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IDENTIFICATION AND BIOLOGICAL ACTIVITY OF VOLATILE ORGANIC COMPOUNDS ISOLATED FROM PLANTS AND INSECTS. III. CHROMATOGRAPHY-MASS SPECTROMETRY OF VOLATILE COMPOUNDS OF *Aegopodium podagraria*

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Gas chromatography-mass spectrometry identified more than 20 volatile organic compounds isolated from leaves and flowers of Aegopodium podagraria *L.*

Key words: *Aegopodium podagraria* L., volatile organic compounds, plant emissions, identification.

Aegopodium podagraria L. (Apiaceae) is one of the most common plants of Russian flora [1] and a basic source of nectar for the forest zone [2, 3].

Mono- and sesquiterpenes in addition to other compounds were identified by liquid-phase extraction in the essential oil of Umbelliferae plants [4, 5]. However, the chemical composition of the volatile organic compounds emitted by Umbelliferae plants has not been reported.

Native volatile compounds play a definite role in the interaction of insects with plants, in particular, of bees with nectar-bearing plants. Therefore, we studied the composition of the phytogenic emission of common aegopodium, a representative of the Umbelliferae family. The volatile compounds emitted by this plant were analyzed by dynamic gas extraction with subsequent cryogenic concentration and chromato-mass spectral analysis by the literature method [6]. The retention indices were calculated by the literature method [7] and compared with the literature data [7-10]. The mass spectral parameters of the analyzed compounds corresponded with those in the Wiley database [11].

It was found that the volatile compounds of common aegopodium consist mainly of terpenic compounds (Table 1). Sabinene (~63%) dominates among them. Substantially smaller quantities of α- and β-pinene, myrcene, α-geraniol, α-thujene, and β-phellandrene were found. The minor components are citronellol and linalool, isoborneol, and terpeneol acetates.

EXPERIMENTAL

Naturally grown *Aegopodium podagraria* L. (Iglinskii region, Bashkortostan) was studied during flowering. Samples of volatile compounds were collected in a sorption tube packed with Tenax GC sorbent by aspirating air at a distance of 10-15 cm from the plant. The amount of aspirated air was 4 L. The air flow rate was 0.2 $L \cdot min^{-1}$. The sorption tube was placed in a thermal desorber. The sorbed compounds were blown for 20 min into a nickel capillary with internal diameter 0.5 mm that was cooled by liquid nitrogen. Under these conditions the chemical compounds are sorbed on a small part of the inner surface of the capillary. This produces good chromatographic resolution. Rapid heating of the capillary transfers the organic compounds concentrated in it into a stream of carrier gas (He) and then into the chromatographic column with simultaneous start of the mass spectrometry system. The chromato-mass spectral analysis was performed on a Finnigan model 4021 (USA) instrument.

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TABLE 1. Composition of Volatile Organic Compounds of *Aegopodium podagraria* L.

Compound	Retention time	Retention index (exp.)	Retention index (lit.)	Content, %
Ethylacetate	7.37	601	592[7]	4.82
3-Methylbutanol	10.33	704	719[7]	0.47
Unidentified compound	15.12	835		6.81
Unidentified compound	16.10	863		2.51
Heptanal	16.58	883		1.17
Unidentified compound	18.44	917		0.50
Unidentified terpenic compound	18.59	922		0.04
α-Thujene	19.08	930	924[8]	0.63
α-Pinene	19.31	939	930[8]	3.60
Sabinene	21.24	971	964[8]	62.94
β-Pinene	21.37	978	969[8]	3.79
Myrcene	22.02	986	983[8]	2.17
1-Isopropyl-4-methylbenzene	23.46	1020		3.39
β-Phellandrene	24.11	1028	1022[8]	0.65
γ-Terpinene	25.38	1056	1049[8]	0.20
1-Isopropenyl-4-methylbenzene	26.56	1083		0.15
Terpinolene	27.11	1087	1079[8]	0.04
Nonanal	27.20	1088		2.08
Camphor	29.25	1136	1123[9]	0.55
Benzylacetate	29.56	1143		0.19
Decanal	32.16	1190		0.76
Unidentified terpenic compound	33.05	1198		0.14
Citronellol	33.26	1218	1216[9]	0.10
Linaloolacetate	34.45	1244	1242[10]	0.17
Isoborneolacetate	36.22	1286	1273[10]	0.03
α-Terpineol acetate	39.01	1345	1333[10]	0.14
α-Geraniol	40.03	1364	1361[9]	0.85
1,2-Dimethoxy-4-(2-propenyl)benzene	40.29	1384		0.22
α-Ionone	42.10	1417		0.06
6,10-Dimethyl-5,9-undecadien-2-one	42.53	1434		0.14
3-Methyl-4-(2,6,6-trimethyl-2-cyclohexenyl)-3-buten-2-one	44.27	1478		0.26
Unidentified compound	46.01	1515		0.14
Unidentified compound	51.52	1638		0.29

The chromatographic conditions were: quartz capillary column SE-30, 50 m × 0.2 mm, linear programmed temperature 50-250°C at 6°C/min. Mass spectra parameters: ion-source temperature 250°C, ionizing-electron energy 70 eV, scan rate 33-280 amu per second.

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