

Essential Oil Composition of *Grimmia trichophylla* Grew and *G. decipiens* (Shultz) Lindb. Grown in Turkey

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The essential oils obtained by hydrodistillation from *Grimmia trichophylla* Grew and *G. decipiens* (Shultz) Lindb. were analyzed by GC-FID and GC-MS. Twenty-three compounds in the oil of *G. trichophylla*, representing 76.7 % and 32 compounds in the oil of *G. decipiens*, representing 65.6 %, were identified. The essential oils are rich in aldehydes (24.3 and 17.4 %) and hydrocarbons (18.3 and 23.5 %) with 2E-nonenal (9.8 %), nonanal (6.3 %), tricosane (5.1 %) and cyclotetradecane (3.7 %) as the major components, respectively.

Key Words: *Grimmia trichophylla* and *Grimmia decipiens*, Essential oils, GC-FID, GC-MS.

INTRODUCTION

Mosses generate a pleasant odour, sometimes distinct in the fresh state. Nowadays, the chemical composition of mosses has been a subject of investigation, because of the abundance of aldehydes and terpenoids¹⁻⁵. The mosses are represented by ca. 25.000 taxa worldwide⁶⁻⁸. Most of the review articles on the chemistry of mosses mentioned the absence or trace amount of terpenoid compounds but, later investigations showed the occurrences of a great variety of terpenes and in addition aliphatic and aromatic compounds^{1-5,8}.

In Turkey, the genus *Grimmia* is represented by 28 taxa (24 species and 4 varieties)⁵⁻⁷. To our best of knowledge, there is no previous report on the composition of the essential oil analysis of *Grimmia trichophylla* and *Grimmia decipiens*. The volatile constituents of the fresh mosses were obtained by hydrodistillation method in a Clevenger-type apparatus. The obtained crude essential oils were then investigated by GC and GC-MS technique⁹⁻²⁰.

EXPERIMENTAL

Grimmia trichophylla Grew was collected on the stony place from Sebinkarahisar, Tamzara, Gümüşhane, Turkey (at a height of ca. 1320 m) in April

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2009. *G. decipiens* (Shultz) Lindb. was collected on the stony place in the forest from Sebinkarahisar, Saraycik, Gümüşhane, Turkey (at a height of ca. 1390 m) in April 2009. The mosses were authenticated immediately after collection⁵⁻⁷. Voucher specimens were deposited in the Herbarium of the Department of Biology, (ÖZ-1152 and 1153, respectively), Karadeniz Technical University, Turkey.

Isolation of the essential oils: The fresh plant materials were separated and cut into small pieces. Crude essential oils of *G. trichophylla* and *G. decipiens* were obtained from the fresh mosses (ca. 50 g, each) by hydrodistillation in a Clevenger-type apparatus with cooling bath (-12 °C) system (4 h) (yields: 0.14, 0.05 and 0.18 % (v/w), respectively). The obtained oils were dissolved in HPLC grade *n*-hexane (0.5 mL) and dried over anhydrous sodium sulphate and stored at 4-6 °C in a sealed brown vial. One µL of the essential oils was directly injected separately into GC and GC-MS instrument.

Gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) analysis: GC-FID and GC-MS analyses were done as described previously^{11,13,14}.

Identification of components: Retention indices of all the components were determined by Kovats method using *n*-alkanes (C₆-C₃₂) as standards. Identification of individual components was made by comparison of their retention times with those of available analytical standards (*n*-tridecane, *n*-tetradecane, *n*-pentadecane, *n*-hexadecane, *n*-heptadecane, *n*-octadecane, *n*-heneicosane, *n*-docosane, *n*-tricosane and *n*-pentacosane) and by computer search, matching mass spectral data with those held in Nist and Wiley library of mass spectra and literature comparison⁹⁻²⁰.

RESULTS AND DISCUSSION

The essential oils of mosses (*G. trichophylla* and *G. decipiens*) were obtained by hydrodistillation method in a Clevenger-type apparatus. The obtained crude essential oils were then investigated by GC-FID and GC-MS technique⁹⁻²⁰. Chemical composition of the essential oils of *G. trichophylla* and *G. decipiens* are listed in Table-1. Altogether, 42 essential components were identified with HP-5 column. Twenty-three components were identified from the oil of *G. trichophylla*, representing 76.7 % of the total oil and the major compounds were 2E-nonenal (9.8 %), nonanal (7.7 %), decanal (6.8 %), tricosane (5.1 %), Z-cadin-4-en-7-ol (4.7) and γ-murolene (4.6 %).

In the essential oil of *G. decipiens*, 32 components were identified, representing 65.6 % of the total oil and nonanal (6.3 %), hexahydrofarnesyl acetone (5.4 %), cyclotetradecane (3.7 %), 2E,4E-decadienal (3.1%), 2E-tetradecen-1-ol (3.2 %) and docosane (3.0 %) were the main constituents. In the oil of *G. trichophylla*, 6 terpenoids (13.8 %), 3 terpene related compounds (11.9 %), 3 aldehydes (24.3 %), 7 hydrocarbons (18.3 %), 4 others (4.4 %) and in the oil of *G. decipiens* 2 terpenoids (2.8 %), 2 terpene related compounds (6.8 %), 7 aldehydes (17.4 %), 14 hydrocarbons (23.5 %), 7 others (12.7 %) were identified (Table-2).

TABLE-1
IDENTIFIED COMPONENTS IN THE ESSENTIAL
OILS OF *G. trichophylla* and *G. decipiens*

Compounds	A (%)	B (%)	Lit. RI	Ex. RI**
	Area*	Area*		
Terpenoids				
Farnesane	2.1	1.1	1378	1377
E- β -Farnesene	1.7	1.7	1457	1458
Dehydro aromadendrene	2.1	–	1460	1460
γ -Muurolene	4.6	–	1480	1477
Δ -Cadinene	1.8	–	1524	1522
Kaurene	1.5	–	2043	2043
Terpene related compounds				
β -Ionene	–	1.4	1489	1488
Z-Cadin-4-en-7-ol	4.7	–	1637	1640
Hexahydrofarnesol	2.2	–	1683	1680
Hexahydrofarnesyl acetone	5.0	5.4	1847	1844
Aldehydes				
E,Z-2,4-Heptadienal	–	1.3	998	999
Nonanal	7.7	6.3	1101	1102
2E-Nonenal	9.8	–	1162	1162
Decanal	6.8	2.2	1202	1203
2E-Decanal	–	1.1	1264	1264
Undecanal	–	2.2	1307	1309
2E,4E-Decadienal	–	3.1	1317	1321
Tetradecanal	–	1.2	1613	1613
Hydrocarbons				
Tridecane	2.1	–	1300	1300
Tetradecane	1.5	1.3	1400	1400
Pentadecane	2.8	2.4	1500	1499
Hexadecene	–	1.4	1593	1592
Hexadecane	2.2	1.9	1600	1599
Cyclotetradecane	–	3.7	1675	1677
Heptadecane	–	2.7	1700	1699
Octadecene	–	2.4	1790	1788
Octadecane	–	0.7	1800	1799
Nonadecene	–	0.7	1892	1892
Eicosene	–	0.9	1986	1983
Heneicosane	1.8	0.7	2100	2100
Docosane	–	3.0	2200	2199
Tricosane	5.1	0.6	2300	2300
Pentacosane	2.8	1.1	2500	2500
Others				
Furan-2-pentyl	–	2.2	991	991
Undecanol	–	2.5	1370	1369
2-Dodecanone	2.6	–	1401	1405
Tridecanol	–	1.1	1572	1573

Tetradecenol	–	1.3	1673	1673
Tetradecanol	2.5	–	1674	1677
E-2-Tetradecen-1-ol	1.4	3.2	1714	1714
Isobutyl phthalate	1.9	0.7	1868	1868
Hexadecanol	–	1.7	1876	1874
Total isolate	76.7	65.6		

A: *Grimmia trichophylla*, B: *Grimmia decipiens*, *% Area obtained by FID peak-area normalization. **RI calculated from retention times relative to that of *n*-alkanes (C₆-C₃₂) on the non-polar HP-5 column.

TABLE-2
THE CHEMICAL CLASS DISTRIBUTION IN THE ESSENTIAL OILS OF *G. trichophylla* AND *G. decipiens*

Constituents	<i>G. trichophylla</i>			<i>G. decipiens</i>		
	Area (%)	NC*	Major component	Area (%)	NC*	Major component
Terpenoids	13.8	6	γ-Murolene	2.8	2	E-β-Farnesene
Terpene related compounds	11.9	3	Hexahydro-farnesyl acetone	6.8	2	Hexahydro-farnesyl acetone
Aldehydes	24.3	3	2E-Nonenal	17.4	7	Nonanal
Hydrocarbons	18.3	7	Tricosane	23.5	14	Cyclotetradecane
Others	8.4	4	2-Dodecanone	12.7	7	E-2-Tetradecen-1-ol
Total	76.7	23		65.6	32	

*NC: Number of compounds.

The qualitative and quantitative determination of essential oil of *G. trichophylla* and *G. decipiens* showed that major constituents were aliphatic aldehydes (24.3 and 18.3 %) and hydrocarbons (23.5 and 17.4 %) were major constituents in the oils, respectively. Generally, the number of volatile compounds present in the oil of *G. decipiens* is more than in *G. trichophylla*. The general chemical profile of the essential oils of mosses showed big differences as in our case, which can be explained by the environmentally, locality and the subspecies of the plant used.

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