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Chemical composition of essential oils of *Origanum vulgare* L. growing in Lithuania

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Twenty essential oils of all aerial parts, inflorescences and leaves of cultivated *Origanum vulgare* L. were analyzed by capillary gas chromatography and mass spectrometry (GC/MS). The main constituents in 6 out of 7 samples of inflorescence oils were sabinene (8.7–19.5%), β-caryophyllene (15.4–24.9%) and germacrene D (12.3–16.0%) and in the same quantity of the leaf oils – β-caryophyllene (15.9–21.3%), germacrene D (12.1–15.7%) and caryophyllene oxide (4.7–11.1%). The amount of phenols, thymol and carvacrol, was 0–3.9 %. The chemical composition with a low concentration of phenols of the above oregano disagreed with the data on high concentrations of these compounds reported in some books describing Lithuanian medical and aromatical plants. The major part (60.5–90.5%) of the oils (except commercial plants) consisted of mono- and sesquiterpene hydrocarbons. The identified constituents made up 79.5–98.0% of the essential oils.

Key words: *Origanum vulgare* L., composition of essential oil, sabinene, β-caryophyllene, germacrene D, caryophyllene oxide

INTRODUCTION

Data on the chemical composition of some essential oils of *Origanum vulgare* L. given in some Lithuanian books are inaccurate. For example: the books “Medicinal Plants” (1973) [1], “Aromatic Plants” (1989) [2]. “The Minor Forest Resources” (1992) [3], “Plants – Our Life” (1996) [4] and “Handbook of Medicinal Plants” (2002) [5] informed us that the essential oils of oregano growing in Lithuania contained up to 40–44% of phenols (thymol and carvacrol). Analysis of oils from plants of Lithuanian botanical gardens (1980) showed that the content of thymol and carvacrol was 2.3% and their derivatives comprised 1.9% [6]. Nearly the same amount of phenols was found in the oil from oregano plants grown in the experimental garden of Lithuanian Institute of Horticulture (1996; Table 1, B) [7]. The major constituents of the above oil were sabinene, 1,8-cineole and caryophyllene oxide.

Only one species of oregano *O. vulgare* ssp. *vulgare* is growing wild in Lithuania [8]. Essential oils of oregano plants grown wild in Eastern Lithuania did not contain phenols, either, and the main constituents were β-ocimene, β-caryophyllene and germacrene D (Tables 1 and 2, W, IW, LW) [9, 10].

More than half of essential oils from 70 clones of *O. vulgare* ssp. *vulgare* cultivated in France (seeds from different European countries) contained 0–1.4% of thymol and only several samples contained ≤14.5% [11]. The amount of carvacrol did not exceed 0–0.95% in all 70 investigated oils. The major constituents of the above leaf oils were mono- (sabinene, cis-sabinene hydrate, β-ocimene, terpinen-4-ol) and sesquiterpenoids (germacrene D, β-caryophyllene, caryophyllene oxide). Essential oils of the same subspecies in India contained 62.0% of γ-muurolene [12].

Inflorescence oils of four chemotypes (β-caryophyllene, thymol, terpinen-4-ol, p-cymene + β-caryophyllene) from *Origanum vulgare* ssp. *vulgare* cultivated in Italy were investigated [13]. Low contents of thymol (1.1%) and carvacrol (0.3–0.6%) were found in the oils of terpinen-4-ol and p-cymene + β-caryophyllene chemotypes. A higher content of carvacrol (7.6%) was determined in the oil of β-caryophyllene chemotype (seeds from USA).

Carvacrol (37.7–83.8%) and thymol (41.3–79.4%) were the major constituents in oils of *O. vulgare* ssp. *hirtum* (7 samples), *O. vulgare* ssp. *glandulosum* (2 samples) and *O. vulgare* ssp. *grasile* (1 sample) cultivated in Italy [13]. Two phenol chemotypes of the oils of *O. vulgare* ssp. *hirtum* were also found by other investigators [14–22]. Thymol (61.0–69.1%) was the main constituent in the oil of *O. vulgare* ssp. *viridulum* from Greece [23]. Some essential oils in Finland from wild *O. vulgare* L. (without specification) contained carvacrol as a dominant constituent [24].

Essential oils of *O. vulgare* ssp. *virens* cultivated (seeds of different origin) in Italy were grouped into two chemotypes: linalool (3 samples) and terpi-

Table 1. **The chemical composition of the essential oils of aerial parts of *Origanum vulgare* L.**[a]

Compound	RI	A	B [7]	C	D	E [31]	W [9]
α-Thujene	931	0.0–0.9	0.4–1.2	tr-0.5	–	0.0–0.1	0.2–1.1
α-Pinene	939	0.4–0.5	0.8–1.0	1.0–1.6	0.2–0.3	0.0–0.1	0.3–1.0
Sabinene	976	**19.2–22.9**	**14.0–14.1**	**8.5–10.6**	0.1–1.5	0.3–1.6	**6.4–14.2**
β-Pinene	980	–	3.0	0.4–1.4	0.6–1.9	0.0–0.4	0.5–1.2
1-Octen-3-ol	984	o.5	3.0	0.1–0.4	–	0.1–0.2	0–0.9
Myrcene	991	0.9	0.2–0.3	1.4	–	0.0–0.2	1.1–2.0
α-Terpinene	1018	0.4–0.9	0.8–0.9	0.4–1.4	tr	0.1–0.2	0.6–1.6
p-Cymene	1026	0.6–4.3	2.5–3.9	0.4–1.0	0.1–0.7	0.1–1.0	0–0.9
β-Phellandrene	1032	0.7–0.9	–	3.0–6.5	–	0.0–0.8	4.7–7.9
1,8-Cineole	1033	tr-3.6	**9.5–11.6**	3.1–6.9	0.1–0.3	0.5–2.9	4.7–7.9
(Z)-β-Ocimene	1040	5.4–6.1	2.1–5.3	5.0–5,9	0.9–1.1	0.2–1.4	**6.2–11.5**
(E)-β-Ocimene	1050	0.8–3.1	1.0–3.3	5.1–5.9	tr	0.5–1.3	**7.0–11.5**
γ-Terpinene	1062	1.2–3.2	1.6–1.9	1.9–2.8	–	0.3–0.9	0–2.6
cis-Sabinene hydrate	1068	tr-1.5	0.9–1.0	0.0–0.2	–	–	0–0.4
Terpinolene	1088	–	0.3–0.4	0.4–0.5	–	0–0.1	0–0.6
Linalool	1099	0.9–1.2	1.7–2.1	0.9–1.0	tr	0.3–1.4	0.6–2.9
Terpinen-4-ol	1177	1.2–1.9	1.2–1.6	0.9–1.2	1.4–4.2	0.5–1.5	0–3.0
β-Terpineol	1187	tr-0.2	1.5–1.7	0.9–1.0	0.1–0.3	0.2–1.5	0.8–2.4
Thymol	1290	tr-0.2	1.4–3.2	0.0–0.6	1.6–1.7	0–0.2	–
β-Bourbonene	1387	0.6–0.8	1.0	1.2–1.6	1.3–1.6	1.9–2.5	0.5–1.0
β-Elemene	1391	–	–	0.0–0.3	tr-0.3	0.6–0.8	0–0.4
β-Caryophyllene	1418	**18.2–18.8**	**5.5–7.7**	**14.2–15.4**	**11.9–12.9**	**24.6–31.3**	**10.8–15.4**
β-Gurjunene	1432	–	0.2	0.3–0.9	0.1–0.3	–	0–0.2
α-Humulene	1454	2.3–3.1	0.8–1.3	2.1–3,3	0.2–0.6	5.0–5.3	1.5–2.6
allo-Aromadendrene	1461	0.4–0.5	–	tr-0.4	0.3–0.7	1.7–2.3	0–0.6
Germacrene D	1480	**9.6–10.5**	**3.8–5.5**	**11.0–11.6**	**11.6–12.8**	**13.7–19.2**	**10.6–16.9**
Bicyclogermacrene	1494	0.6–3.5	–	tr-3.2	1.0–1.7	2.8–3.7	1.4–4.5
α-Muuralene	1499	0.3–3.0	–	0.4–0.5	tr-0.5	0.9–1.1	0–0.8
α-Farnesene + β-bisabolene	1508 1509	1.1–5.5	0.5–1.0	3.2–6.0	5.0–7.1	8.4–11.5	4.1–6.9
δ-Cadinene	1524	tr-0.9	0.3–0.5	0.7–1.5	1.7–3.0	3.5–5.0	1.3–3.2
Spathulenol	1576	3.9–4.9	1.5–3.1	0.9–3.2	9.3–12.1	1.2–1.7	1.4–3.2
Caryophyllene oxide	1581	**8.6–8.7**	**9.6–10.6**	**4.3–8.0**	**21.9–23.4**	5.0–5.9	0.9–7.1
α-Cadinol	1653	0.4–1.4	0.4–0.6	0.2–0.6	0.5–1.0	2.0–3.1	0–1.2
Total		91.6–97.4	89.6–90.7	88.4–92.9	79.5–80.0	89.3–97.5	85.6–98.0
Monoterpene Hydrocarbons C_{10}		34.7–39.1	30.8–34.9	33.9–35.6	2.9–4.9	1.6–8.2	29.5–41.8
Monoterpenoids		35.9–46.0	54.9–59.4	40.1–46.2	5.9–12.0	4.9–10.6	39.9–52.0
Hydrocarbons C_{15}		36.2–38.5	12.0–17.8	35.7–39.9	33.9–35.5	65.6–80.4	38.5–46.8
Caryophyllane skeleton		**26.8–26.9**	14.3–16.1	18.5–23.4	**35.3–35.8**	**29.6–37.2**	**21.5–30.9**

[a] tr – traces; some more constituent with low concentration beside given in table were in [7, 31] essential oils.

RI – retention indexes on nonpolar column, **A** – Rokiðkis district (Aleknos) and Vilnius (Ðeðkinë), **B** – – data of P.R. Venskutonis [7], **C** – Vilnius district (Nemenèinë and Siponys), **D** – bought in the chemist shops, **E** – plants with pink flowers (seed from Moscow botanical garden) [31], **W** – aerial part of wild plants from Vilnius district [9].

Table 2. **Chemical composition of essential oils of *Origanum vulgare* L. inflorescences (F, G, H, J, IW) and leaves (F', G', J', H', LW)[a]**

Component	RI	Leaves					Inflorescences				
		F	G	H	J	IW[10]	F'	G'	H'	J'	LW[10]
α-Thujene	931	tr	0.4–0.5	0.5–1.7	0.4	tr-0.8	tr	tr	0–0.3	tr	tr-0.3
α-Pinene	939	0.1	tr-1.7	tr-0.6	0.5	0.5–1.2	tr	tr	tr-1.1	0.4	0.4–0.9
Sabinene	**976**	**5.8**	**8.7–19.5**	**14.4–15.7**	**17.1**	**10.5–15.8**	3.8	3.4–4.5	6.2–8.1	7.7	6.7–9.8
β-Pinene	980	0.1	0.6–0.8	1.1–1.5	1.1	1.0–1.6	1.4	tr	tr–0.4	0.6	0.6–1.0
Myrcene	991	0.4	–	tr-0.7	1.0	0.4–1.3	–	tr	tr-1.1	**2.7**	2.4–3.5
α-Terpinene	1018	–	0.2–0.5	0.6–0.8	1.2	0–1.4	0.2	–	0.1–0.3	0.1	tr-0.6
p-Cymene	1026	–	0.7	0.5–0.7	0.2	0–2.0	0.1	tr	0.4–1.7	0.3	tr–0.3
β-Phellandrene	1032	0.2	0–0.2	tr-1.1	1.3	3.2–9.5	–	tr	0.1–3.9	0.3	1.7–4.6
1,8-Cineole	1033	3.7	tr	2.7–4.5	7.8	3.2–9.5	3.4	tr	0.9–4.1	5.6	1.7–4.6
(Z)-β-Ocimene	1040	1.1	1.5–2.0	4.7–5.2	5.8	**2.8–5.4**	5.1	0.9–1.0	3.6–5.5	7.8	**14.0–16.6**
(E)-β-Ocimene	1050	4.3	1.7–2.8	6.1–6.4	6.9	**9.8–12.7**	3.5	0.3–0.4	2.1–2.9	6.1	**6.6–8.5**
γ-Terpinene	1062	0.8	0.5–1.3	1.5–2.3	1.1	0.6–2.4	0.3	tr	0.2–2.9	0.7	0.3–1.0
cis-Sabinene hydrate	1068	tr	–	0.1–0.5	0.2	0–0.6	0.3	–	0–0.3	tr	0–0.1
Terpinolene	1088	tr	–	0.2–0.6	0.2	tr-0.4	0.2	tr	0–0.1	tr	0–0.2
trans-Sabinene hydrate	1096	tr	–	0–0.3	tr	tr-1.0	–	–	–	-	tr-0.2
Linalool	1099	0.4	0.7–1.2	0.7–1.6	1.1	0.3–5.9	0.5	tr-0.1	tr-1.1	0.9	tr-2.1
allo-Ocimene	1129	–	–	–	–	–	3.4	tr-0.6	0–1.9	–	–
Terpinen-4-ol	1177	0.6	tr-0.6	0.6–1.5	0.3	tr-1.2	0.3	0–0.2	0.1–0.9	1.2	0–0.6
α-Terpineol	1187	0.2	0.1–0.8	0.6–1.4	0.9	0.5–3.7	0.1	0.2–0.7	0.1–1.2	0.2	0-0.6
Thymol	1290	1.2	0.1–0.2	0.2–1.4	0.4	-	1.6	0.5–0.8	0.1–1.7	–	–
Carvacrol	1298	–	tr	0–0.2	–	-	1.3	-	0–0.2	–	–
Bourbonene	1387	0.2	0.7–0.8	0.5–0.9	0.6	tr-0.4	0.7	0.6–3.2	1.7–5.9	2.9	0.4–1.4
β-Elemene	1391	0.7	0.4–0.8	0.7–1.2	0.5	–	0.8	0.7–0.9	0-tr	0.4	–
β-Caryophyllene	1418	**11.6**	**21.9–24.9**	**15.4–17.0**	**18.7**	**10.2–14.5**	**11.0**	**20.3–21.3**	**15.9–18.3**	**16.1**	**9.3–13.7**
β-Gurjunene	1432	1.6	1.5–1.7	0.6–1.8	0.5	tr-1.3	1.5	1.6	0.9–1.4	0.5	tr-0.3
α-Humulene	1454	2.5	4.7–5.4	2.5–3.7	3.2	0.5–2.7	2.3	5.0–5.3	2.3–3.1	3.1	0.8–2.6
allo-Aromadendrene	1461	1.5	tr-1.1	0–0.3	tr	0.5–0.9	1.7	0-tr	0-0.8	tr	–
γ-Muurolene	1477	–	–	–	–	–	tr	1.1–1.5	tr-0.2	0.1	–
Germacrene D	**1480**	16.0	12.9-14.6	12.3–13.7	11.4	9.5–15.9	14.3	15.1–15.7	12.1–13.8	14.0	12.7–15.7
Bicyclogermacrene	1494	6.4	5.4	0.4–2.1	1.7	1.4–3.5	6.0	5.5–6.7	tr-1.2	2.0	2.6–4.1
α-Muurolene	1499	–	–	0–0.8	tr	tr-0.7	tr	–	0.1–3.9	0.1	0.2–0.5
α-Farnesene	1508	–	tr-0.1	4.1–6.8	4.9	6.1–9.4	–	tr-5.5	0.4–4.1	2.3	2.5–3.6
β-Bisabolene	1509	5.5	4.3–5.0	0.7–2.0	1.9	6.1–9.4	2.4	2.4–4.7	1.6–4.1	1.6	2.5–3.6
γ-Cadinene	1524	1.3	tr	tr-0.1	0.2	–	1.4	0.1–0.4	tr-0.1	tr	–
δ-Cadinene	1524	4.3	2.0–4.0	0.6-1.6	0.7	1.6-2.5	3.7	0.4–1.2	0.1–0.9	0.6	1.7–2.4
α-Cadinene	1538	–	–	–	–	–	0.4	tr-2.8	0.2.6	1.1	–
Germacrene D-4-ol	1574	0.3	0.1–0.3	tr-1.9	1.2	1.7-3.4	0.1	0.3–0.5	0–1.1	0.7	2.6–4.9
Spathulenol	1576	6.5	2.7–3.0	0.1–0.9	1.3	–	5.0	4.5–5.3	0.5–3.1	0.3	–
Caryophyllene oxide	1581	1.3	2.9–3.1	1.6–3.6	1.7	1.2–4.8	2.7	7.6–8.9	4.7.11.1	5.2	1.4–4.1
epi-γ-Eudesmol	1619	2.2	0.7–0.9	0.2–0.6	0.4	–	0.3	0.5–1.4	0.1–0.3	0.1	–
epi-α-Muurolol	1642	3.6	1.5–2.4	0.3–0.9	0.5	0.4–1.6	2.3	0.7–1.1	0.2–0.5	0.4	0.4–2.1
α-Cadinol	1653	1.0	0.3–0.5	1.0–1.8	1.2	0.3–3.1	0.4	0.4	0.8–0.5	0.4	0.4–2.1
Total		85.4	86.5–96.4	89.1–95.1	97.9	93.0–97.8	82.5	84.3–84.5	82.4–85.7	86.7	87.2–95.0
Hydrocarbons C_{10}		14.0	15.4–29.2	33.0–35.3	37.0	33.9–39.9	20.9	5.3–6.3	17.2–24.6	26.7	34.9–43.2
Monoterpenoids		18.9	16.7–31.3	38.3–45.6	47.3	45.2–59.9	25.5	6.3–7.3	18.3–33.0	34.6	38.7–48.3
Hydrocarbons C_{15}		51.6	56.3–61.2	43.3–45.7	44.3	34.1–44.0	46.2	61.3–62.3	43.3	44.8	36.0–43.2
Caryophyllane skeleton		12.9	24.8–28.0	17.5–20.3	20.4	14.9–16.7	13.7	28.9–29.2	20.6–29.4	21.3	12.0–16.7

[a] tr – traces, RI – retention indexes on nonpolar column.
F,F' – Vilnius (Antakalnis).
G,G' – Vilnius (Ðeðkinë and Salininkai).
H,H' – Vilnius district (Nemenèinë) and Rokiðkis district (Aleknos, plants with pink and rse-pink flowers).
J, J' – Aleknos, plants with white flowers.
IW, LW – inflorescences and leaves of wild *Oregano* from Eastern Lithuania [10].

neol (3 samples) [13]. Linalool dominated in the oil of the above subspecies in Portugal [25], sabinene + germacrene D in France [26] and carvacrol + γ-terpinene + p-cymene in Moldavia [27]. The oil of *O. vulgare* L. (without specification) also contained linalool as a main constituent in India [28]. Linalyl acetate dominated in the oil of *O. vulgare* ssp. *viride* in Iran [29].

Essential oils of *O. vulgare* L. (without specification) growing wild in West Siberia were of β-ocimene type [30] as the oils of wild *O. vulgare* ssp. *vulgare* in Eastern Lithuania [9, 10]. Oils of *O. vulgare* L. cultivated in Leningrad region (seeds from the Moscow Botanical Garden) contained β-caryophyllene as a major constituent [31]. The cultivated plants with white flowers synthesized more monoterpenoids than plants with pink and rose-pink flowers [31].

The most bioactive compounds in essential oils of *O. vulgare* L. are the phenols carvacrol and thymol. Carvacrol exhibits antimicrobial [15, 30, 32–34], antioxidative [32], cytotoxic [15], genotoxic [18], insecticidal [18, 35], acaricidal [35] and antifungal [36, 37] activity. The antimicrobial [30] and antifungal [37] activity of thymol is lower than that of carvacrol. The essential oil of oregano with a low concentration of thymol (0.2%) also is antimicrobially active [30]. The main constituent of the oils under study, β-caryophyllene, is bioactive [34, 35]. It exhibited cytotoxity against two human carcinoma cell lines and enhanced activity of indole and indole-3-carbinol [38]. β-Caryophyllene is used as an additive for food in USA [38]. Caryophyllene oxide can change the behavior of corn borers [39]. Antimicrobial activity was noticed for essential oils containing large amounts of terpinen-4-ol [34]. Antimicrobial activity [40], allelophatic effect [41] and other forms of influence of 1,8-cineole [42] were investigated.

An analysis of twenty essential oils produced by oregano cultivated in East Lithuania was done in order to determine which major volatile compounds were biosynthesized by plants.

MATERIALS AND METHODS

Plants of cultivated *Origanum vulgare* were collected at full flowering in the following gardens: A – Rokiškis district (Aleknos) and Vilnius (Šeškinë); C – Vilnius district (Nemenèinë and Siponys); D – bougth in chemist's shops; F, F' – Vilnius (Antakalnis); G, G' – Vilnius (Ðeðkinë and Salininkai); H, H' – Vilnius district (Nemenèinë) and Rokiðkis district (Aleknos, plants with pink and rose-pink flowers); J, J' – Rokiškis district (Aleknos, plants with white flowers). F, G, H, J – indicated inflorescences; F', G', H', J' – leaves. Earlier investigated plants: B – data of P. R. Venskutonis [7]; E – plants with pink flowers [31]; W – aerial part of wild plants from Vilnius district [9]; IW, LW – inflorescences and leaves of wild oregano from Eastern Lithuania [10]. Essential oils from each garden were analyzed separately and grouped according to the obtained data.

The samples of plants with pink flowers whose essential oils are presented in A and C columns of Table 1 were collected in August 2000. The plants in Table 2 F – J and F' – J' columns were collected in August 2001.

All samples were dried at room temperature (20–25 °C). Essential oils were prepared by hydrodistillation of 20–100 g of air-dried plants.

Analysis of essential oils was carried out by GC and GC–MS. An HP 5890 II chromatograph equipped with FID and capillary column HP-FFAP (30 m × 0.25 mm) was used for quantitative analysis. The GC oven temperature was set at 70 °C for 10 min and then programmed from 70 to 210 °C at a rate of 3 °C min^{-1}, using He as the carrier gas (0.7 ml min^{-1}). The injector and detector temperatures were 200 and 250 °C, respectively. Analyses by GC–MS were performed using a chromatograph interfaced to a HP 5971 mass spectrometer (ionization voltage 70 eV) and equipped with a CP-Sil 8 CB capillary column (50 m × 0.32 mm). The oven temperature was held at 50 °C for 2 min, then programmed from 50 to 180 °C at a rate 3 °C, held for 1 min, then programmed from 180 to 250 °C at a rate 20 °C min^{-1} and isothermal at 250 °C for 2 min, using He as the carrier gas (1.0 ml min^{-1}). The injector and detector temperatures were 250 °C.

The percentage composition of the essential oils was computed from GC peak areas without correction factors. Qualitative analysis was based on a comparison of retention times and indexes on both columns and mass spectra with corresponding data in the literature [43–45] and computer mass spectra libraries (Wiley and NBS 54K).

RESULTS AND DISCUSSION

Essential oils from the plants of cultivated *O. vulgare* L. collected at full flowering in six gardens in August 2000 and 2001 contained low levels of phenols (Tables 1 and 2: thymol 0–3.2%, carvacrol 0–1.3%) than in earlier investigated oils of oregano cultivated in botanical and experimental gardens (Table 1, B) [6, 7]. Experimental data showed that the amount (<5%) of phenols in essential oils of cultivated (Tables 1 and 2) [6, 7] and wild plants [9, 10] markedly differed from the data given in some books (phenols 44%) [1–5].

The major constituent, β-caryophyllene, in more than half of the oils under study was from aerial parts of *O. vulgare* L. plants (Table 1, C), inflorescences (Table 2, G, H) and leaves (G', H', J'). A small habitat of wild plants producing the

β-caryophyllene chemotype essential oil was found in Sapieginë [9]. Seeds of the wild plants with oil of the above chemotype might originate from plants cultivated in gardens. β-Caryophyllene was the major constituent of some oils from cloned plants in France [11] and in plants cultivated in Leningrad region (Table 1, E) [31]. Volatile oils from Russia contained a notably lower amount of sabinene than did oils of all aerial parts and inflorescences of plants under study (Tables 1 and 2, compare E with C, G, H, J). The chemical composition of the oils under study was rather like that in France.

Sabinene was the main constituent in the oils of aerial parts of oregano plants collected in two gardens (Table 1, A) and caryophyllene oxide – in crushed aerial parts of plants bought in chemist's shops (D). Caryophyllene oxide in the above crushed plants might be synthesized not in the growing plants but during storage in chemist's shops, in paper boxes. Part of volatile monoterpenoids might also be evaporated during storage. The chemical composition of oils from commercial plants (Table 1, D) was most similar to that of oils from the plants with pink flowers collected in a garden of Leningrad region (Table 1, E) [31]. The amounts of the compounds with the caryophyllane skeleton (β-caryophyllene + caryophyllene oxide) were 35.3–35.8% in the oils D under study and 29.6–37.2% in the oils E from Russia. The above oils contained the close quantities of monoterpenoids (Table 1, D – 5.9–12.0% and E – 4.9–10.6%).

Essential oils of inflorescences (Table 2, F) and leaves (F') of the plants from a garden in Antakalnis contained germacrene D as a major constituent (Table 2). The oil of the same type was found in plants growing wild in a small habitat in Rokantiðkës (the edge of the forest) at a distance of ~2.5 km from this garden [9]. These wild plants might originate from cultivated plants.

The main constituents in essential oils of the oregano aerial parts collected in 2000 (Table 1, A, C) were sabinene (8.5–22.9%), β-caryophyllene (14.2–18.8%), germacrene D (9.6–11.6%) and caryophyllene oxide (4.3–8.7%). The inflorescence oils (Table 2, G, H, J) contained the same major constituents as aerial part oils. β-Caryophyllene (15.9–21.3%), germacrene D (12.1–15.7%) and caryophyllene oxide (4.7–11.1%) prevailed in the leaf oils G', H' and J'. The oils H, H' and J' contained a larger amount of β-ocimene (10.8–13.9%) than G and G'oils (1.2–4.8%). The main compounds were germacrene D (14.3–16.0%), β-caryophyllene (11.0–11.6%), bicyclogermacrene (6.0–6.4%) and spathulenol (5.0–6.5%) in F and F' oils.

The content of sabinene in the volatile inflorescence oil (Table 2, 5.8–19.5%) was several times higher than in the leaf oil (3.4–8.1%) of plants from the same garden. An opposite correlation was found for caryophyllene oxide 1.3–3.6% and 2.7–11.1%, respectively. The amount of compounds with caryophyllane skeleton in the oil from plants of the same garden was also larger in leaf than in inflorescence oils (Table 2). The plants under study synthesized more monoterpene hydrocarbons and monoterpenoids in inflorescences than in leaves, except one garden (F, F'). The oils presented in Table 2 contained more sesquiterpene (43.3–62.3%) than monoterpene (5.3–37.0%) hydrocarbons. The largest amount of sesquiterpene hydrocarbons was found in G' leaf oils (61.3–62.3%). The above hydrocarbons made up more than half of the inflorescence oils in three gardens (F, G, 51.6–61.2%).

The largest amount of monoterpene hydrocarbons (26.7–37.0%) and monoterpenoids (34.6–47.3%) contained oils (J, J') from plants with white flowers. The above correlation had been noticed in Russia during investigation of oregano oils from aerial parts of plants [31].

Thirty-three identified constituents of essential oils from the aerial parts of cultivated *O. vulgare* L. plants made up 79.5–97.4%. The amount of 42 identified compounds in inflorescence oils was 85.4–97.9% and in the leaf oils 82.5–86.7%. Mono- and sesquiterpene hydrocarbons made up the major part in essential oils from inflorescences and leaves (except plants bought in chemist's shops) – 65.6–90.4% and 60.5–71.8%, respectively.

Cultivated oregano plants growing in Eastern Lithuania biosynthesized essential oils with sabinene, caryophyllene, caryophyllene oxide or germacrene D as the main constituents and without or with small amounts of phenols than in the earlier investigated plants from the Kaunas Botanical Garden [6] and the experimental garden of Lithuanian Institute of Horticulture [7]. The chemical composition of oregano essential oils under study differed from that presented in the books [1–5], where the content of phenols (≤44%) was indicated without any references.

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LIETUVOJE AUGANÈIØ PAPRASTØJØ RAUDONËLIØ (*ORIGANUM VULGARE L.*) ETERINIØ ALIEJØ CHEMINË SUDËTIS

Santrauka

Dujø chromatografijos ir masiø spektrometrijos metodais tirta 20 eteriniø aliejø, iðskirtø ið kultûriniø paprastøjø raudonëliø þiedø, lapø ir visos antþeminës dalies. Pagrindiniai komponentai (ðeðiø ið septyniø tirtø þiedø aliejø) buvo sabinenas (8,7–19,5%), β-kariofilenas (15,4–24,9%) ir germakrenas D (12,3–16,0%), tokiame pat ið lapø iðskirtø eteriniø aliejø skaièiuje – β-kariofilenas (15,9–21,3%), germakrenas D (12,1–15,7%) ir kariofileno oksidas (4,7–11,1%). Minëti junginiai vyravo ir tirtuose ðeðiuose antþeminës augalo dalies eteriniuose aliejuose. Didþioji dalis komponentø (60,5–90,5%) buvo mono- ir seskviterpeniniai angliavandeniliai. Monoterpeniniø fenoliø timolio ir karvakrolio kiekis lakiuose aliejuose buvo nedidelis (0–3,9%). Ðie rezultatai skiriasi nuo pateikiamø duomenø ávairiose lietuviðkose knygose apie vaistaþoles, kur teigiama, kad fenoliø kiekiai siekia 44% raudonëlio eterinio aliejaus.

Trisdeðimt vienas identifikuotas komponentas sudarë 79,5–97,4% raudonëlio antþeminës dalies eterinio aliejaus. Keturiasdeðimt du junginiai, identifikuoti þiedø ir lapø aliejuose, sudarë atitinkamai 85,4–96,4% ir 82,5–86,7%.