Section 6. Chemistry

https://doi.org/10.29013/AJT-22-5.6-50-55

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COMPARATIVE STUDY OF THE ELEMENTAL COMPOSITION OF CISTANCHE SEEDS (CISTANCHE SALSA) FROM VARIOUS REGIONS OF KARAKALPAKSTAN

Abstract. Mass spectrometry with inductively coupled plasma was used to study the macro- and microelement composition of seeds of the Cistanche salsa (**Cistanche salsa**), growing in various regions of Karakalpakstan. Differences in the composition and quantitative content of elements depending on the place of growth of cistanche were established. Of the 44 elements determined by the analysis in the studied objects, potassium, calcium, phosphorus are dominant.

Keywords: Cistanche salsa (C. A. Mey) Beck., essential trace elements, toxic microelements.

Introduction

Macro- and microelements are a component of medicinal plant materials, affect the vital functions of plants and play a significant role in the pharmacological activity of herbal medicines [1].

Plants accumulate chemical elements and serve as the best natural source of a natural complex of vital elements with valuable groups of biologically active substances [2].

At the same time, researchers are increasingly trying to determine the existing relationship between the accumulation of certain groups of pharmacologically active substances in plants and the concentration of microelements. Thus, plants producing cardiac glycosides selectively accumulate manganese, molybdenum and chromium. Alkaloid plants accumulate cobalt, zinc, manganese, less often copper, saponin-containing plants accumulate molybdenum and tungsten, and terpene -containing plants accumulate manganese [2].

Many researchers also believe that the main trends in the formation of the elemental composition of plants are related to the environment [3].

We continue to study the chemical compound plants of salsa, growing in the conditions of Karakalpakstan [4; 5].

This report presents the results of studies of macro- and microelements of seeds of saline cistanche growing in three regions of Karakalpakstan, which, according to their geographical location, are conventionally accepted as northern, central and southern regions.

the prospects of using Cistanche salina in pharmacology, along with its well-known types of Cistanche, which have been widely used since ancient times in Chinese folk medicine. imposed on the quality of medicinal plant raw materials.

Based on this, we set a goal: to determine the composition and degree of accumulation of macro- and microelements in the seeds of saline cistanche growing in three regions of Karakalpakstan in comparison with data for a sample of cistanche seeds grown in China.

Materials and research methods

The objects of our study were the seeds of Cistanche salsa, which were collected during flowering and the beginning of fruiting in May 2019 from three regions of the Republic of Karakalpakstan (Karatau, Kuskanatau, Ustyurt), which were conditionally divided by geographical location into the northern, central and southern parts of Karakalpakstan. The seeds are separated from the pods.

Sample 1 – Cistanche seeds from China provided by local entrepreneurs.

Sample 2 – seeds of Cistanche salsa collected from the southern region, the Karatau upland.

Sample 3 – seeds of Cistanche salsa, collected in the Bozatau region, Kuskanatau uplands, the central region of Karakalpakstan

Sample 4 – seeds of Cistanche salsa, collected during the fruiting period in the territory of the village of Jaslyk on the Ustyurt plateau of the Republic of Karakalpakstan, the northwestern region of Karakalpakstan.

The accumulation of macro- and microelements in the studied objects was determined by inductively coupled plasma mass spectroscopy (ICP-MS) on the device ISP – MS (Nexion 2000) by Perkin Elmer. The multi-element standard and the Hg standard were used as standards. An S-200 Perkin-Elmer autosampler was used, generator power – 1500 W, peristaltic pump flow rate – 1.2 ml/min, argon flow – 12–15 l/min, axial view, nebulizer – 0.8 l/min.

Results and discussion

As a result of the study of the elemental composition of *seeds of Cistanche salsa*, growing in different regions of the Republic of Karakalpakstan and the Chinese sample of seeds by mass spectrometry with inductively coupled plasma on the device ISP – MS (Nexion 2000) 44 contents were identified macro- and microelements. Table 1 presents the results of the analyzes of these samples.

Table 1.– Macro- and microelements of seeds of Cistanche salsa, mg/l

No.	Element	Sample 1, China	Sample 2, Karatau	sample 3, Bozatau	Sample 4, Ustyurt
Bioelements-macroelements					
1	**2**	**3**	***4***	***5***	***6***
1	Na	3029.364	2197.377	3438.104	2083.459
2	K	5744.298	13764	11260.316	7092.323
3	Ca	6904.802	5303.021	6022.110	5570.931
4	P	3582.135	5115.599	4302.023	846.086
5	mg	4886.816	3599.925	2958.273	4815.804
6	S	860.754	842.88	773.712	708.366
		Ca > K > Mg > P > Na > S	K > Ca > P >Mg > Na > S	K > Ca > P >Na > Mg > S	K> Ca >Mg>Na>P>S
Essential microelements					
7	Fe	900.301	365.626	909.988	902.377
8	Zn	3.121	5.511	4.135	3.168
9	Cu	1.285	1.161	1.882	1,100
10	Mn	13.974	6.266	215.960	11.559
11	Mo	0.154	0.096	0.139	0.065

1	2	3	4	5	6
12	Co	0.167	0.067	0.267	0.167
13	Cr	1.327	1.079	2.252	1.117
14	Se	0.107	0.049	0.138	0.142
		Fe > Mn > Zn > Cr > Cu > Co > Mo > Se	Fe > Mn > Zn > Cu > > Cr > Mo > Co > Se	Fe > Mn > Zn > Cr > > Cu > Co > Mo > Se	Fe> Mn >Zn>Cr> >Cu>Co>Se>Mo
Conditionally essential					
15	B	6.453	5.757	7.140	6.497
16	Si	1001.823	894.746	1512.293	715.068
17	Ni	1.469	0.815	2.119	1.040
18	V	0.566	0.312	0.885	0.717
19	Li	1.767	0.637	1.897	1.847
20	As	0.160	0.066	0.195	0.120
		Si > B > Li > Ni > V > As	Si > B > Ni > Li > > V > As	Si > B > Ni > Li > V > As	Si>B>Li>Ni>V>As
Potentially toxic microelements					
21	Rb	0.496	0.380	0.511	0.302
22	Zr	0.029	0.017	0.044	0.019
23	sn	0.160	0.170	0.108	0.0 56
24	Ag	0.002	0.001	0.001	0.001
25	W	0.139	0.078	8.252	1.378
26	Ge	0.003	0.001	0.003	0.001
27	Ga	0.567	0.491	0.534	0.422
28	Sr	12,570	10.203	10.301	15.041
29	Ti	793.096	32.793	33.270	34.971
		Ti > Sr > Ga > Rb > > Sn > W > Zr > Ge >Ag	Ti > Sr > Ga > Rb > > Sn > W > Zr > Ag > Ge	Ti > Sr > W > Ga > Rb> > Sn > Zr > Ge > Ag	Ti> Sr >W> Ga > Rb> > Sn > Zr >Ag> Ge
Toxic trace elements					
30	Al	938.957	301.524	1192.128	1153.096
31	Pb	0.100	0.204	0.269	0.106
32	Ba	2.789	2.487	2.528	2.028
33	Bi	0.001	0.000	0.001	0.001
34	CD	0.004	0.008	0.007	0.003
35	hg	0.052	0.027	0.239	0.407
36	Ta	0.000	0.000	0.000	0.000
37	Be	0.060	0.033	0.60	0.052
38	Sb	0.006	0.010	0.007	0.004
39	Tl	0.001	0.001	0.001	0.001
40	U	0.040	0.032	0.042	0.027
41	In	0.000	0.000	0.000	0.000
42	Nb	0.011	0.003	0.018	0.008
43	Cs	0.010	0.002	0.010	0.007
44	Re	0.000	0.000	0.001	0.000

1	*2*	*3*	*4*	*5*	*6*
A series of quantitative decrease in elements		Al > Ba > Pb > Be > Hg > U > Nb > Cs > Sb > Cd > Tl > Bi	Al > Ba > Pb > Be > U > Hg > Sb > Cd > Nb > Cs > Tl	Al > Ba > Be > Pb > Hg > U > Nb > Cs > Cd > Sb > Tl > Bi > Re	Al>Ba>Hg> Pb >Be>U> Nb >Cs> Sb >Cd> Tl >Bi
Sum		**28689.94**	**22453.42**	**32662.703**	**23969.88**

As can be seen from Table 1, 44 elements were analyzed in each sample, but in samples No. 1 (Chinese) and No. 4 (Ustyurt) 41 elements were determined, and in samples No. 2 (Karatau) and No. 3 (Bozatau) 40 and 42 elements each respectively. Elements such as Ta, In are absent in all seed samples, Re, Bi are also not found in the Karatau sample, and Re is not found in the Chinese and Ustyurt samples, or their content is beyond the limits of the determination of this method.

Table 2 presents the rows of elements in descending order of their content in the studied samples of seeds of Cistanche salsa.

Table 2.– Series of quantitative decrease of macro- and microelements of Cistanche seeds of China and regions of the Republic of Karakalpakstan

Sample	**A number of elements in descending order**
№ 1, China	Ca > K > Mg > P > Na > Si > Al > Fe > S > Ti > Mn > Sr > B > Zn > Ba > Li > Ni > Cr > Cu > Ga > V > Rb > Co > As > Sn > Mo > W > Se > Pb > Be > Hg > U > Zr > Nb > Cs > Sb > Cd > Ge > Ag > Tl > Bi
№ 2, Karatau	K > Ca > P > Mg > Na > Si > S > Fe > Al > Ti > Sr > Mn > B > Zn > Ba > Cu > Cr > Ni > Li > Ga > Rb > V > Pb > Sn > Mo > W > Co > As > Se > Be > U > Hg > Zr > Sb > Cd > Nb > Cs > Ag > Tl > Ge
№ 3, Bozatau	K > Ca > P > Na > Mg > Si > Al > Fe > S > Mn > Ti > Sr > W > B > Zn > Ba > Cr > Ni > Li > Cu > V > Be > Ga > Rb > Pb > Co > Hg > As > Mo > Se > Sn > Zr > U > Nb > Cs > Cd > Sb > Ge > Ag > Tl > Bi > Re
№ 4, Ustyurt	K > Ca > Mg > Na > Al > Fe > P > Si > S > Ti > Sr > Mn > B > Zn > Ba > Li > W > Cr > Cu > Ni > V > Ga > Hg > Rb > Co > Se > As > Pb > Mo > Sn > Be > U > Zr > Nb > Cs > Sb > Cd > Ag > Tl > Bi > Ge

If we analyze the quantitative content of macroelements (Na, K, Mg, P, Ca, S) in the studied samples of cistanche seeds growing in different regions of Karakalpakstan in comparison with the data for cistanche seeds from China, it can be seen that in all Karakalpakstan samples, the maximum content falls on K, and the Chinese pattern is dominated by Ca. The maximum content of K, Ca, and S is contained in the seed sample from the southern Karatau region, while Na and Ca predominate in the Bozatau (central region). In sample 4 from Ustyurt, the maximum indicator falls only on magnesium, for all the rest it has the lowest indicators (except for P) and is closest to the values of the Chinese sample. In turn, the Chinese sample is superior in calcium content and slightly in phosphorus and sulfur ions.

The sequence of decreasing quantitative content of macroelements is preserved for 3 Karakalpakstan seed samples, except for the abnormally low content of phosphorus in Ustyurst cistanche seeds.

Previously, we reported on the results of studies of the elemental composition of the aboveground and underground parts of the stolon cistanche saline of Karakalpakstan, where a similar predominance of potassium and other macroelements was also shown [6].

Based on the analysis of table 1 and previous data [4], the following conclusion can be drawn: Cistanche salsa, regardless of the area of growth in

Karakalpakstan, is rich in macroelements, such as Na, K, Mg, P, Ca, S, with a predominant predominance of potassium in all samples stolons and seeds.

Of the essential elements (Fe, Zn, Cu, Mn, Mo, Co, Cr, Se) in all objects, the iron content is many times higher than the rest of the elements and varies within 900–910 mg / l, with the exception of a sample of Karatau seeds (365.6 mg/l). We observed an overestimated iron content earlier in the aboveground and underground parts of the cistanche stem [6], and noted that they can serve as a raw material source for replenishing iron deficiency in the body.

The overestimated content in seeds in comparison with stolons is also preserved in the case of manganese, zinc, and cobalt. At the same time, the maximum zinc content is observed for Karatau seeds, and the minimum for Chinese (3.121 mg/l) and Ustyurt seeds (3.168 mg/l).

Unlike macronutrients, the content of most essential elements (Fe, Mn, Co, Cr, Se) in the Krantaus seed sample is minimal.

maximum content of essential elements, especially manganese, is accumulated in a seed sample from the central Bozatau district.

And in the case of conditionally essential elements (B, Si, Ni, V, Li, As), we observe that their maximum concentration falls on the seeds of the Bozatau region, exceeding the content in other samples by 1.5–2 or more times. Similarly, the minimum accumulation is in the seeds of cistanche from Krantau, and the values of the samples from China and Ustyurt are close to each other. It should be noted that silicon dominates in all samples (1512.3–715.068 mg/l).

For humans and animals, silicon is especially important as a structural element of connective tissue [7].

The values of the conditionally essential elements B, Si, V, As for the human body have not been fully established; they are better known as structural or functional cofactors of biochemical processes in other organisms [8]. It is currently known that boron is especially necessary for plants, in particular, due to the active participation of this bioelement in the synthesis of bioflavonoids [7].

Among the potentially toxic elements, Ti and Sr predominate. There is especially a lot of titanium in the sample of China (793.1 mg/l), while for the samples of cistanche seeds from Karakalpakstan its content is in the range of 32.8–34.97 mg/l. Titanium at a daily dose of 0.85 mg is not toxic to humans, and there is no data on a lethal dose. Strontium maximum content in sample 4 (Ustyurt) (15.041 mg/l), for the rest of Karakalpakstan samples corresponds to 10.2 mg/l. Among the other trace elements, an abnormally high content of tungsten is observed for the Bozatau sample (8.252 mg/l), while for the remaining three samples this value ranges from 0.078–1.378 mg/l).

When analyzing the results for toxic trace elements, as can be seen from Table 1, aluminum predominates in all samples. The maximum concentration of aluminum is concentrated in the cistanche seeds samples 3 and 4, and the lowest in Sample 2. The content of barium is in the range of 2.028–2.7.89 mg/l, and the presence of lead in the samples ranges from 0.1–0.27 mg/l.

For all other toxic elements, their concentration is approximately hundredths or thousandths, or has trace amounts, which does not exceed the permissible norms for a living organism.

Conclusion

Thus, as a result of the analysis by the ICP-MS method macro- and microelement composition of seeds of saline cistanche found the influence of the place of growth on the accumulation of macro- and microelements. The maximum accumulation of elements both in terms of composition and in terms of mass is observed in the seeds of the central Bozatau region, and the minimum – in the southern Karatau sample. Seed samples from the northern region of Ustyurt, where the gypsum-bearing nature of the soil composition and from China, are more similar both in composition and in weight for most elements.

All vital elements in the studied objects, potassium, calcium, phosphorus are dominant.

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