China's list of novel food raw materials has spurred ongoing scientific investigations in regions such as Inner Mongolia, Ordos, Ningxia Hui Autonomous Region, Gansu, and Qinghai. Notably, local food safety standards have been established in Gansu (DBS62/003-2021) and Qinghai (DBS63/00016-2021), with the latter recommending a daily intake of 6-10 grams of Cistanche. As of June 29, 2022, the national "special food information inquiry platform" has registered 60 health food products incorporating Cistanche or its extracts as primary ingredients [32].

The arid environment of Uzbekistan provides a compelling rationale for investigating the potential of Cistanche as a medicinal plant within the food industry. A comprehensive phytochemical analysis is crucial to elucidate its beneficial properties. Beyond its traditional applications, the regular consumption of Herba Cistanche is hypothesized to contribute to longevity in certain regions of China and Japan, areas renowned for their high life expectancy rates and oasis landscapes [31]. Experimental studies have demonstrated that extracts from Cistanche salsa and Cistanche tubulosa exhibit immunomodulatory effects, activating lymphoid cells and enhancing apoptosis in cancer cells [19].

The rapid advancement of scientific research and industrial intensification exerts detrimental effects on the ecosystem. Consequently, these environmental alterations precipitate various pathological conditions in living organisms. Diseases such as diarrhea and anemia lead to the depletion of diverse macro and microelements in the human body. This elemental imbalance subsequently triggers a spectrum of disorders.

For instance, sodium deficiency can result in hyponatremia, a condition characterized by disrupted water and sodium homeostasis. Under normal physiological conditions, serum sodium levels should be maintained within a range of 135-145 mEq/L. Clinical manifestations of hyponatremia typically emerge when serum sodium concentrations fall below 130 mEq/L. It is noteworthy that the human body lacks the capacity to synthesize sodium endogenously; therefore, adequate dietary intake is essential for maintaining optimal sodium levels.

Hypokalemia, characterized by abnormally low serum potassium levels, can arise from various etiologies and manifest with a spectrum of clinical symptoms ranging from mild to severe. Pharmacological interventions and medical conditions associated with gastrointestinal disturbances, such as diarrhea and emesis, are among the predominant causative factors [12].

Calcium plays a crucial role in maintaining skeletal integrity and dental health. This divalent cation is instrumental in conferring hardness, strength, and elasticity to tissues, thereby facilitating locomotion. The physiologically active, ionized calcium pool in the circulatory system, extracellular milieu, and diverse tissues mediates multiple processes including vasoconstriction and vasodilation, myocyte function, hemostasis, neuronal signal transduction, and endocrine secretion [25].

Calcium deficiency can compromise bone mineral density, potentially leading to osteoporosis—a metabolic bone disorder characterized by decreased bone mass, microarchitectural deterioration, and increased fracture risk [13]. The interrelationship between calcium and vitamin D requirements in the prevention of rickets and osteomalacia is notable. Lower serum 25-hydroxyvitamin D [25(OH)D] concentrations necessitate higher calcium intake to mitigate the risk of these disorders [24].

A comprehensive review of the literature reveals the crucial physiological roles of various macro- and microelements, even when present in trace amounts within living organisms. Recent studies have elucidated the multifaceted functions and potential pathological consequences associated with alterations in the homeostasis of elements such as iron, magnesium, manganese, zinc, nickel, and copper.

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Waldvogel-Abramowski et al. [28] provided insights into iron metabolism, while Fiorentini et al. [9] explored the biochemical significance of magnesium and the societal impact of its deficiency. Li and Yang [30] investigated the intricate relationships between manganese, oxidative stress, and metabolic disorders. The multidimensional effects of zinc on biological systems were examined by Cuajungco et al. [5]. Genchi et al. [11] conducted a thorough analysis of nickel's implications for human health and environmental toxicology. Additionally, Ruiz et al. (2021) elucidated copper's role in mitochondrial function and metabolism.

These studies collectively emphasize the delicate balance required in elemental homeostasis. They not only delineate the pathophysiological consequences of deficiencies but also provide a scientific analysis of the potential toxicological effects associated with excessive accumulation of these elements in biological systems.

The consumption of cultivated Cistanche species as a dietary component may facilitate the bioavailability and potential assimilation of its constituent elements by the human organism in physiologically relevant quantities.

The nutritional composition of Cistanche is notable for its inclusion of vital micronutrients, such as vitamins A and C, as well as dietary fiber. Vitamin A, a fat-soluble nutrient, is essential for maintaining healthy vision, immune response, and skin integrity. It is also known to delay cellular aging and enhance wound healing [8, 33]. Vitamin C, being water-soluble, is crucial for immune function, wound repair, and antioxidant protection, and is frequently used as a preservative in foods [3,14]. Dietary fiber, a polysaccharide, is key to supporting healthy bowel movements, regulating blood glucose and lipid levels, and bolstering immune defenses [16, 34]. The elemental makeup of Cistanche further contributes to normal physiological functions, with each metal ion exerting specific effects on biological systems [35].

The acknowledgment of Cistanche as both a safe and effective food and medicinal material has led to its growing incorporation into the food industry and traditional Chinese medicine. As of June 29, 2022, 60 health food products containing Cistanche, its extract, or related compounds have been registered, with these products marketed for their potential benefits, including reducing physical fatigue, modulating immunity, and providing antioxidant support [32].

Flavonoids, a group of polyphenolic compounds, are widespread in plant-derived foods and beverages and are associated with various health benefits, such as antioxidant, anti-inflammatory, and anticancer properties [1, 2, 18]. These compounds are linked to the prevention and treatment of numerous diseases, including cancer, Alzheimer's disease, and atherosclerosis [2, 18]. Despite the well-documented advantages of flavonoids, the specific flavonoid content in Cistanche species has not been extensively explored.

Earlier studies have focused on isolating and characterizing diverse compounds from Cistanche species, including terpenoids, steroids, iridoids, phenolic compounds, and lignans [26]. Research has also examined the nutritional composition of Cistanche mongolica, detailing its micro- and macronutrient content, as well as its vitamin and amino acid profiles [26, 27]. Findings suggest that Cistanche species possess anti-inflammatory, antioxidant, and immunostimulating properties, likely due to the presence of bioactive substances, including flavonoids [29].

Cistanche mongolica, a perennial plant belonging to the Orobanchaceae family, is distinguished by its straight, cylindrical stem, which typically reaches a height of 30-40 cm and a thickness of 1-2 cm [10]. The plant produces a cylindrical inflorescence, ranging from 20-50 cm in length, with numerous flowers, blooming in April-May and fruiting in June-July. Cistanche mongolica is native to Central Asia, Afghanistan, and Xinjiang, China, and is commonly found in river valleys and desert regions, where it parasitizes the roots of Tamarix species [10]. In Uzbekistan, the plant is distributed across the

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Tashkent, Fergana, Surkhandarya, and Khorezm regions [10].

Figure 1. Cistanche mongolica plant growing in the Amudarya delta of Khanka and Yangibozor districts in Khorezm region

In our efforts to investigate the medicinal properties and composition of *Cistanche*, our research team is undertaking a series of scientific studies to evaluate the plant's potential applications in the food industry and its implications for public health.

Cistanche has demonstrated a variety of nutritional and functional properties, positioning it as a promising ingredient for the development of functional foods. Nevertheless, additional research is required to comprehensively understand the bioactive compounds present in this plant. To fill this knowledge gap, our study focuses on analyzing the chemical composition of *Cistanche mongolica* cultivated in the Khorezm region.

This review aims to present an overview of the nutritional and bioactive constituents of *Cistanche* and their possible effects on human health, with the objective of providing a theoretical foundation for the safe incorporation of *Cistanche* into the food industry.

Within traditional Chinese medicine, *Cistanche mongolica* is a widely used medicinal herb, appreciated for its invigorating properties. Morphologically, the plant is distinguished by its hard, cylindrical body, which is either straight or slightly curved, with a brown or gray-brown surface marked by wavy rings [32]. Previous studies have employed various analytical techniques, including combustion analysis, Filin's method, hydroxyl titration, and Soxhlet extraction, to assess the nutritional content of *Cistanche* [17]. Specifically, ultraviolet spectrophotometry has been utilized to measure total nutrient content, including vitamins A and C, as well as cholesterol levels in *Cistanche mongolica*, while atomic emission spectrophotometry has been applied to determine its elemental composition.

Vitamins are essential organic molecules that play a critical role in numerous physiological processes within the human body, including the synthesis of enzymes, hormones, and neurotransmitters, as well as energy metabolism and antioxidant defenses [21, 4]. Despite their significance, the effects and potential toxicity of vitamins in humans have not been extensively studied since their discovery in the early 20th century.

Vitamins are generally categorized into two groups: water-soluble (B and C) and fat-soluble (A,

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D, E, and K) [4]. Maintaining a balanced diet is crucial for ensuring adequate vitamin levels, particularly for populations with increased needs, such as pregnant and lactating women. Vitamin deficiencies, which may result from poor nutrition, malabsorption, or elevated requirements, can lead to various pathological conditions, including pellagra, beriberi, and scurvy [4].

To address the need for increased vitamin intake, standardized pharmaceutical formulations have been developed and are available as over-the-counter supplements [20]. However, while vitamins are generally regarded as safe, excessive consumption or long-term use can pose health risks. The potential for overdose is particularly significant with dietary supplements, especially fat-soluble vitamins, which are eliminated more slowly and tend to accumulate in the body [22, 4]. Therefore, it is important to exercise caution when consuming vitamins, especially at high doses or over extended periods.

Materials and methods of the research

In this study, a combination of analytical techniques was utilized to examine the elemental content, flavonoid composition, and water-soluble vitamin levels in the stems of *Cistanche mongolica*, including its root, shoot, and floral components. The plant samples were collected during the flowering period in April 2024 from the Amudarya delta, specifically within the Khanka and Yangibozor districts of the Khorezm region.

Elemental analysis was conducted using inductively coupled plasma optical emission spectrometry (ICP-OES) on a Perkin Elmer Avio-200 instrument. The sample preparation involved microwave-assisted digestion, where the plant material was treated with nitric acid and hydrogen peroxide in Teflon autoclaves, followed by cooling and dilution. The resulting solutions were analyzed for macro- and micro-elements, heavy metal salts, and rare metals, with results compared against a standard reference sample.

The ICP-OES analysis was carried out under optimized conditions, with temperatures ranging from 50°C to 230°C and pressures up to 40 bar, over a period of 35-45 minutes. Precision and relative standard deviation (RSD) values were automatically calculated based on the mass of the samples and their dilution ratios.

Flavonoid analysis was performed using high-performance liquid chromatography (HPLC) on an Agilent Technologies 1260 instrument equipped with a diode array detector (DAD). Chromatographic separation was achieved using isocratic elution with a mixture of acetonitrile and buffer solution (35:75) at pH 2.92, with a flow rate of 0.75 ml/min and an injection volume of 5 µl. Spectral data were recorded over the range of 200-400 nm.

The analysis of water-soluble vitamins was also conducted using HPLC on the same instrument, employing gradient elution with DAD detection. The mobile phase consisted of acetonitrile and buffer solution, with spectral data collected in the 200-400 nm range.

The analytical approaches used in this study enabled precise quantification of the elemental content, flavonoid composition, and water-soluble vitamin levels in *Cistanche mongolica*, offering valuable insights into the nutritional and bioactive characteristics of this medicinal plant.

Instrumentation and chromatographic conditions:
ICP-OES: Perkin Elmer Avio-200
HPLC: Agilent Technologies 1260
Column: Eclipse XDB - C18, 5.0 µm, 4.6x250 mm
Mobile phase: Acetonitrile and buffer solution (35:75)
pH: 2.92
Flow rate: 0.75 ml/min

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Injection volume: 5 µl

Detector: Diode matrix detector, wavelength 254, 320, 381 nm.

Chromatographic conditions:

Mobile phase (gradient mode) - acetonitrile - buffer solution pH=2.92 (4%: 96%) 0-6 min., (10%: 90%) 6-9 min., (20%: 80%) 9 -15 ., (4% : 96%) 15-20 min.

Injection volume - 10 µl.

The speed of the mobile phase is 0.75 ml/min.

Column - Eclipse XDB - C18. 5.0 µm, 4.6x250 mm.

Detector - diode-matrix detector, wavelengths 272, 292, 254, 297, 360 nm.

Extraction of free amino acids.

Protein and peptide precipitation from aqueous extracts of samples was achieved through the addition of 20% trichloroacetic acid (TXUK) to the test sample in a 1:1 ratio. The mixture was incubated for 10 minutes, followed by centrifugation at 8000 rpm for 15 minutes to separate the precipitate. A 0.1 ml aliquot of the precipitated solution was then separated and subjected to freeze-drying.

The resulting hydrolyzate was evaporated, and the dry residue was dissolved in a triethylamine-acetonitrile-water mixture (1:7:1) to neutralize any residual acid. This process was repeated twice to ensure complete acid neutralization.

The amino acid composition of the sample was then determined by reacting the hydrolyzate with phenylthioisocyanate to form phenylthiocarbamyl (PTC) derivatives, according to the method of Steven A. and Cohen Daviel. The PTC derivatives were subsequently identified using high-performance liquid chromatography (HPLC) on an Agilent Technologies 1200 instrument equipped with a diode array detector (DAD).

The chromatographic conditions were as follows: a 75x4.6 mm Discovery HS C18 column was used, with a mobile phase consisting of 0.14 M sodium acetate (CH3COONa) and 0.05% triethylamine (TEA) at pH 6.4 (Solution A), and acetonitrile (CH3CN) as Solution B. The flow rate was set at 1.2 ml/min, and the absorbance was monitored at 269 nm. A gradient elution program was employed, with the following conditions: 1-6% B from 0-2.5 minutes, 6-30% B from 2.51-40 minutes, 30-60% B from 40.1-45 minutes, 60-60% B from 45.1-50 minutes, and 60-0% B from 50.1-55 minutes.

Results and discussion

The present study investigated the elemental composition of Cistanche mongolica, a plant species native to the Amudarya delta. The analysis of macro- and microelements was conducted using inductively coupled plasma mass spectroscopy (ICP-MS) on a Nexion 2000 instrument. The results revealed that Cistanche mongolica exhibits a unique elemental profile, characterized by a high total acid content and low cholesterol content.

The elemental composition of Cistanche mongolica was found to be dominated by the macroelement sodium (Na), followed by potassium (K). The microelements manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn) were also present in significant amounts, while nickel (Ni) was detected at the lowest concentration.

A comparative analysis of the macro- and micronutrient composition of Cistanche mongolica grown in the desert zones of Khorezm region, North-western region of the Republic of Uzbekistan, and China is presented in Table 1. The results highlight the variations in elemental composition between Cistanche mongolica plants grown in different geographical regions.

These findings provide valuable insights into the nutritional and elemental properties of Cistanche mongolica, and have implications for its potential use as a dietary supplement or medicinal

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plant. Further research is needed to fully elucidate the elemental composition and nutritional value of this plant species.

Table 1

Macro-microelement composition of Cistanche mongolica species grown in the desert zones of China and in the Amudarya delta of Khorezm region

Nutrients	Content (100g for the original fruit)		Element	Content (mkg/g the original fruit)	
Moisture (g)	7.16	7.1562	K	7.60×10^4	245.7×10^4
Fat (mg)	12	12.154	Na	1.14×10^5	45.15×10^4
Cholesterol (μg)	102	101.46	Ca	3.63×10^4	14.65×10^4
Ash (g)	0,24	0,2357	Fe	1.05×10^4	1.43×10^4
Klechatka fiber (gr)	0,19	0,1908	Mg	9.09×10^3	13.73×10^4
Carbohydrates (mg)	7,34	7,3403	Mn	2.02×10^2	6.8×10^2
Total Acid (g)	1,56	1,5501	Zn	1.07×10^2	1.07×10^2
Vitamin A (g)	2,42	2,4255	Cu	9.42×10^2	10.20×10^2
Vitamin C (g)	3,12	-	Sr	1.55×10^2	16.30×10^2
			Ni	11.53	-
			Al	-	$9,25 \times 10^3$
			Zn	-	$7,6 \times 10^2$
			Se	-	$8,7 \times 10^2$
			B	-	$85,6 \times 10^2$
			S	-	$279,5 \times 10^2$
			P	-	$22,6 \times 10^4$
			Si	-	$6,742 \times 10^4$

The elemental analysis of Cistanche mongolica revealed that the plant is rich in various essential elements, as presented in the table. Notably, the results indicate that Cistanche mongolica from the Khorezm region contains significant amounts of aluminum (Al), zinc (Zn), selenium (Se), boron (B), sulfur (S), phosphorus (P), and silicon (Si). The quantities of these elements were found to be sufficient, suggesting that Cistanche mongolica from this region may be a valuable source of these essential nutrients.

In addition to the elemental analysis, the flavonoid content of Cistanche mongolica from the Khorezm region was investigated for the first time. The results of the flavonoid analysis are presented in Table 2, providing novel insights into the phytochemical composition of this plant species. While previous studies have reported on the flavonoid analysis of Cistanche species from other regions, this study provides the first comprehensive analysis of the flavonoid content of Cistanche mongolica from the Khorezm region.

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Table 2
Flavonoid content of the *Cistanche mongolica*

№	Names of flavonoids	Flavonoid content mg/100g		
		Root part of the Cistanche mongolica	**Shoot part of the Cistanche mongolica**	**Flowers of the Cistanche mongolica**
1	**Apigenin**	-	17,253	29,629
2	**Hypolaetin**	-	-	-
3	**Rutin**	106,078	-	-
4	**Hypolaetin 7-O-D-Gly**	-	-	-
5	**Isoramietin**	-	-	-
6	**Gallic acid**	-	48,414	53,565
7	**Hyperazid**	-	-	-
8	**Quercetin**	-	-	-

The flavonoid composition of Cistanche mongolica was analyzed, and the results are presented in Table 2. The data indicate that Cistanche mongolica contains a range of flavonoids, with varying concentrations in different plant parts. Notably, the root part of the plant was found to contain the highest amount of Rutin, at a concentration of 106,078 mg/g. In contrast, the shoot part was found to contain a significant amount of Gallic acid, at a concentration of 48,414 mg/g, while the flower part contained an even higher amount of Gallic acid, at 53,565 mg/g. Additionally, Apigenin was detected in the stem and flower parts, at concentrations of 17,253 mg/g and 29,629 mg/g, respectively. These findings suggest that Cistanche mongolica is a rich source of flavonoids, with different plant parts exhibiting distinct flavonoid profiles.

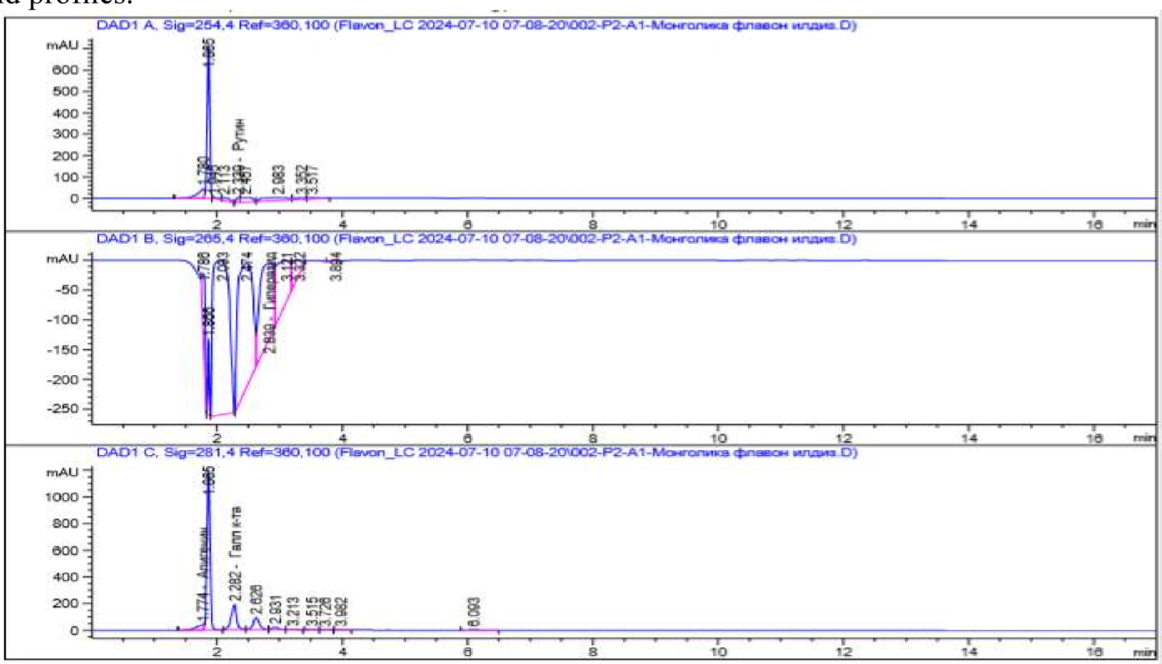

Figure 2. Spectrum of flavonoid analysis in the root part of the Cistanche mongolica

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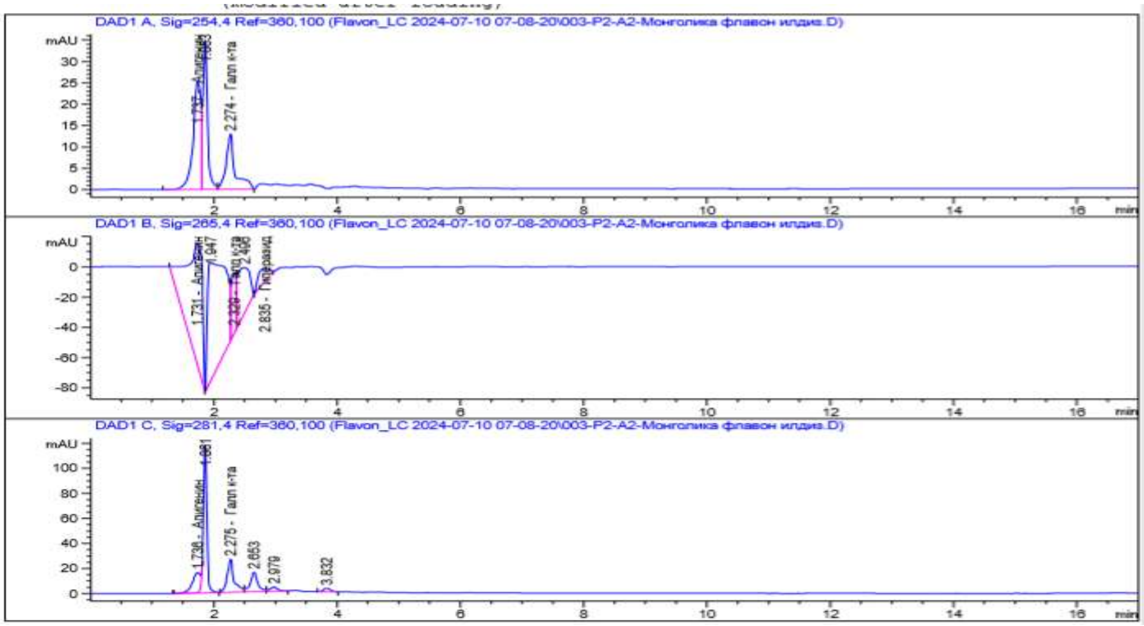

Figure 3. Spectrum of flavonoid analysis in the shoot part of the Cistanche mongolica

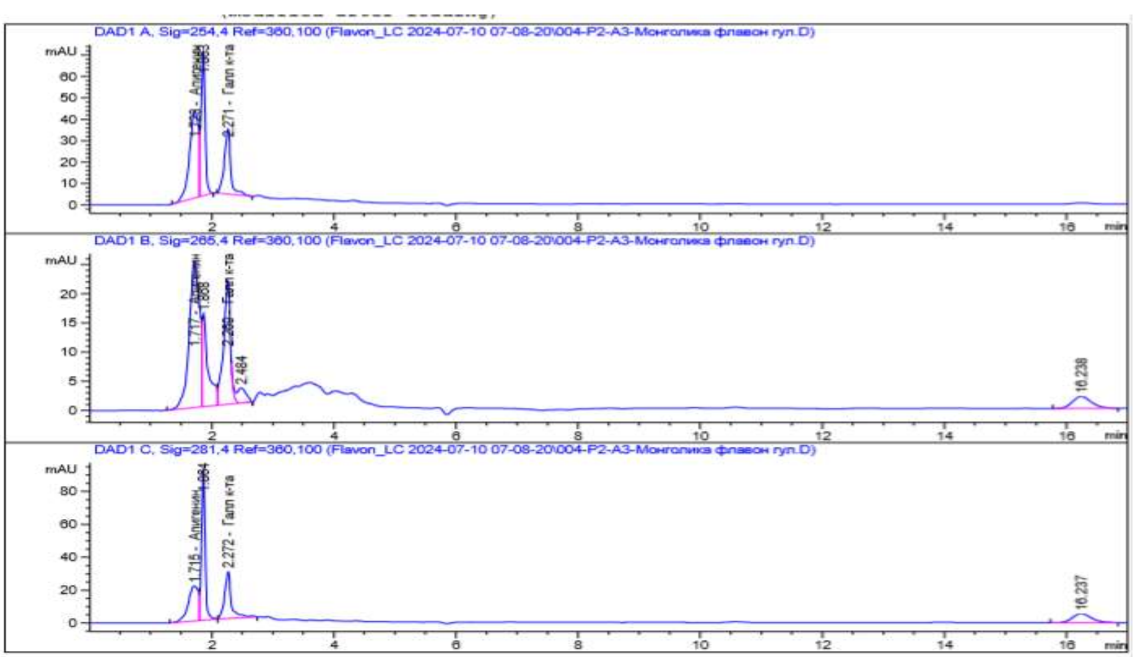

Figure 4. Spectrum of flavonoid analysis in the flowers of the Cistanche mongolica

A comprehensive analysis of the vitamin content of Cistanche mongolica, a plant species native to the Amudarya delta of Khorezm region, was conducted for the first time. To investigate the vitamin profile of this plant, samples were collected from the root, shoot, and flower parts of Cistanche mongolica and subjected to quantitative analysis. The resultant data are summarized in Table 3, providing a detailed account of the vitamin composition of this plant species.

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Table 3

Vitamin content of the plant *Cistanche mongolica*

№	Names of vitamins	Root part of the Cistanche mongolica	Shoot part of the Cistanche mongolica	Flowers of the Cistanche mongolica
		Quantitative content mg/100 g		
1	B_1	-	-	-
2	B_2	689,987	424,362	-
3	B_6		51,245	58,417
4	B_9	29,197	83,954	8,362
5	B_{12}	84,457	81,254	20,274
6	PP	7,378	0,573	1,416
7	C	-	-	-

The vitamin analysis of Cistanche mongolica revealed distinct distribution patterns of various vitamins in different plant parts. As presented in Table 3, the root part of the plant was found to be rich in vitamin B12, with a concentration of 689,987 mg/100g, representing the highest amount among all plant parts. In contrast, the shoot part exhibited the highest concentration of vitamin B2, at 424,362 mg/100g, while the flower part contained the highest amount of vitamin B6, at 58,417 mg/100g. These findings suggest that different plant parts of Cistanche mongolica exhibit unique vitamin profiles, highlighting the importance of considering the specific plant part when evaluating the nutritional value of this species.

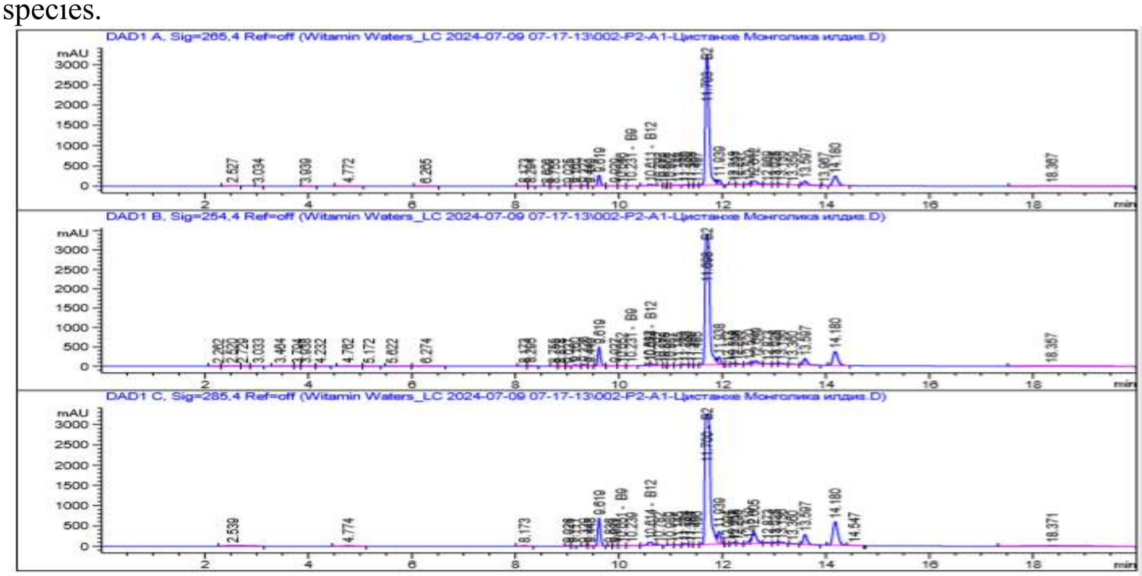

Figure 5. Spectrum of vitamin analysis in the root part of the Cistanche mongolica

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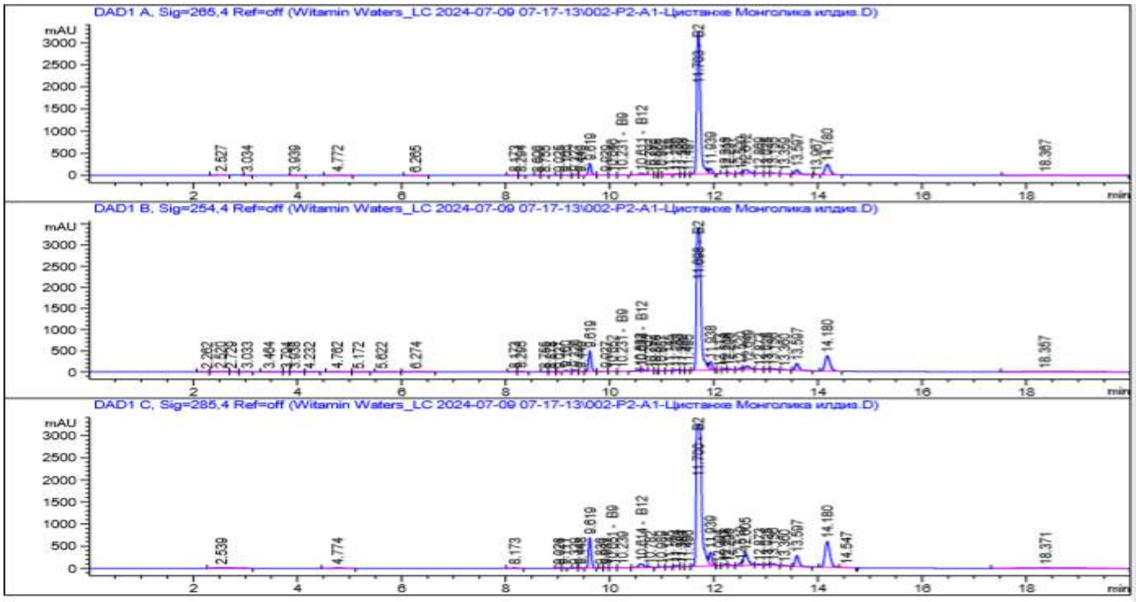

Figure 6. Spectrum of vitamin analysis in the shoot part of the Cistanche mongolica

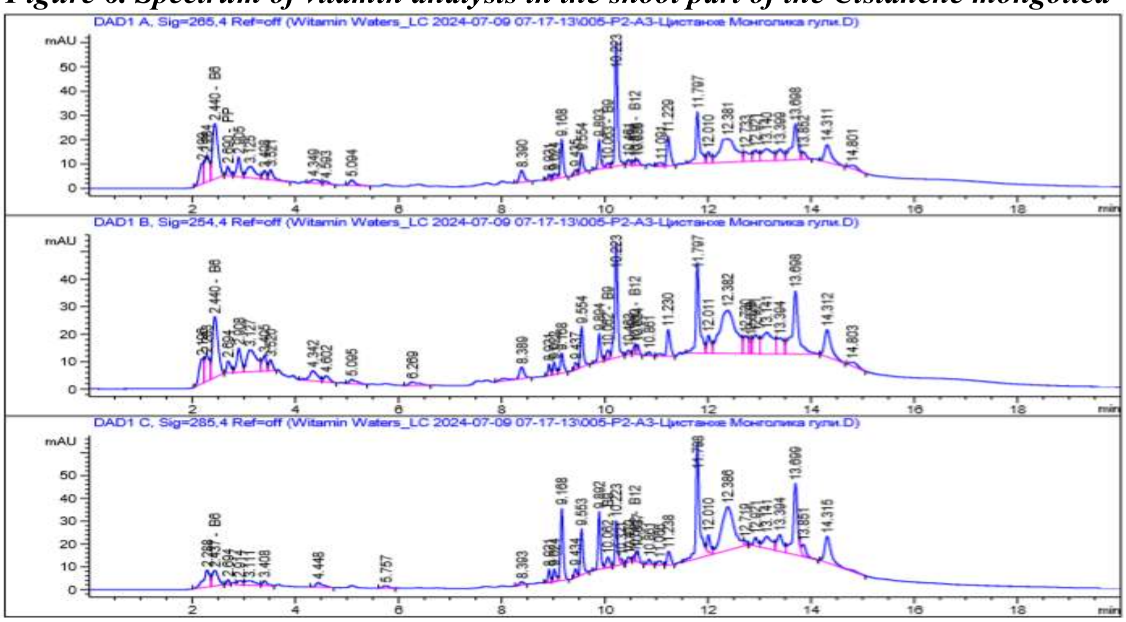

Figure 7. Spectrum of vitamin analysis in the flowers of the Cistanche mongolica

A comprehensive analysis of the amino acid composition of Cistanche mongolica, a plant species native to the Amudarya delta of Khorezm region, was conducted for the first time. To investigate the amino acid profile of this plant, samples were collected from the root, shoot, and flower parts of Cistanche mongolica and subjected to quantitative analysis. The resultant data are summarized in Table 4, providing a detailed account of the amino acid composition of this plant species.

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Table 4
Results of the amino acid composition of the plant *Cistanche mongolica*

Names of aminoacids	Root part of the Cistanche mongolica	Shoot part of the Cistanche mongolica	Flowers of the Cistanche mongolica
	Amount of aminoacids mg/gr		
Aspartic acid	0.766698	0.394795	0.195986
Glutamic acid	0.356557	0.29855	0.558638
Serine	4.333227	0.293048	1.173151
Glycine	1.212404	0.356844	0.442802
Asparagine	2.423522	0.715296	0.886247
Glutamine	1.551129	0.669987	4.135458
Cysteine	5.416393	0.839344	3.87541
Threonine	0.601825	2.161616	0.88563
Arginine	0.707641	0.713078	0.933857
Alanine	0.284248	0.642824	0.373659
Proline	13.78994	0.595322	6.87511
Tyrosine	0.11408	1.026718	0.452926
Valin	0.135299	3.302828	1.62785
Methionine	0.150713	2.672117	1.594233
Histidine	0.29368	0.33891	0.660471
Isoleucine	0.362118	2.016448	0.927268
Leucine	0.304278	6.569315	2.748794
Tryptophan	0.5272	2.827934	1.517726
Phenylalanine	0.081513	0.73483	0.23746
Lysine	0.30521	0.319238	0.333066
Total	**33.71767**	**27.48904**	**30.43574**

The amino acid analysis of Cistanche mongolica revealed significant variations in the total amino acid content among different plant parts. As presented in Table 4, the root part of the plant contained a total amino acid content of 27,48904 mg/g, while the shoot part exhibited a slightly higher content of 30,43574 mg/g. Notably, the flower part of the plant displayed the highest total amino acid content, with a value of 33,71767 mg/g. These findings indicate that the flower part of Cistanche mongolica is the richest source of amino acids, suggesting its potential as a valuable nutritional resource.

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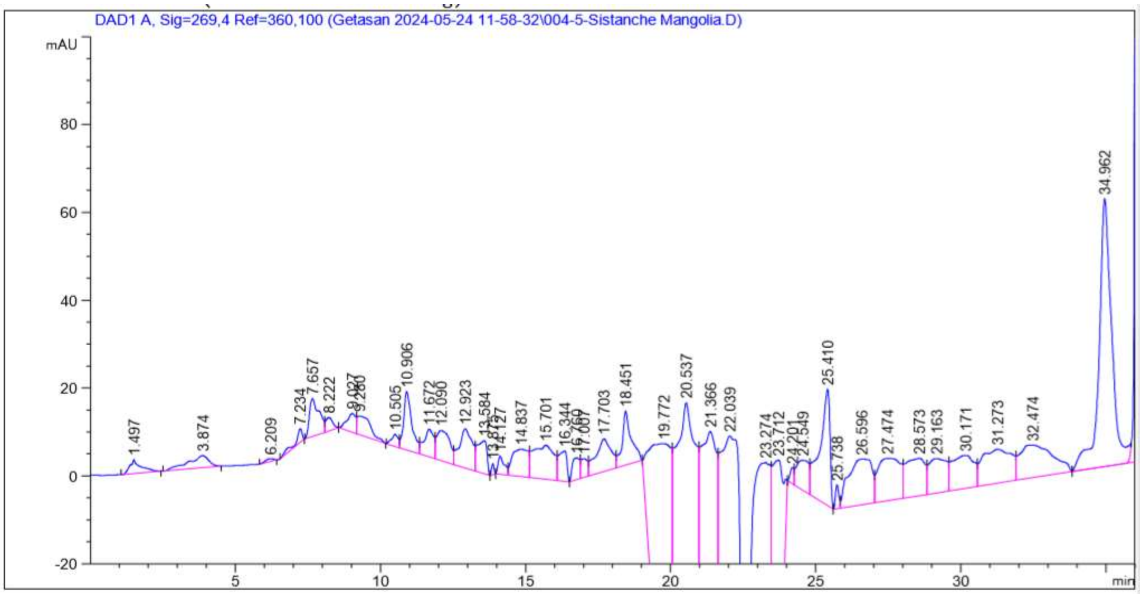

Figure 8. Spectrum of amino acid analysis in the root part of the Cistanche mongolica plant

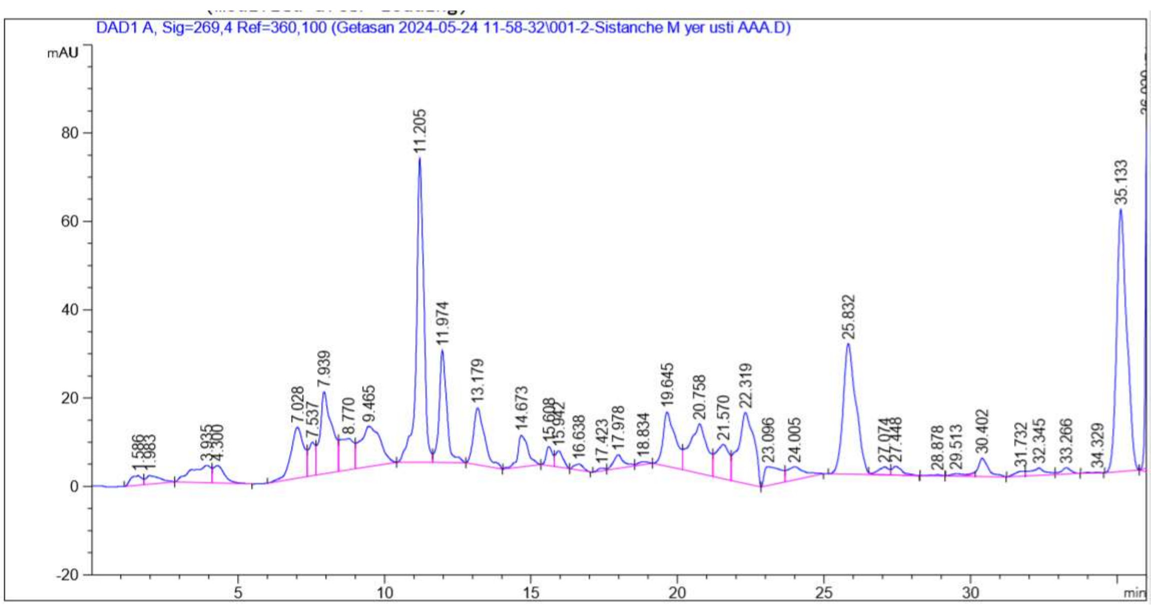

Figure 9. Spectrum of amino acid analysis in the shoot part of the Cistanche mongolica plant

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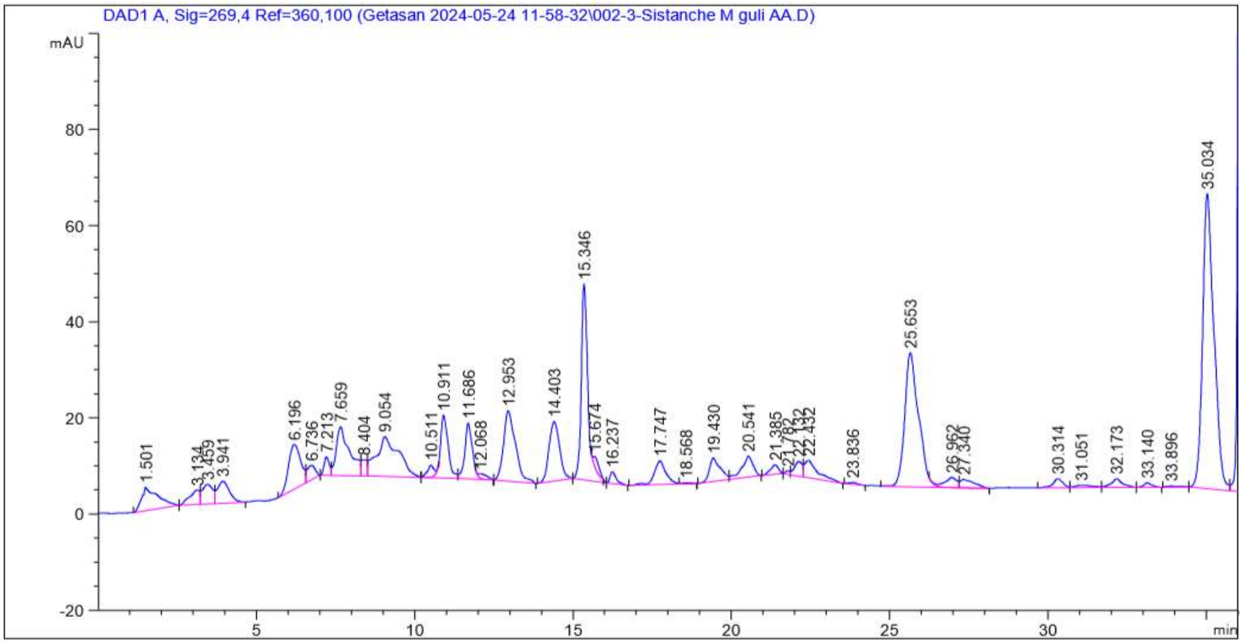

Figure 10. Spectrum of amino acid analysis in the flower part of the Cistanche mongolica plant

Conclusion

In conclusion, this study provides a comprehensive analysis of the elemental composition, flavonoid, vitamin, and amino acid profiles of Cistanche mongolica, a plant species native to the Amudarya delta of Khorezm region. The results of the ICP-OES analysis reveal a rich composition of essential macro- and microelements in the root part of the plant, with toxic microelements present at levels that meet regulatory requirements or are negligible. Furthermore, the study demonstrates that Cistanche mongolica is a valuable source of flavonoids, vitamins, and amino acids. Overall, the findings suggest that Cistanche mongolica has significant potential as a raw material source for cultivation in the Khorezm region, warranting further exploration of its agricultural and industrial applications.

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