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ELEMENTAL COMPOSITION OF SOME *RUMEX* SPECIES (*POLYGONACEAE*)

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Abstract

Determination of plant materials elemental composition is a useful tool for modern phytochemical research. The analysis of the element composition of medicinal plant seeds, leaves and roots could provide new data for their biological and ecological assessment. The purpose of the research is a comparative study of the quantitative content of macro- and microelements in the leaves, roots and seeds of some Rumex species (Polygonaceae), R. pamiricus Rech. f, R. conglomeratus Murray, R. confertus Willd, R. aquaticus L. In this work, using the method of ICP-MS analysis the elemental composition of seeds, leaves and roots was studied. As a result for most elements their similarity was noted, which indicates the commonality of the metabolic processes in plants of related species. The macroelements in the seeds, leaves and roots of the studied species, ***Na, Mg, Al, Si, P, K, and Ca*** *are accumulated in the maximum amount, and of the microelements –* ***Fe****. Also, 5,619 mg/kg* ***Pb*** *in R. confertus leaves, 20,726 mg/kg in R. pamiricus seeds, 3,036 mg/kg in R. aquaticus roots, significant accumulation of 10,055 mg/kg was observed in R. conglomeratus seeds and 33,338 mg/kg* ***Bi*** *in R. aquaticus leaves.*

Keywords: *Polygonaceae, Rumex, micro- macroelements, seeds, leaves, roots, composition*

1. INTRODUCTION

From a scientific and practical point of view, it is important to solve the problem of providing the population with medicines based on local plant materials. In order to expand the raw material base and create effective, economically and environmentally beneficial original drugs, a search is being made for new non-deficient raw materials sources of medicinal plants, and the study of natural biologically active substances is being deepened.

Rumex is the second largest genus of *Polygonaceae*, which is rich in resources. There are more than 250 species of *Rumex* plants in the world, with 16 species located in Uzbekistan [1]. *Rumex pamiricus* Rech. f., *Rumex confertus* Willd, *Rumex aquaticus* L. and *Rumex conglomeratus* are the most common

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species among them [2,3]. Plants of the genus *Rumex* L. (sorrel, dock) are widely distributed in North America, Central and Eastern Europe, Kazakhstan, the Far East and partly in the Caucasia, Russia and East Asia [4,5,6,7,8]. Many plants from genus *Rumex* are traditional folk medicinal plants in Uzbekistan, which have been used for a long history to treat various bleeding and thrombocytopenia, fungal dermatosis and diarrhea, dysentery, stercoral ulcer, as appetizer, analeptic medicine for lever, heart, as antihemorrhagic, to treat hepatitis, fever and other diseases [2,9]. Modern pharmacology research shows that they have great development and utilization value and curative effect in 8 aspects, namely bacteriostasis, anti-inflammatory, antiviral, cardiovascular, liver, anti-oxidation and anti-corrosion, anti-tumor, immune regulation [1].

Plants belonging to the *Polygonaceae* are known to produce a large number of biologically important secondary metabolites, such as anthraquinones, flavonoid glycosides, phenolic acids, naphthalenes, stilbenoids, steroids and leucoanthocyanidins [10]. We have reported in previous articles on phenolic substances isolated from some *Rumex* species [1, 2]. Among wild plants, *Rumex* plants have a great potential [1]. They are already widely used as food, fodder, melliferous, and medicinal plants [6, 11, and 12]. In some countries, the fresh leaves of *Rumex* plants (such as *R. vesicarius*, *R. acetosella*, *R. abyssinicus*, *R. crispus*, *R. induratus*, *R. sanguineus*, *R. obtusifolius*, *R. tuberosus*, *R. thyrsiflorus*, and *R. acetosa*) are used as an important ingredient in salads and soups [13, 14, and 15]. According to the literature information, several *Rumex* species are included in the pharmacopoeias of various countries. For example, *R. crispus* is listed in the American Herbal Pharmacopoeia as a general detoxifier and an agent for skin treatment [16]. The State Pharmacopoeia of the Russian Federation includes the roots of *R. confertus* as an herbal medicine, which is used in the treatment of liver diseases, dysentery, pulmonary and uterine bleeding, as well as a laxative [17, 18]. To date, about 70 elements are known that a human needs to fully function. The accumulation level of individual elements in plants depends on their content in the soil, the amount and form of fertilizer applied [19]. In our previous articles, the information provided about the chemical composition of *Rumex confertus* Willd. and *Rumex pamiricus* Rech. f. plants and their biological activities [20].

The study of the phytogenetic relationship between the leaves, roots and seeds of *Rumex* species, as well as pharmacognostic studies to find natural raw materials sources of biologically active substances effective in the treatment of various diseases is being carried out. Based on the foregoing, the purpose of this work is to study the micro-, macroelement composition of the species *Rumex* growing in Uzbekistan.

2. EXPERIMENTAL PART

2.1. Plant Material

The plant leaves, roots and seeds of the following species were used as the objects of study: *Rumex pamiricus* Rech. f, *Rumex conglomeratus* Murray, *Rumex confertus* Willd, *Rumex aquaticus* L. [1,7]. Leaf samples (on April 2021), seeds and roots (on July, September 2021) of the plants were collected from Tashkent Botanical Garden. Based on the foregoing, the purpose of this work is to study the micro-, macroelement composition of the species *Rumex* growing in Uzbekistan (Tables 1-3).

2.2. Methods

Method for the quantitative determination of micro and macro elements by inductively coupled plasma mass spectrometry (ICP-MS)

0.05-0.5 g of an accurate sample of the test substance is weighed on an analytical balance and transferred to autoclave with teflon liner. Then, the appropriate amount of purified concentrated

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mineral acids (nitric acid) and hydrogen peroxide is poured onto the autoclaves. The autoclaves are closed and placed on a Berghof microwave digester with MWS-3+ software or a similar type of microwave digester. The decomposition program is determined based on the type of the test substance, the degree of decomposition and the number of autoclaves (up to 12 pcs) are indicated.

After decomposition, the contents in autoclaves are quantitatively transferred into 50 or 100 ml volumetric flasks and the volume is adjusted to the mark with 0.5% nitric acid. The determination of the test substance is carried out on an ISP MS instrument or a similar instrument of the optics of an emission spectrometer with inductively coupled argon plasma. In the determination method, the optimal wavelength of the determined micro or macro elements is indicated, at which they have maximum emission. In the construction of a sequence of analyzes, the amount in mg and the degree of its dilution in ml are indicated. After receiving the data, the instrument automatically calculates the true quantitative content of the substance in the test sample and enters it in the form of mg/kg or µg/g with error limits and RSD in %. Appliances and utensils used: ICP MS NEXION-2000 or equivalent mass spectrometer, microwave decomposition device Berghof (Germany) or similar autoclave with teflon liner, volumetric flasks. Reagents used: multi element standard for MS, standard - Hg (mercury), nitric acid (chemically pure) purified, hydrogen peroxide, deionized water, argon (gas purity 99.995%) [21].

3. RESULTS AND DISCUSSION

Table 1: Elemental composition results

№	Plant name	Sample	Li 7 (mg/kg)	Be 9 (mg/kg)	B 11 (mg/kg)	Na 23 (mg/kg)	Mg 24 (mg/kg)	Al27 (mg/kg)	Si 28 (mg/kg)	P31 (mg/kg)	K39 (mg/kg)	Ca 42 (mg/kg)
1	*R. confertus*	Leaf	2.391	0.036	54.263	**866.750**	**9452.661**	**510.569**	**1107.593**	**6962.817**	**40451.934**	**67322.554**
2	*R. pamiricus*	Leaf	2.721	0.044	22.844	**1936.457**	11030.183	**901.560**	**984.838**	**4792.515**	**34771.201**	**38376.063**
3	*R. aquaticus*	Root	0.733	0.003	4.429	**471.448**	**1510.822**	**192.084**	**317.711**	**3569.000**	**5654.538**	**6782.916**
4	*R. pamiricus*	Root	0.456	0.009	8.741	**525.898**	**3254.304**	**127.251**	**230.325**	**4794.430**	**3703.773**	**20097.160**
5	*R.conglomeratus*	Root	0.240	0.020	8.686	**380.533**	**2077.012**	**178.156**	**176.092**	**4802.540**	**4071.305**	**60992.095**
6	*R. confertus*	Seed	0.292	0.018	8.571	**312.152**	**940.028**	95.247	**192.032**	**4050.926**	**8559.468**	**4864.040**
7	*R. aquaticus*	Leaf	0.244	0.022	11.949	**501.950**	**623.773**	**157.661**	**129.606**	**3283.555**	**4912.655**	**8643.259**
8	*R. pamiricus*	Seed	0.333	0.024	9.474	**1529.804**	**1285.874**	**109.350**	**176.528**	**5798.352**	**16325.633**	**4459.746**
9	*R. confertus*	Root	0.405	0.029	4.511	**337.754**	**3894.376**	**142.288**	**323.671**	**6671.692**	**8982.879**	**13617.790**
10	*R.conglomeratus*	Leaf	0.288	0.036	2.355	**405.326**	**2487.009**	**164.710**	**217.548**	**6563.332**	**13086.703**	**9237.921**
11	*R.conglomeratus*	Seed	1.015	0.008	1.225	**613.963**	**4390.056**	**518.688**	**688.268**	**11271.288**	**13895.168**	**26353.480**
12	*R. aquaticus*	Seed	0.511	0.032	6.268	**328.095**	**3701.858**	**268.829**	**540.608**	**7983.973**	**13038.153**	**15445.351**

№	Plant name	Sample	Ti 48 (mg/kg)	V51 (mg/kg)	Cr 52 (mg/kg)	Mn 55 (mg/kg)	Fe 57 (mg/kg)	Co 59 (mg/kg)	Ni 60 (mg/kg)	Cu 63 (mg/kg)	Zn 66 (mg/kg)	Ga 69 (mg/kg)
1	*R. confertus*	Leaf	**3419.173**	1.273	15.331	55.252	**2264.733**	0.791	28.691	11.816	37.829	1.383
2	*R. pamiricus*	Leaf	45.107	1.909	3.784	53.425	**2523.417**	0.660	3.521	9.803	28.792	1.354
3	*R. aquaticus*	Root	9.811	0.880	2.369	15.241	**424.191**	0.131	1.471	2.552	23.364	0.500
4	*R. pamiricus*	Root	12.880	0.788	3.079	6.734	**471.660**	0.121	2.068	5.291	10.801	0.573
5	*R.conglomeratus*	Root	7.402	0.568	2.613	4.455	**1133.539**	0.181	2.844	3.042	9.897	0.882
6	*R. confertus*	Seed	**576.922**	0.185	2.091	6.072	**228.030**	0.192	1.703	2.845	7.237	0.299
7	*R. aquaticus*	Leaf	62.585	0.252	1.551	9.381	**336.786**	52.620	37.189	2.307	11.877	0.377
8	*R. pamiricus*	Seed	16.495	0.242	3.231	10.673	**2386.882**	0.134	2.661	12.774	**105.777**	0.360
9	*R. confertus*	Root	6.897	0.288	2.712	15.853	**525.975**	0.116	1.631	5.027	21.753	0.693
10	*R.conglomeratus*	Leaf	**372.860**	0.229	4.311	13.263	**792.924**	0.116	3.455	5.274	15.366	0.396
11	*R.conglomeratus*	Seed	28.022	0.884	5.541	27.419	**1228.178**	0.321	3.193	8.772	34.656	36.820
12	*R. aquaticus*	Seed	13.640	0.760	4.688	30.661	**1731.268**	0.143	2.338	4.698	35.478	1.183

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Table 2: Elemental composition results

№	Plant name	Sample	Ge 74 (mg/kg)	As 75 (mg/kg)	Se 82 (mg/kg)	Rb 85 (mg/kg)	Sr 88 (mg/kg)	Zr 90 (mg/kg)	Nb 93 (mg/kg)	Mo 98 (mg/kg)	Ag 107 (mg/kg)	Cd 111 (mg/kg)
1	*R. confertus*	Leaf	0.012	0.616	0.459	4.911	58.864	0.695	0.039	6.715	0.023	0.108
2	*R. pamiricus*	Leaf	0.010	0.573	0.249	7.792	44.231	0.507	0.064	1.099	0.037	0.108
3	*R. aquaticus*	Root	0.007	0.184	0.184	2.914	15.590	0.694	0.010	0.437	0.012	0.041
4	*R. pamiricus*	Root	0.004	0.096	0.354	1.408	30.701	0.329	0.005	0.762	0.011	0.020
5	*R.conglomeratus*		0.004	0.100	0.210	0.946	51.604	0.344	0.005	0.673	0.009	0.027
6	*R. confertus*	Seed	0.003	0.071	0.346	1.108	5.510	0.175	0.013	0.580	0.027	0.011
7	*R. aquaticus*	Leaf	0.004	0.151	0.187	4.157	7.020	0.271	0.014	0.324	0.060	0.031
8	*R. pamiricus*	Seed	0.006	0.173	0.302	2.510	6.390	0.240	0.007	0.509	0.043	0.044
9	*R. confertus*	Root	0.004	0.130	0.298	1.515	20.914	0.458	0.011	0.316	0.023	0.021
10	*R.conglomeratus*	Leaf	0.003	0.153	0.267	3.637	12.189	0.152	0.008	0.905	0.032	0.032
11	*R.conglomeratus*	Seed	0.008	0.417	0.349	2.205	30.560	0.740	0.029	0.838	0.062	0.132
12	*R. aquaticus*	Seed	0.022	0.298	0.181	4.526	10.383	0.190	0.022	1.321	0.024	0.151

№	Plant name	Sample	In115 (mg/kg)	Sn 118 (mg/kg)	Sb 121 (mg/kg)	Cs 133 (mg/kg)	Ba 138 (mg/kg)	Ta 181 (mg/kg)	W 184 (mg/kg)	Re 187 (mg/kg)	Hg 202 (mg/kg)	Tl 205 (mg/kg)
1	*R. confertus*	Leaf	0.001	3.147	0.129	0.043	24.499	0.001	0.465	0.003	0.215	0.002
2	*R. pamiricus*	Leaf	0.001	3.656	0.192	0.055	21.882	0.001	0.072	0.008	0.251	0.002
3	*R. aquaticus*	Root	0.000	3.127	0.081	0.013	8.045	0.000	0.023	0.000	0.022	0.001
4	*R. pamiricus*	Root	0.000	4.277	0.058	0.006	9.267	0.000	0.047	0.001	0.040	0.007
5	*R.conglomeratus*	Root	0.000	3.340	0.050	0.004	14.645	0.000	0.033	0.000	0.012	0.012
6	*R. confertus*	Seed	0.000	3.661	0.042	0.005	4.709	0.001	0.135	0.000	0.044	0.015
7	*R. aquaticus*	Leaf	0.000	2.607	0.727	0.006	5.802	0.001	0.030	0.001	0.021	0.011
8	*R. pamiricus*	Seed	0.000	4.896	0.109	0.015	5.107	0.001	0.034	0.002	0.299	0.012
9	*R. confertus*	Root	0.000	2.784	0.039	0.008	10.636	0.001	0.029	0.000	0.004	0.012
10	*R.conglomeratus*	Leaf	0.001	3.239	0.068	0.006	5.980	0.000	0.068	0.001	0.148	0.012
11	*R.conglomeratus*	Seed	0.000	4.696	0.132	0.025	**1021.966**	0.002	0.074	0.000	0.468	0.009
12	*R. aquaticus*	Seed	0.000	2.156	0.070	0.011	17.373	0.001	0.682	0.000	0.135	0.012

As a result Table-1,2, in the leaves of *R. confertus* Na, Mg, Al, Si, P, K, Ca, Ti, Fe, in the roots Na, Mg, Al, Si, P, K, Ca, Fe, in the seeds Na, Mg, Si, P, K, Ca, Ti, Fe. In the leaves of *R. pamiricus* Na, Mg, Al, Si, P, K, Ca, Fe, in the roots Na, Mg, Al, Si, P, K, Ca, Fe, in the seeds Na, Mg, Al, Si, P, K, Ca, Fe, Zn. In the leaves of *R. aquaticus* Na, Mg, Al, Si, P, K, Ca, Fe in the roots Na, Mg, Al, Si, P, K, Ca, Fe, in the seeds Na, Mg, Al, Si, P, K, Ca, Fe. In the leaves of *R.conglomeratus* Na, Mg, Al, Si, P, K, Ca,Ti, Fe, in the roots Na, Mg, Al, Si, P, K, Ca, Fe, in the seeds Na, Mg, Al, Si, P, K, Ca, Fe, Ba. This macro and micro elements were the highest content than other elements.

These elements are of high biological significance for human health [22].

Table 3: Heavy metals elemental composition results

№	Plant name	Sample	Pb 208 (mg/kg)	Bi 209 (mg/kg)	U 238 (mg/kg)
1	*R. confertus*	Leaf	**5.619**	0.023	0.084
2	*R. pamiricus*	Leaf	6.888	0.019	0.221
3	*R. aquaticus*	Root	**3.036**	0.013	0.091
4	*R. pamiricus*	Root	1.201	0.007	0.107
5	*R. conglomeratus*	Root	1.219	0.011	0.072
6	*R. confertus*	Seed	0.571	0.008	0.038
7	*R. aquaticus*	Leaf	1.928	**33.338**	0.043
8	*R. pamiricus*	Seed	**20.726**	1.793	0.063
9	*R. confertus*	Root	1.291	0.054	0.027
10	*R. conglomeratus*	Leaf	2.608	0.017	0.036
11	*R. conglomeratus*	Seed	**10.055**	0.123	0.073
12	*R. aquaticus*	Seed	3.003	0.039	0.049

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According to the results of the third table, Pb in the leaves of *R. confertus* is 5.619 mg/kg, in the roots 1.291 mg/kg, in the seeds 0.571 mg/kg. Pb in the leaves of *R. pamiricus* is 6.888 mg/kg, in the roots 1.201 mg/kg, in the seeds 20.726 mg/kg. *R. aquaticus* leaves Bi- 33.338 mg/kg, roots Pb- 3.036 mg/kg, seeds 3.003 mg/kg. organized. Also, Pb in *R. conglomeratus* leaves is 2.608 mg/kg, in the roots is 1.219 mg/kg, and in the seeds is 10.055 mg/kg.

4. CONCLUSION

Thus, studies on the quantitative content of the macro- and microelements in the leaves, roots and seeds of some *Rumex* species by the ICP-MS analysis have shown that most elements their similarity was noted, which indicates the commonality of the metabolic processes in plants of related species and characterized by a unique and valuable elemental complex (Table 1,2).

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