

## ESSENTIAL OIL OF *Galium salicifolium* FLOWERS AND HERB

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The genus *Galium* L. (Rubiaceae Juss.) is represented in the flora of Ukraine by greater than 50 species. We investigated earlier the essential oil constituents of *G. verum* L., *G. hercynicum* Weigel., and *G. humifusum* M. Bieb. [1, 2]. In continuation of research on plants of this genus, we studied the essential oil composition of *G. salicifolium* Klovov flowers and herb. Specimens were collected in the vicinity of Sokolovo, Kharkiv Oblast, in June 2010 (herbarium specimen No. 10/10 is preserved in the Herbarium at the Department of Pharmacognosy, NPU).

Steam distillation with subsequent treatment of the distillate with high-purity pentane was used to obtain the essential oil. This isolated the essential oil contained in the plant in minor or trace quantities [3]. The constituent composition of the essential oil from flowers and herb was established on an Agilent Technology 6890N chromatograph with a 5973N mass-spectrometric detector. The analytical conditions were quartz chromatography column, HP-5MS capillary; column length 30 m; inner diameter 0.25 mm; stationary phase diphenyl (5%)–dimethylsiloxane (95%) copolymer, stationary phase film thickness 0.25  $\mu\text{m}$ ; He carrier gas, carrier-gas flow rate 1 mL/min; sample volume 2  $\mu\text{L}$ ; sample injection in splitless mode (without flow division); sample injection rate 1.2 mL/min for 0.2 min. The thermostat temperature was 50°C with programming at 4°C/min to 220°C. The detector and vaporizer temperatures were 250°C. Mass spectra were recorded in an HP MSD 5971 quadrupole mass spectrometer with electron-impact ionization at ionizing electron energy 70 eV. Data were collected at 1.9 scans/s in the range 30–650 amu (Agilent 5973N). Compounds were identified by comparison with mass spectra of compounds in the Wiley 275 and NIST98 mass spectra libraries and with mass spectra of standard samples.

We found qualitative and quantitative differences for the constituent compositions of essential oils from herb and flowers (Table 1). A total of 63 compounds were identified in *G. salicifolium* flowers. They included 18 monoterpenoids, 4 sesquiterpenoids, 2 diterpenoids, 1 triterpenoid, 3 aromatic compounds, and 35 hydrocarbons and their derivatives. The monoterpenoids comprised the nor-terpenoid  $\alpha$ -isophorone; acyclic *trans*-linalool oxide, *cis*-linalool oxide, linalool, nerol, geraniol, and geranylacetone; monocyclic  $\alpha$ -phellandren-8-ol,  $\beta$ -phellandren-8-ol,  $\alpha$ -terpineol, terpinen-4-ol, and eucarvone; bicyclic chrysanthenone, myrtenol, and *trans*-verbenol; bornylacetate; monocyclic aromatic *p*-cymen-8-ol; and the monoterpene oxide syringyl alcohol B. The sesquiterpenoids were represented by the nor-terpenoid and  $\beta$ -ionone; acyclic  $\alpha$ -farnesene and hexahydrofarnesylacetone. Diterpenoids included phytol and geranyl-linalool. The triterpene squalene was present. Aromatic and phenolic compounds ranged from benzaldehyde and phenylacetaldehyde to 2-methoxy-4-vinylphenol.

The dominant constituents in the flowers were (%) *trans*-verbenol (19.49),  $\beta$ -phellandren-8-ol (14.23),  $\alpha$ -phellandren-8-ol (3.30); terpineols  $\alpha$ -terpineol (2.01) and terpinen-4-ol (1.31); linalool (2.53); and geraniol (2.38).

The herb of *G. salicifolium* contained 61 identified compounds. Of these, 13 were monoterpenoids, 4 sesquiterpenoids, 1 diterpenoid, 1 triterpenoid, 3 aromatic compounds, and 39 hydrocarbons and their *O*-containing derivatives. The monoterpenoids included acyclic linalool and its oxides, *trans*-linalool oxide and *cis*-linalool oxide, nerol, geraniol, and geranylacetone; monocyclic terpinen-4-ol,  $\alpha$ -terpineol, and eucarvone; bicyclic *trans*-pinocarveol and *trans*-verbenol, borneol; and monocyclic aromatic eugenol. The sesquiterpenoids were the nor-terpenoid  $\beta$ -ionone; acyclic  $\alpha$ -farnesene and hexahydrofarnesylacetone; tricyclic longiborneol; the diterpenoid phytol, and the triterpenoid squalene. The aromatic compounds were represented by benzaldehyde, phenylacetaldehyde, and 2-methoxy-4-vinylphenol.

The dominant constituents in herb were (%) linalool (4.15), borneol (3.02), geraniol (2.55) and  $\alpha$ -terpineol (2.51).

In contrast with leaves and stems, flowers contained the nor-monoterpene  $\alpha$ -isophorone; monocyclic monoterpenoids  $\alpha$ -phellandren-8-ol,  $\beta$ -phellandren-8-ol, and eucarvone; bicyclic monoterpenoids and their esters *trans*-verbenol, chrysanthenone, myrtenol, and bornylacetate; the acyclic diterpenoid geranyl-linalool, and the aromatic alcohol syringyl alcohol.

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TABLE 1. Terpenoids and Aromatic Compounds of Essential Oil from *Galium salicifolium* Flowers and Herb

Compound	RI	Content, %		Retention time, min	
		in flowers	in herb	flowers	herb
Benzaldehyde	962	0.41	1.90	6.57	6.55
Phenylacetaldehyde	1005	0.75	0.47	8.98	8.97
<i>trans</i> -Linalool oxide	1089	1.01	1.06	9.87	9.87
<i>cis</i> -Linalool oxide	1091	0.45	0.27	10.38	10.37
Linalool	1104	2.53	4.15	10.81	10.77
$\alpha$ -Isophorone	1123	0.50		11.46	
Chrysanthenone	1127	0.45		11.57	
<i>trans</i> -Pinocarveol	1141		1.48		12.03
<i>trans</i> -Verbenol	1152	19.49	0.48	12.41	12.26
$\alpha$ -Phellandren-8-ol	1154	3.30		12.48	
Borneol	1168		3.02		12.96
Terpinen-4-ol	1181	1.31	0.50	13.37	13.32
$\beta$ -Phellandren-8-ol	1190	14.23		13.69	
$\alpha$ -Terpineol	1195	2.01	2.51	13.86	13.80
Myrtenol	1201	1.67		14.04	
Syringyl alcohol B	1205	0.43		14.19	
Eucarvone	1222	1.58		14.75	
Nerol	1232	0.69	0.71	15.09	15.1
Geraniol	1259	2.38	2.55	15.99	15.95
Bornylacetate	1287	0.39		16.91	
2-Methoxy-4-vinylphenol	1327	0.67	0.45	17.89	17.9
Eugenol	1368		0.57		19.12
$\beta$ -Damascenone	1389		0.37		19.78
Geranylacetone	1440	0.31	0.80	21.32	21.31
$\beta$ -Ionone (isomer)	1488	0.30	0.69	22.02	22.02
$\alpha$ -Farnesene	1496	0.56	0.62	22.16	22.15
Longiborneol	1613		1.55		24.1
Hexahydrofarnesylacetone	1848	0.90	1.87	27.61	27.61
Geranyl-linalool	2036	0.75		29.97	
Phytol	2118	0.63	2.93	30.94	30.93
Squalene	2830	1.61	2.65	38.06	38.05

Finally, *trans*-verbenol, borneol,  $\beta$ -damascenone, geranylacetone, longiborneol, and eugenol were found only in the essential oil from the herb.

The compositions of these essential oils were studied for the first time.

## REFERENCES

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