

STUDY OF MACRO- AND MICROELEMENTS COMPOSITION OF *VERONICA LONGIFOLIA L.* HERB AND *VERONICA TEUCRIUM L.* HERB AND RHIZOMES, AND EXTRACTS OBTAINED FROM THESE SPECIES

**Alina P. Osmachko, Alla M. Kovaleva, Tatyana V. Ili'ina,
Oleq N. Koshovyi, Andrey M. Komisarenko, Elshan Yu. Akhmedov**

National University of Pharmacy, Kharkiv, Ukraine

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Plants of the genus *Veronica* L. (*Plantaginaceae*) are distributed worldwide and comprise about 500 species. In addition, species are grown as ornamental plants, which have many ornamental varieties [1, 2]. The unofficial species – *V. longifolia* L. and *V. teucrium* L. have been used in folk medicine of many countries mainly as expectorant and antibacterial agents for many years [3]. Experimental studies had shown anti-inflammatory, antibacterial, antioxidant, cyto-static and anti-radical activities [4-7]. Despite of the experience of folk medicine and preclinical studies, the chemical compositions of plants have not been studied in complex [3].

In *V. longifolia* L. herb and its alcohol extracts we identified and quantified polysaccharides, amino acids, aliphatic, phenolcarboxylic, hydroxycinnamic and fatty acids, components of essential oils, flavonoids, iridoids, chlorophylls, carotenoids, oxidizable polyphenols [8-11].

In herb and extracts of *V. teucrium* L. we studied amino acids, polysaccharides, hydroxycinnamic and phenolcarboxylic acids, flavor-noids, coumarins, iridoids, terpenoids, chlorophylls, carotenoids, catechins, aglycones of triterpene saponins [12-14].

V. teucrium L. rhizomes are studied poorly. According to scientific sources rhizomes contain vitamin C and saponins. According to our experimental data, *V. teucrium* L. rhizomes also contain polysaccharides, hydroxycinnamic acids, flavonoids and chlorophylls [3].

Microelements have high biological activity, are involved in a large number of physiological and biochemical reactions in plant and human organism. They are highly related with other biologically active substances (BAS), including flavonoids, therefore the aim of our study was to identify and quantify elemental composition of studied objects.

Materials and methods

Objects of research – *V. longifolia* L. herb, *V. teucrium* L. herb and rhizomes, extract of *V. longifolia* L. herb and extract of *V. teucrium* L. herb, obtained by 70% alcohol at a ratio of 1:10 v/v (extract A and B, respectively), extract of *V. teucrium* L. herb obtained by hot water (extract C).

For obtaining extracts A and B to accurately weighed samples of herbal drugs 70% ethanol was added at a ratio of 1:10 v/v, flasks were heated in a water bath with reflux for 30 min, extracts were cooled, filtered and studied. The yield of extract A was 23.33%, the yield of extract B – 28.58%. For obtaining extract C to accurately weighed sample of herbal drug distilled water was added (1:10 v/v) and it was heated with constant stirring for 40 min. The extraction has been performed for three times. Extracts were cooled, filtered, and then evaporated to 1/3 of the total volume. The yield of extract C was 23.59%.

Accurately weighed samples of *V. longifolia* L. herb, *V. teucrium* L. herb and rhizomes, and extracts A, B, C were placed in precalcined and weighed porcelain crucibles. Crucibles had been kept in an oven at a temperature of 100 – 105 °C for 1 hour. Herbal drugs and then the left coal were burned in a muffle furnace at the possibly lowest temperature; after coal has burned almost completely, flame was increased. Calcination was carried out in a muffle furnace at red ignition (about 500 °C), then crucibles were cooled in a desiccator and weighed. Calcination was carried out to constant weight.

Total ash was calculated by the formula:

$$X = \frac{m_1 * 100 * 100}{m * (100 - W)} \text{ where: } m - \text{mass}$$

of herbal drug before ignition, g; m_1 – mass of

herbal drug after ignition, g; W – loss on drying, %

Loss on drying was studied using moisture analyzer «Sartorius MA150» (Germany). To determine loss on drying accurately weighed samples of herbal drugs (about 1 g) were used. The temperature range was 100-250° C.

The study of elemental composition was carried out on the base of DNU “STC “Institute for Single Crystals” of NAS of Ukraine (Kharkiv). The identification and quantification of elements were conducted using atomic emission spectrophotometry. Spectrograph DFS-8 with a measuring complex for photoelectric registration of emission spectra had been used. The arc of alternating current was generated by generator «JVS -28». The following conditions of powders evaporation have

Results and discussion

The highest index of total ash was for *V. teucrium* L. herb, the lowest index – for

been set: the amperage of arc alternating current – 16A, the frequency of igniting pulse – 100 bits per second, the analytical slit – 2 mm, the slit width – 0,012 mm, an exposure – 60 seconds. Spectra have been recorded on the photographic film using spectrograph DFS-8 with a diffraction grating of 600 lines/mm and a three-lens system of slit lighting. Lines of spectra have been determined at wavelength of 270 nm to 347 nm in samples comparing with standard samples of the mineral elements mixture using microphotometer MF-4.

We have studied macro- and microelement content of herbal drugs (herb and rhizomes) of *V. longifolia* L. and *V. teucrium* L., and extracts obtained from them. Results are shown in Tables 1, 2 and 3.

V. longifolia L. herb. The highest index of total ash was for extract C, the lowest index – for extract B (*Table 1*).

Table 1. Total ash and loss on drying of studied objects

№	Sample	Loss on drying, %	Total ash, %
1	<i>V. longifolia</i> herb	7,93±0,13	6,26±0,21
2	<i>V. teucrium</i> herb	7,84±0,19	9,18±0,23
3	<i>V. teucrium</i> rhizomes	7,54±0,17	6,40±0,17
4	Extract of <i>V. longifolia</i> herb (A)	-	4,49±0,12
5	Extract of <i>V. teucrium</i> herb (B)	-	1,70±0,16
6	Extract of <i>V. teucrium</i> herb (C)	-	15,86±0,25

*Note: (n=5, P=0,95), «-» not determined

In herbal drugs of studied species and extracts 19 elements have been identified and quantified: among them 8 microelements (Fe, Mn, Al, Sr, Mo, Cu, Zn, Ni) and 6 macroelements (K, Na, Ca, P, Mg, Si) (*Table 2*).

The total content of elements in *V. longifolia* L. herb was 3397.95 mg/100 g, in *V. teucrium* L. herb – 4375.86 mg/100 g, in *V. teucrium* L. rhizomes – 4322.67 mg/100 g, in extract A – 2161.20 mg/100 g, in extract B – 584.37 mg/100 g, in extract C – 5621.15 mg/100 g (*Fig.1*). The highest content of macroelements was in *V. teucrium* L. herb, of microelements – in *V. teucrium* L. rhizomes. Among extracts the content of macro- and microelements in the extract C was the highest.

In *V. longifolia* L. herb the dominant macroelements are (mg/100 g) K (1860), Ca (620), Mg (185), Si (435), in *V. teucrium* L. herb – macroelements K (2300), Ca (920), Si (550), Mg (275) and microelement Al (110) domi-

nate, in *V. teucrium* L. rhizomes – macroelements K (2240), Ca (575), Si (770), Mg (190), P (160), and microelements Al (160), Fe (130) dominate.

In extract A the dominant macroelements are (mg/100 g) K (1350), Ca (360), Si (180), Mg (110), Na (90) and microelement Al (31); in extract B – macroelements K (250), Si (120), Na (35), Ca (85), Mg (70), and microelement Al (12) dominate; in extract C – macroelements Ca (1580), Na (950), Si (870), Mg (790), K (790), P (395) and microelement Al (160) dominate.

The descending series of chemical elements in *V. longifolia* L. herb K>Ca>Si>Mg>P, Al>Na, Fe>Zn>Sr>Mn>Cu>Mo>Ni>Pb, Co>Cd, As, Hg; in *V. teucrium* L. herb K>Ca>Si>Mg>Al>P>Fe>Na>Zn>Sr>Mn>Cu>Ni>Mo>Pb, Co>Cd, As, Hg; in *V. teucrium* L. rhizomes K>Ca>Si>Mg>P>Al>Fe>Na>Zn>Mn>SrCu>Ni>Mo>Pb, Co>Cd, As, Hg have been formed.

Table 2. Element compositions of *V. longifolia L. herb*, *V. teucrium L. herb* and rhizomes, extracts A, B and C obtained from these species

№	Element	Element composition, mg/100 g					
		<i>V. longifolia</i> herb	<i>V. teucrium</i> herb	<i>V. teucrium</i> rhizomes	Extract A	Extract B	Extract C
1	K	1860	2300	2240	1350	250	790
2	Ca	620	920	575	360	85	1580
3	Si	435	550	770	180	120	870
4	Mg	185	275	190	110	70	790
5	P	95	92	160	4.5	3.0	395
6	Fe	43	55	130	9.0	4.0	55
7	Al	95	110	160	31	12	160
8	Na	43	46	65	90	35	950
9	Mn	2.0	4.6	4.8	4.5	0.5	11.8
10	Zn	15.5	13.8	22.4	13.5	3.4	1.6
11	Sr	3.1	7.3	3.2	1.8	0.5	11.0
12	Cu	1.2	1.8	1.9	6.7	0.8	5.5
13	Ni	0.06	0.27	0.25	0.15	0.17	1.1
14	Mo	0.09	0.09	0.12	0.045	<0.03	0.15
15	Heavy metals: Co, Pb	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
17	Cd	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	As	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Hg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total:		3397.95	4375.86	4322.67	2161.20	584.37	5621.15

In extracts: of *V. longifolia L. herb* (A) K>Ca>Si>Mg>Na>Al>Zn> Fe>Cu>Mn, P>Sr>Ni>Mo>Pb, Co>Cd, As, Hg; of *V. teucrium L. herb* (B) K>Si>Ca>Na>Mg>Al>Fe>Zn>P>Cu>Mn>Sr>Ni>Mo, Pb, Co>Cd, As, Hg; of *V. teucrium L. herb* (C) Ca>Na>Si>K, Mg>Al>Fe>Mn>Sr>Cu>Zn>Ni>Mo>Pb, Co>Cd, As, Hg. The descending series of chemical elements showed the individual characteristics of their accumulation in studied objects.

We have determined transition coefficients of elements from *V. longifolia L. herb* and from *V. teucrium L. herb* to extracts A, B, C (*Table 3*).

In studied objects microelements Co (<0.03), Cd, As, Hg (<0.01) are absent or are beyond the determination capabilities of device, and thus are present in herbal drug within acceptable limits on the level of heavy metals specified in State Pharmacopoeia of Ukraine and European Pharmacopoeia. Therefore, herbal drugs can be recommended for medical use.

Macro- and microelements have been identified and quantified, that in the presence of others BAS in herbal drugs create conditions

for development of new drugs compositions with combined activity for treatment and prevention of cardiovascular system pathologies and diseases related with mineral imbalance. It was found that herbal drugs accumulate K, Ca, Mg, Si, Na, P, Al, therefore, herbal drugs can be used more complex.

Conclusions

19 Elements have been identified and quantified: including 8 microelements and 6 macro-elements. The highest content of macroelements was in *V. teucrium L. herb*, of microelements – in *V. teucrium L. rhizomes*. The content of macro- and microelements in extract of *V. teucrium L. herb* (C) was the highest. Macroelements K, Ca, Mg, Si, Na, P and microelements Al, Fe quantitatively dominate.

The obtained data indicate the possibility of prognostication that pharmacological activity of extracts of *V. longifolia L. herb* and *V. teucrium L. herb* can vary depending on the extragent, which requires further experimental confirmation and can be used for development of specifications on herbal drugs and extracts obtained from them.

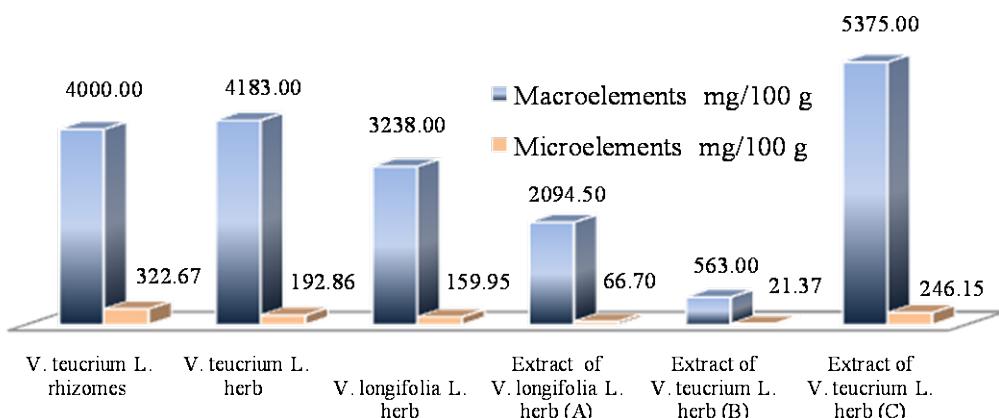


Figure 1. The content of macro- and microelements in *V. teucrium L.* herb and rhizomes, *V. longifolia L.* herb and extracts obtained from these species.

Table 3 . Transition coefficients of elements from *V. longifolia L.* herb and from *V. teucrium L.* herb to extracts A, B and C obtained from these species

№	Element	Coefficients of element transition, %		
		From <i>V. longifolia</i> herb to extract A	From <i>V. teucrium</i> herb to extract B	From <i>V. teucrium</i> herb to extract C
1	K	72.58	10.87	34.35
2	Ca	58.06	9.24	171.74
3	Si	41.38	21.82	158.18
4	Mg	59.46	25.45	287.27
5	P	4.74	3.26	729.35
6	Fe	20.93	7.27	100.00
7	Al	32.63	10.91	145.45
8	Na	209.30	76.09	2065.22
9	Mn	225.00	10.87	256.52
10	Zn	87.10	27.64	11.59
11	Sr	58.06	6.85	150.68
12	Cu	558.33	44.44	305.56
13	Ni	250.00	62.96	47.41
14	Mo	50.00	-	166.67
15	Heavy metals: Co, Pb, Cd, As, Hg	-	-	-

*Note: --> not determined

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VERONICA LONGIFOLIA L. OTUNUN, VERONICA TEUCRIUM L. OTU VƏ KÖKÜMSOVLARININ VƏ ONLAR ƏSASINDA OLAN EKSTRAKTALARIN MAKRO- VƏ MİKROELEMENT TƏRKİBİNİN ÖYRƏNİLMƏSİ

**Alina P. Osmaçko, Alla M. Kovalyova, Tatyana V. Ilyina, Oleq N. Koşevoy, Andrey M. Komissarenko,
Elşən Y. Əhmədov**

Milli Əczaçılıq Universiteti, Xarkov, Ukrayna

Açar sözlər: *Veronica longifolia L.*, *Veronica teucrium L.*, makroelementlər, mikroelementlər, atom-emission spektrofotometriya

V. longifolia L. otunda, *V. teucrium* L. otu və kökümsovlarında, *V. longifolia* L. və *V. teucrium* L. otunun 70 % etil spirti ilə 1:10 nisbətində alınmış ekstraktlarında, *V. teucrium* L. otunun qaynar su ilə alınmış ekstraktında atom-emission spektrofotometriya üsulu ilə makro- və mikroelementlərin miqdari müəyyən edilmişdir. 19 element aşkar olunub: bunlardan 8 mikroelement və 6 makroelementdir. Tədqiqat obyektlərində elementlərin miqdarının azalma sırası tərtib edilmiş və elementlərin xammaldan ekstraktlara keçmə koeffisiyenti müəyyən olunmuşdur. Tədqiq olunan obyektlər üçün qurudulduqda çəki itkisi (%) və ümumi külün (%) miqdarı təyin edilmişdir. Müəyyən olunub ki, *Veronica* L. cinsinin iki növünün xammalında K, Ca, Mg, Si, Na, P, Al toplanır, bu da bitki xammalını kompleks istifadəsinə imkan yaradır.

ИССЛЕДОВАНИЕ МАКРО- И МИКРОЭЛЕМЕНТНОГО СОСТАВА ТРАВЫ *VERONICA LONGIFOLIA* L., ТРАВЫ И КОРНЕВИЩ *VERONICA TEUCRIUM* L., И ЭКСТРАКТОВ НА ИХ ОСНОВЕ

Алина П. Осьмачко, Алла М. Ковалева, Татьяна В. Ильина, Олег Н. Кошевой,

Андрей. Н. Комиссаренко, Эльшан Ю. Ахмедов

Национальный фармацевтический университет, Харьков, Украина

Ключевые слова: *Veronica longifolia L.*, *Veronica teucrium L.*, макроэлементы, микроэлементы, атомно-эмиссионная спектрофотометрия.

В траве *V. longifolia* L., в траве и корневищах *V. teucrium* L., экстрактах из травы *V. longifolia* L. и *V. teucrium* L. полученных 70 % спиртом этиловым в соотношении 1:10, и в экстракте из травы *V. teucrium* L., полученного горячей водой определено содержание макро- и микроэлементов методом атомно-эмиссионной спектрофотометрии. Идентифицировано 19 элементов: среди них 8 микроэлементов и 6 макроэлементов. Сформировано ряды уменьшения содержания элементов в исследуемых объектах и определено коэффициенты перехода элементов из сырья в экстракти. Для исследуемых объектов установлено потерю в массе при высушивании (%) и общую золу (%). Установлено, что сырье двух видов рода *Veronica* L. накапливает K, Ca, Mg, Si, Na, P, Al, что позволяет использовать растительное сырье более комплексно.

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