Heavy metals content of *Sanguisorba officinalis* L. in some regions of Siberia

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Abstract. Heavy metals content was studied in soil, herb and rhizomes with roots of *Sanguisorba officinalis* L. obtained in the Kemerovo, Novosibirsk and Krasnoyarsk regions. The study found that the root layer soil samples at all survey sites have significant elemental composition fluctuations and that its content does not exceed the maximum permissible concentration (MAC) in accordance with hygienic standards. It was revealed that biophyllic metals – Fe, Mn, Zn and Cu – accumulate more, mainly in *Sanguisorba officinalis* L. underground organs – rhizomes and roots (390.00…8.20 mg/kg). The raw materials samples collected in the Krasnoyarsk, Kemerovo and Novosibirsk regions comply the GMP.1.5.3.0009 GF XV requirements for standardized heavy metals.

1 Introdution

The Siberia regions have not only rich mineral reserves but also plant resources. These resources include medicinal plants. Developed industry (mining, chemical, metallurgical, etc.) and the development of new territories in Siberia have a certain environmental situation negative impact in these regions.

In addition to biologically active substances medicinal plants also contain chemical elements. Depending on their quantity they can have both a positive physiological role on the human body and a negative one [1]. The World Health Organization named the toxic substances contamination possibility among the risks of using medicinal plants for medical purposes which include heavy metals [2].

HMs can enter the plants in different ways both from the soil and from the atmosphere as a result of dust pollution; moreover they have an unequal ability to accumulate in the plant organism [3]. Therefore, studying the problem of heavy metals accumulation and content in medicinal plant materials is an urgent task and attracts the attention of many scientists [1–5].

This research is a continuation of previously published the ecological and hygienic assessment studies of the *Sanguisorba officinalis* L. raw material growing in areas with different anthropogenic loads [4, 5].

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The aim of this study was to make a comparative assessment heavy metals (Cu, Zn, Fe, Mn, Ni, Cd, Pb, Co, Cr) content in the above-ground and underground parts of *Sanguisorba officinalis* L. growing in the Kemerovo, Novosibirsk and Krasnoyarsk regions.

2 Materials and methods

The study object was the aboveground (grass) and underground (rhizomes and roots) organs of the great burnet (*Sanguisorba officinalis* L.). This medicinal plant is quite widespread in Siberia. Due to its rich biologically active complex it has found wide use in both official and folk medicine [6].

The raw materials collection was carried out at three sites: 1 – 17 km away from the Kemerovo city, in the vicinity of the Starye Topki village, Kemerovo region (KR); 2 – in the vicinity of the Ignatievka village, Novosibirsk region (NR); 3 – 25 km to the northwest from the Lesosibirsk city, Krasnoyarsk region (KrR).

Raw materials were collected during the period 2022: grass - in July, during the flowering phase; rhizomes and roots - in early September, in accordance with the medicinal plant materials collection requirements. Samples were air-shadow dried and stored in paper bags, protected from light in a well-ventilated area.

At the same time the root layer (A 0–15 cm) soil samples (at least 50 g) were taken from the sites, according to the generally accepted method.

The analysis was carried out in the agrochemical service "Kemerovo" (Kemerovo) accredited testing center. The atomic absorption method in an acetylene-air flame on AAS-30 devices from Karl Ceis Jena (Germany) was used to conduct the medicinal plants and soil samples elemental analysis [4]. The 9 heavy metals (lead, cadmium, copper, zinc, manganese, nickel, cobalt, iron, chromium) content was determined in the studied objects.

All analyzes were performed in triplicate; the obtained data were processed using standard statistical methods (MS Excel, STATISTICA 6.1).

3 Results and discussion

The 9 elements: Cu, Zn, Fe, Mn, Ni, Cd, Pb, Co, Cr content was determined in the great burnet raw material and associated soil samples. The study results are presented in Table 1.

Table 1. HM average content in soil samples and in *S. officinalis* L. raw materials

Object	HM content mg/kg								
	Pb	Cd	Cu	Zn	Mg	Ni	Co	Fe	Cr
1. Kemerovo region									
soil	0.99	0.09	0.20	1.13	28.60	0.77	0.45	21.70	1.83
rhizomes and roots	0.66	0.02	8.15	49.02	52.30	4.62	0.53	119.90	0.62
herb	0.46	0,01	5.91	13.50	31.30	7.39	0.25	102.50	0.65
2. Novosibirsk region									
soil	0.62	0.24	0.06	11.30	240.00	1.35	0.87	9.01	0.51
rhizomes and roots	0.57	0.11	4.48	30.00	15.00	3.90	0.93	56.50	1.07
herb	0.46	0.13	3.13	12.10	21.50	3.27	1.05	55.70	0.80
3. Krasnoyarsk region									
soil	3.67	0.32	6.96	276.00	48.70	1.89	0.99	13.40	0.53
rhizomes and	1.01	0.12	23.70	50.70	8.90	3.47	1.57	130.00	0.60

roots									
herb	1.09	0.15	7.02	36.00	30.05	4.22	1.67	91.10	0.70
MAC, APC*	6.0	1.0*	3.0	23.0	140-500	4.0	5.0	-	6.0
MAC for herbal substances	6.0	1.0	-	-	-	-	-	-	-

*Notice: APC * - approximate permissible concentration [6]; the error of average values does not exceed 5%.*

Results analysis revealed that all root layer soil samples at all three sites have significant fluctuations in elemental composition (Table 1). The maximum values are characterized by Zn (276.0 mg/kg) in KrR and Mn (240.0 mg/kg) in NR, the minimum values are Cd (0.09 mg/kg) in KR and Cu (0.06 mg/kg) in NR. HMs content comparison did not reveal their maximum permissible concentration (MAC) excess with hygienic standards in the study sites soils (Table 1) [7].

The obtained data comparative analysis showed that the average content (mg/kg) of Pb (1.01), Cd (0.12), Cu (23.7), Zn (50.7), Co (1.57) in burnet officinalis rhizomes with roots in KrR is higher than from other represented regions. For Mn (52.30 mg/kg), Ni (4.62 mg/kg) and Fe (149.8 kg/kg) higher concentrations were noted in underground organs collected in the KR, and for Cr (1.07 mg /kg) in NR.

The great burnet data evaluation revealed that the average content (mg/kg) of Pb (1.09), Cd (0.15), Cu (7.02), Zn (36.0) and Co (1.67), Fe (91.10) in KrR are higher than in other regions. For Mn (31.1 mg/kg), Ni (7.39 mg/kg), Fe (102.5 mg/kg) higher concentrations were observed in the herb collected from the KR and for Cr (0.8 mg /kg) in NR. It is possibly relate with specific environmental conditions and the anthropogenic pollution nature.

In addition it should be noted that the burnet underground and above-ground organs accumulate more biophyllic metals - Fe, Mn, Zn and Cu (Table 1). We obtained similar results earlier [4,5]. The plants increased need in biophilic metals is obviously associated with their vital biochemical processes participation that determine normal growth and development. It should be also noted that the burnet rhizomes and roots accumulate more metal biophylls than its above-ground. The other elements content is within close limits both in underground and above-ground organs. At the same time the minimum amount is characteristic for Cd (Table 1).

According to standardized HMs (Pb, Cd) all great burnet herbal substances studied samples which collected in different Siberia regions comply with the GPM.1.5.3.0009 requirements “Heavy metals and arsenic content determination in medicinal plant raw materials and medicinal herbal preparations” (GF XV) (Table 1). However, it is necessary to research the radionuclides content and its compliance with standards for commodity characteristics (humidity, ash content, biologically active substances) for the possibility of using collected *S. officinalis* as a medicinal plant raw material.

4. Conclusion

It has been experimentally established that the soil from the *Sanguisorba officinalis* L. sites is characterized by significant elemental composition fluctuations. The maximum values were noted for Zn (276.0 mg/kg) in the Krasnoyarsk region and Mn (240.0 mg/kg) in the Novosibirsk region, the minimum values were Cd (0.09 mg/kg) in the Kemerovo region

and Cu (0.06 mg/kg) and Cu (0.06 mg/kg) in the Novosibirsk region. The heavy metals content in soils did not exceed the maximum permissible concentration (APC).

It was revealed that different Siberia regions burnet accumulate more biophyllic metals - Fe, Mn, Zn, Cu and Ni - mainly in underground organs - rhizomes and roots (149.80...3.47 mg/kg).

In accordance with GPM.1.5.3.0009 GF XV a heavy metals content assessment did not reveal permissible levels excess in *Sanguisorba officinalis* medicinal plant raw materials growing in the Kemerovo, Novosibirsk and Krasnoyarsk regions.

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