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COMPONENT COMPOSITION OF ESSENTIAL OILS FROM LEAVES, INFLORESCENCES AND STEMS OF *PEROVSKIA SCROPHULARIFOLIA* GROWN IN UZBEKISTAN

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Essential oils as secondary metabolites, promising sources of biologically active substances with pronounced antimicrobial, antifungal and antiviral effects, are of considerable interest for study and possible use in medicine, pharmaceuticals, and aromatherapy. We have studied the composition of the essential oil of an endemic species for the first time *Perovskia scrophularifolia* Bunge. (Lamiaceae = Labiatae). This species of plant is of considerable interest as a medicinal plant, which is widely used in folk medicine in Uzbekistan and neighboring countries. Studies of biologically active substances of this species did not concern the essential oil. During the period of mass flowering in the inflorescences of *Perovskia scrophularifolia* contains 0.65%, in leaves – 0.71% of essential oil. The stems of the plant contain essential oils in small quantities. The composition and content of the components of the studied samples were determined according to the data of gas chromatographic and chromate-mass-spectrometric analysis. 26 substances were identified in essential oils from leaves, 43 from inflorescences and 18 substances from stems. The main components of essential oils from leaves and inflorescences are 1,8-Cineol up to 19.3% and Isobornyl acetate – up to 15.9%. This species is a promising source of biologically active compounds with biological activity (including antibiotic).

Keywords: Lamiaceae, Labiatae, 1,8-Cineol, Isoborneol, Isobornyl acetate, camphor, trans-caryophyllene, biological activity.

Introduction

Perovskia scrophulariifolia Bunge. (Lamiaceae), perennial shrub, numerous stems up to 1–1.20 m tall, lignified at the base, leaves opposite, entire or pinnate, purple, pink, pale yellow or white flowers. This is an essential oil plant. Grows in mountainous and foothill areas (up to 1800 m above sea level) on rocky slopes, rocks, screes, dry riverbeds, often as a weed, rises to the mid-mountain belt of the mountains of Central Asia (Pamir-Alay, Tien Shan, Kashkadarya region), endemic [1, 2].

Data on the possibility of obtaining preparations from the aerial part of *Perovskia scrophulariifolia* were actively studied in the 20th century, which is reflected in some works [3–8]. The aqueous extract has been shown to be used in sunburn and scabies baths, and applied to the skin for various wounds, as a wound healing, skin disease, such as dermatitis. The decoction is also used to combat human intestinal parasites, antibacterial activity; ointment – as an antiprotozoal agent. Grass was used to dye silk and cotton pink, good honey plant and perganos (or ambrosia – pergsha source), and food for goats and sheep [5–7, 9–12].

Materials and methods

The material was collected in natural habitats at the point of the Pamir-Alay, Gissar Range, 1469 m above sea level, in places of natural growth of plants during the period of mass flowering of plants. To obtain essential oil, 5–10 individuals were taken (each

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time at least 200 g of raw materials), divided by organs: leaves, flowers and stems. The essential oil was distilled off at least 5 times, then all samples of the obtained essential oil were combined, dried with calcined and anhydrous sodium sulphate. Herbarium samples collected in places of natural growth are stored in the private herbarium of Kh. Dzhumaev (Department of Botany, Termez Pedagogical University, Uzbekistan).

Essential oils from leaves, stems and inflorescences of *Perovskia scrophulariifolia* growing in the vicinity (Baysuntau, Pamir-Alai mountains) were obtained by hydrodistillation. In the period of mass flowering, inflorescences of plants contain an average 0.65% (from 0.59 till 0.71), leaves – contain an average 0.71% (from 0.68 till 0.73) of essential oil of the wet weight. The stems of the plant contain essential oils in a small amount (trace) contains an average of about ~0.1%. The bulk (up to 90% of the total amount) of the essential oil is collected 30 minutes after the start of boiling water in the flask. The production of essential oil was continued until the moment when there was no noticeable addition of essential oil in the receiver for 20 minutes. The resulting essential oils were yellow in color (from slightly colored to fairly intense color), with a specific, characteristic pungent odor.

The composition and content of the components of the studied samples were determined according to the data of gas chromatographic and chromate-mass-spectrometric analysis. Components were identified by mass spectra and RI values. Mass spectra were recorded on an LKB 2091 chromate-mass spectrometer (Sweden) using a packed glass column 1.8 m × 2 mm with 3% polydimethylsiloxane elastomer SE-30 on Chromosorb W (80–100 mesh) in the temperature programming mode from 50 to 200 °C at a rate of 5 °C/min. Evaporator temperature 200 °C, separator 220 °C, ion source 250 °C. Carrier gas helium, flow rate 25 ml/min. For mass spectrometric identification, the base (version 2017 and its predecessors) was used. Quantitative analysis of the essential oil, as in the works [13–15], was carried out on a Biochrome-1 chromatograph with a flame ionization detector using a 50 m × glass capillary column. 0.25 mm with polydimethylsiloxane stationary phase OV-101 (phase film thickness 0.25 mm) in the temperature programming mode from 50 to 200 °C at a speed of 5 °C/min. The temperature of the evaporator is 200 °C, the detector is 220 °C. Carrier gas helium, linear velocity in the column 18 cm/s. The sample volume was 0.5 μl, the division of the carrier gas flow at sample dosing was 1 : 15. To determine the retention indices, a mixture of reference *n*-alkanes C6–C18 was added to the samples; linear-logarithmic indices were calculated using the QBasic program. For identification by RI values, the NIST database was used [16].

Experimental part

Data on the composition of the studied essential oils from different organs of the studied plant species are presented in Table.

26 substances have been identified in essential oils from the leaves. The main components of essential oils are 1,8-Cineol (19.3%) and Isobornyl acetate (15.9%). Significant amounts also contain Camphor – 4.1%, Linalyl acetate – 4.5%, Isoborneol (Borneol) – 7.3%, Santalen (Kalaren) – 7.5%, *trans*-Caryophyllene – 8.3% and β-Santalene (α-Humulene) – 8.3%.

43 components were identified in essential oils from inflorescences, the main components of which are 1,8-Cineol – 16.7%, Camphor – 10.0%, Isoborneol (Borneol) – 10.2%, Isobornyl acetate – 8.4%, *trans*-Caryophyllene – 6.9%, Santalen (Kalaren) – 6.5% and β-Santalene (α-Humulene) – 6.2%. The content of Camphor and Isoborneol in the essential oils from the inflorescences increased, the content of the other main components decreased compared to those from the leaves.

The component composition of essential oils from plant stems is much less, there are only 18 of them, the main ones are Isoborneol (Borneol) – 10.7%, $C_{15}H_{25}OH$ (presumably δ-Kadinol) – 10.0, Santalen (Kalaren) – 9.6%, *trans*-Caryophyllene – 9.2%, β-Santalene (α-Humulene) – 8.2% and Isobornyl acetate – 8.4%.

Inflorescences and leaves of the *Perovskia scrophulariifolia* plant containing essential oil (0.65–0.71% of wet weight) can be used as raw materials to obtain 1.8-Cineol (16.7–19.3%) and Isobornyl acetate (8.4–15.9%).

Even if the essential oils from the leaves, inflorescences and stems of the plant contain the same substances, nevertheless, each of them has its own unique composition.

Discussion of the results

An analysis of published works over the past few years (since 2000, and especially the last 5–10 years) shows that there is a search for a comparison of different plant species of different families (Pinaceae, Myrtaceae, Apiaceae (Umbelliferae), Asteraceae (Compositae), and of course Lamiaceae), the essential oils of which will provide antimicrobial, antibacterial, antifungal, antiviral activity. And also, a lot of work is devoted to the study of individual components of essential oils, which also show antibacterial, antifungal and antiviral activities, but also exhibit other properties that are valuable for medical use [17–26].

Perovskia scrophulariifolia is not widespread species, therefore, in order to ensure the production of essential oils from this plant, it is necessary to carry out work on introducing it into the culture. Work out the cultivation technology, agricultural technology and evaluate how the accumulation of essential oil in the leaves and inflorescences of the plant will change, and what will happen to the component composition.

Quantitative content (in%) of individual components in essential oils from leaves, inflorescences and stems of *Perovskia scrophulariifolia* (mass flowering phase)

Retention indices*	Identified substances	Leaves	Inflorescence	Stems
926	α-Pinene 1,3	1.9	2.3	–
937	Camphene	1.8	1.0	–
965	β-Pinene	1.5	1.2	–
981	Myrcene	0.3	0.3	–
996	α-Phellandren	–	0.8	–
1000	3-Karen	0.8	–	–
1011	*n*-Cymol	0.8	0.5	–
1017	1,8-Cineol, Limonene	19.3	16.7	–
1026	*cis*-Ocimene	–	0.5	–
1068	*trans*-Linalooloxide (furan)	–	0.7	–
1085	Linalool	2.9	1.5	–
1115	Camphor	4.1	10.0	1.0
1149	Isoborneol (borneol)	7.3	10.2	10.7
1157	Linalooloxide (pyran)	–	3.0	–
1159	Terpinen-4-ol	2.5	–	–
1171	α-Terpineol	3.1	2.3	1.3
1180	γ-Terpineol, Myrtenol	–	0.3	–
1198	Neral	–	0.4	–
no clear signal	Nerol	0.5	–	–
1140	Linalyl acetate	4.5	0.4	–
1265	Isobornyl acetate	15.9	8.4	6.6
1292	Dihydrogarvilacetate	–	0.8	0.8
1300	Unidentified substance	1.7	–	–
1330	Terpinyl acetate	0.6	3.2	4.2
1344	Nerylacetate	0.3	0.4	–
1360	Geranyl acetate, α-Longipinene	–	0.2	–
1364	α-Ylangen	0.4	0.4	–
1400	Longifolene	0.3	0.7	0.6
1408	trans-Caryophyllene	8.3	6.9	9.2
1428	*cis*-Caryophyllene (*trans*-β-Farnisene)	0.6	0.8	–
1440	Santalen (kalaren)	7.5	6.5	9.6
1448	β-Santalene (α-humulene)	8.3	6.2	8.2
1460	Alloaromadendren	–	0.4	–
1479	δ-Germacrene, β-selinene	–	0.3	–
1483	β-Guayen, α-Element	–	0.3	–
1498	β-Bisabolene	–	0.6	2.6
1505	γ-Kadinene, α-bisabolene	–	0.4	1.4
1518	δ-Kadinene, calamenene	–	0.2	–
1527	$C_{15}H_{25}OH$	–	0.2	–
1560	$C_{15}H_{23}OH$	2.8	3.3	5.2
1571	Caryophyllene oxide	–	0.4	–
1583	α-Caryophyllene alcohol	–	2.0	3.9
1583	α-Cedrenepoxide	1.9	–	–
1592	α-Bisabolene	–	0.6	1.5
1601	Elemol	–	0.3	–
1618	$C_{15}H_{25}OH$ (presumably δ-Kadinol)	–	3.0	10.0
1628	T-Kadinol	–	0.7	3.4
1640	Apiol	–	0.6	–
1681	Trimethoxypropenylbenzene (presumably isoelemycin)	–	–	5.8

Note: * – n=5; «–» substance not found.

The presence of biologically active components in the composition of essential oils of *P. scrophulariifolia* should be assumed that it will have a pronounced abiotic effect on various types of microorganisms. This may open up prospects for the use of essential oils in the fight against pandemics.

Conclusion

The essential oil of *Perovskia scrophulariifolia* has a pleasant smell, contains active components that will exhibit biological activity, therefore, they can be used in medicine and aromatherapy [27–29]. These essential oils may also be of significant interest in the fight against phytophages, given that these essential oils are not toxic to humans, but may exhibit a repellant and/or insecticidal effect [30–36].

As our studies have shown, leaves, inflorescences and stems of *Perovskia scrophulariifolia* contain a significant amount from 5 to 20% of the total number of identified components) 1,8-Cineol, Limonene, Camphor, Isoborneol (Borneol), Isobornyl acetate, trans-Caryophyllene, Santalen (Kalaren), β-Santalene (α-Humulene) this gives us reason to believe that the assessment of the biological activity of both these essential oils and its individual components will show a high abiotic activity. This allows us to conclude that it is necessary to develop technologies for the plantation cultivation of *P. scrophulariifolia* in Uzbekistan as a promising essential oil plant.

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