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CHEMICAL COMPOSITION OF THE ESSENTIAL OILS OF *Ziziphora* GROWING UNDER VARIOUS ECOLOGICAL CONDITIONS

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It has been established that, in spite of different ecological conditions of the growth of the endemic species Ziziphora vychodceviana, Z. pedicellata, *and* Z. persica, *they are characterized by identical biosyntheses of terpenoids and differ by the ratio of the main components of their essential oils.*

Many species of *Ziziphora* are used in folk medicine in cases of gastric intestinal and cardiovascular diseases [1, 2]. They owe their pharmacological action to the presence of essential oils the chemical composition of which should differ in species growing under sharply differing ecological conditions.

We have previously investigated the chemical compositions of zizifora bungovskaya* and zizifora dushitsevidnaya†, the areas of which coincide over a considerable geographical area. It may be that because of mutual genetic influence their morphological and chemical characteristics differ slightly.

In the present paper we report on the chemical composition of the essential oils of endemic species of *Ziziphora*: *Z. vychodceviana*, *V. tkatsch.* (valley of the R. Chilik, Trans-Ilii Ala-Tau range, Kazakhstan), *Z. pedicellata* Pazij et Vved. (Chimgan area, Tashkent province, Uzbekistan), and *Z. persica* Bge. (Bonzhansai area, Kara-Tau range, Kazakhstan, and the environs of Zengilan, Azerbaidzhan). In view of the geographic conditions of their growth, these species cannot undergo genetic exchange with one another and, consequently, should differ in chemical composition, as is observed in numerous cases for other species of Labiatae family [4, 5]. However, the results of the chemical analysis of the essential oils obtained from plants of populations of the above-mentioned *Ziziphora* species growing in different geographical and ecological conditions showed that the qualitative compositions of the terpenoids were practically identical. They all contained main components belonging to *para*-menthane series: pulegone, isomenthone, menthone, menthol, neoisomenthol, piperitone, piperitenone, limonene, γ-terpinene, thymol, carvacrol, and other compounds. However, these species differed by the quantitative levels of these substances. Thus, the essential oil of *Z. pedicellata* had a higher level of menthol and that of *Z. persica* higher levels of limonene, γ-terpenene, piperitone, and piperitenone. If we take into account the closeness of the quantitative ratios of the main components in the essential oils of *Z. persica* growing in Kazakhstan and in Azerbaidzhan and also the above-mentioned closeness of those for zizifora dushitsevidnaya and zizifora bungovskaya, it may be concluded that each species of the plants is characterized not only by its qualitative component composition but also by the quantitative ratios of the components [6, 7].

EXPERIMENTAL

The preparation of the raw material and the isolation of the essential oils were carried out by an identical method on the instrument described in [3].

Gas-liquid analysis was performed on a Chrom-41 instrument with a 0.3 × 350 cm column filled with Celite-545 having a grain size of 0.20-0.25 mm impregnated with 15% of poly(ethylene glycol adipate). Linear programming in the

*Probably *Ziziphora bungeata*.

†Not identified. "Marjoram-like ziziphora."

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TABLE 1. Chemical Compositions of the Essential Oils of *Z. vychodceviana*, *persica*, and *pedicellata*

Components	*Ziziphora vychodceviana*	*Ziziphora pedicel-lata*	*Ziziphora persica*	
			Kazakhstan	Azerbaidzhan
α-Pinene	0.8	0.8	0.3	0.1
Camphene	[illegible]	0.1	0.1	0.1
β-Pinene	0.8	1.0	0.2	0.3
Sabinene	0.3	0.4	0.3	0.1
Terpinolene	0.2	0.3	0.1	Tr.
Limonene	1.3	0.6	3.1	2.3
β-Phellandrene	0.2	0.4	0.3	0.2
1,8-Cineole	0.1	0.1	0.2	0.1
γ-Terpinene	0.1	0.1	4.8	5.8
p-Cymene + terpinolene	0.3	2.2	2.1	1.8
Heptan-2-ol	2.0	0.4	Tr.	0.1
Menthone	2.3	5.5	1.4	1.1
Isomenthone	15.7	11.5	5.1	5.6
Linalool	Tr.	0.1	0.3	Tr.
Neoisomenthol	0.9	1.2	3.0	3.2
Menthol	1.6	9.2	2.8	3.5
Isomenthol	0.1	Tr.	0.8	0.5
Pulegone	66.0	62.0	57.5	61.3
Carvone	0.3	0.6	0.5	0.4
Nerol	0.6	0.5	0.3	0.4
Piperitone	1.1	0.6	4.1	3.2
Geraniol	0.1	0.3	0.9	0.5
Piperitenone	1.0	0.2	4.3	5.7
Piperitenone oxide	1.0	0.2	0.8	0.6
Thymol	1.1	Tr.	0.5	0.1
Carvacrol	0.2	Tr.	0.6	0.4
Sesq. alcohol	0.4	0.1	1.4	0.8
Ylangene	0.1	0.1	0.2	0.3
Gurjunene	Tr.	0.1	Tr.	0.4
β-Caryophyllene	Tr.	0.5	0.3	0.2
γ-Cadinene.	0.8	Tr.	0.2	0.3

interval of 70-195°C at 3 deg/min. Carrier gas — argon, 25 ml/min. Identification was achieved by the addition of authentic terpenoids and, where necessary, their isolation with the aid of PGLC and comparison of their spectral characteristics with those given in the literature. The essential oil of *Z. vychodceviana* had the following constants: n_D^{20} 1.4800; d_{20}^{20} 0.9439; $[\alpha]_D^{20}$ 12.3; acid No. 1.7; ester No. 23.3; yield 0.42%; of *Z. pedicellata*: n_D^{20} 1.4698; d_{20}^{20} 0.9211; $[\alpha]_D^{20}$ 8.1; acid No. 2.9; ester No. 9.5; yield 0.53%; of *Z. persica* (Kazakhstan) n_D^{20} 1.4820; d_{20}^{20} 0.9230; $[\alpha]_D^{20}$ 12.8; acid No. 2.5; ester No. 5.1.; yield, 0.60%; and of *Z. persica* (Azerbaidzhan): n_D^{20} 1.4908; d_{20}^{20} 0.9207; acid No. 3.78; ester No. 21.67.

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