Chemistry of Natural Compounds, Vol. 47, No. 6, January, 2012 [Russian original No. 6, November–December, 2011]

CHEMICAL COMPOSITION OF THE ESSENTIAL OILS OF *Levisticum officinale* GROWING WILD IN IRAN

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UDC 547.913

The genus *Levisticum*, belonging to the Umbelliferae family, is represented in the flora of Iran by only one species, *Levisticum officinale* Koch. (Lovage) [1, 2]. This plant has been cultivated in European countries for a long time and the essential oil composition studied as well [3, 4]. All parts of the plant exhibit a strong flavor generally characteristic of celery. The root extract has a warm-spicy note, but the seeds and leaf flavor are more diffusive and penetrating [5]. The essential oil from the roots, leaves, and seeds of *L. officinale* are used in the food, beverage, perfumery, and tobacco industries. The root of the plant has also been known for centuries as a traditional medicine possessing spasmolytic, diuretic, and carminative activities [5–9]. Many methods have been used for the isolation of volatiles from the different parts of *L. officinale*. The variation of oil composition depends on the isolation method, the parts of the plant, harvesting, and geographical location [10–12].

It is noteworthy that our previous study was carried out regarding the water-distilled essential oil obtained from the aerial parts of *L. officinale* growing wild in Iran. Results showed that the major components were α-terpinyl acetate (40.5%) and β-phellandrene (16.7%) [13].

In this work, hydrodistilled essential oils from crushed dry leaves, stems, seeds, and roots of *L. officinale* Koch. from Hezar Mountains, Kerman Province (Iran) were separately studied by GC and GC/MS. A voucher specimen (No. 93801) has been deposited in the Herbarium of the Research Institute of Forests and Rangelands (TARI), Tehran, Iran. The air-dried leaves, stems, seeds, and roots of the plant yielded 3.2%, 2.9%, 3.8%, and 3.4% (w/w) of a light yellowish colored oil, respectively.

GC analysis of the volatile components was carried out using a Hewlett-Packard 6890 instrument coupled to a flame ionization detector (FID). Compounds were separated on a HP-5 capillary column (5% phenylmethylpolysiloxane, 30 m × 0.25 mm, film thickness 0.25 μm). The column temperature was kept at 60°C for 5 min and programmed to 220°C at a rate of 7°C/min. Injector and detector temperatures were 270°C, and the flow rate of helium as carrier gas was 1 mL/min.

GC/MS analysis was performed using a Hewlett-Packard 5973 mass spectrometer coupled to a Hewlett-Packard 6890 gas chromatograph equipped with a HP-5MS capillary column (5% phenylmethylpolysiloxane, 30 m × 0.25 mm, film thickness 0.25 μm). The carrier gas was helium and the chromatographic conditions were as above. MS were taken at 70 eV.

All constituents of the oils, which were identified on the basis of their mass spectral characteristics and retention indices [14], are listed in Table 1. As is shown, 19 and 15 components (95.34% and 97.35%) were identified in the leaf and seed oils. The major components were γ-terpinene (14.52% and 12.37%), β-phellandrene (13.85% and 15.54%), (*Z*)-β-ocimene (12.91% and 23.70%), and α-terpinyl acetate (8.68% and 10.68%). In the stem oil, 20 compounds (90.72%) were identified, and the main constituents were γ-terpinene (12.86%), α-terpineol (10.81%), (*Z*)-β-ocimene (10.42%), and α-terpinyl acetate (8.52%). Furthermore, γ-terpinene (12.56%), terpinolene (9.16%), (*Z*)-β-ocimene (8.89%), and β-pinene (8.47%) were the major components among the 32 constituents (93.83%) characterized in the root oil.

As the results indicate, the leaf, stem, and seed (aerial parts) oils were characterized by only monoterpenes (89.44, 83.35, and 96.33%, respectively), while the root oil consisted of both monoterpenes and sesquiterpenes (72.61 and 11.70%, respectively). In addition, most of the identified components in the leaf, stem, and seed oils of *L. officinale* were common in the oil of aerial parts of the plant that has been studied previously [13].

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0009-3130/12/4706-1007

TABLE 1. Percentage Composition of the Essential Oils from Leaves, Stems, Seeds, and Roots of *Levisticum officinale*

Compound*	RI**	Leaves	Stems	Seeds	Roots
Nonane	900	–	–	–	0.29
α-Thujene	931	1.36	1.12	–	0.71
α-Pinene	938	5.14	5.30	2.93	3.78
Camphene	953	1.58	1.66	–	0.82
Sabinene	975	–	0.38	8.31	5.12
β-Pinene	980	4.11	4.91	4.98	8.47
α-Phellandrene	1005	2.31	1.45	2.85	2.23
α-Terpinene	1018	4.35	3.11	2.09	0.51
p-Cymene	1025	4.29	5.02	4.82	3.87
β-Phellandrene	1030	13.85	7.21	15.54	6.95
(*Z*)-β-Ocimene	1040	12.91	10.42	23.70	8.89
(*E*)-β-Ocimene	1051	2.33	1.34	1.64	0.31
γ-Terpinene	1062	14.52	12.86	12.37	12.56
Terpinolene	1088	2.53	2.89	–	9.16
Isopentyl-2-methyl butanoate	1098	4.12	4.81	1.02	1.10
Isopentyl isovalerate	1103	1.14	1.35	–	–
allo-Ocimene	1130	1.82	1.75	1.69	0.96
Terpinen-4-ol	1177	3.73	4.60	1.28	0.64
α-Terpineol	1190	5.93	10.81	3.45	1.48
α-Terpinyl acetate	1350	8.68	8.52	10.68	6.15
Eugenol	1359	–	–	–	0.48
α-Copaene	1382	–	–	–	0.73
Methyl eugenol	1405	0.64	1.21	–	7.65
β-Gurjunene	1434	–	–	–	1.26
(*E*)-β-Farnesene	1456	–	–	–	0.78
γ-Muurolene	1478	–	–	–	0.92
Germacrene D	1485	–	–	–	1.63
β-Selinene	1490	–	–	–	3.12
α-Selinene	1498	–	–	–	0.73
β-Himachalene	1506	–	–	–	0.48
δ-Cadinene	1524	–	–	–	0.87
Selina-3,7(11)-diene	1545	–	–	–	0.42
Germacrene B	1560	–	–	–	0.76
Monoterpenes	–	89.44	83.35	96.33	72.61
Sesquiterpenes	–	–	–	–	11.70
Nonterpenoids	–	5.90	7.37	1.02	9.52
Total percentage	–	95.34	90.72	97.35	93.83

*The compounds have been sorted according to retention indices on an HP-5MS capillary column.

**Retention indices as determined on an HP-5MS column using the homologous series of *n*-alkanes.

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