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VOLATILE CONSTITUENTS OF AERIAL PARTS OF *Lasiopogon muscoides*

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Lasiopogon muscoides (Desf.) DC. (syn. *Gnaphalium muscoides* Desf.) is a member of the subtribe *Gnaphaliinae*, family Asteraceae. This plant is a rare annual herb, 1–5 cm high with thin prostate branching, densely gray and white woolly. Leaves are small, linear, or narrowly spathulate, obtuse, sessile, entire, dense woolly. Capitula terminal, glomerate, are surrounded by closely touching floral leaves, equalling capitula, white woolly [1].

Gnaphalium species are known in traditional medicine, above all in the Chinese tradition, for their different biological activities: antitussive, expectorant, antiasthmatic, anti-inflammatory, immunomodulating, antimicrobial, antidiabetic, and cytotoxic [2–6]. The genus is characterized by the presence of diterpenes [6, 7], some of which showed cytotoxicity against human epithelioid cervical carcinoma cells [6], flavonoids [8–12], and caffeoylquinic acid derivatives [10]. Phenolic compounds showed antifeedant [8, 9], anti-inflammatory [10], and anti-diabetic activities [12].

Also volatile oils characterize the genus *Gnaphalium* [13–16], but there are no exhaustive studies on their composition. A literature search revealed no references to previous work on the essential oil of *L. muscoides*.

The hydrodistillation of the aerial parts of *L. muscoides* yielded 0.21% (w/w) of essential oil characterized by a pale yellow color [17]. GC and GC/MS analysis enabled the identification of a total of 51 constituents, representing 92.4% of the oil [18]. The relative concentrations of the volatile components identified are presented in Table 1 according to their elution order (LRI) on an HP-5 column. The components may be grouped in to five main classes: fatty acids (31.3%), sesquiterpenoids (29.7%), carbonylic compounds (22.7%), hydrocarbons (4.8%), and phenols (3.0%). Hexadecanoic acid (13.7%), (*Z,Z,Z*)-9,12,15-octadecatrienoic acid (7.8%), and tetradecanal (7.3%) were recognized as the main constituents. Fatty acids and esters (31.3%), in the main, were the most abundant components, together with sesquiterpenoids (29.7%). In the first fraction hexadecanoic acid (13.7%) and (*Z,Z,Z*)-9,12,15-octadecatrienoic acid (7.8%) clearly prevailed, but there was also a good quantity of (*Z,Z*)-9,12-octadecadienoic acid (4.3%). As regards sesquiterpenoids, sesquiterpene hydrocarbons (17.4%) and oxygen-containing sesquiterpenes (12.3%) were present in a quite similar percentage. γ-Cadinene (3.9%), caryophyllene (3.2%), and *epi*-bicyclosesquiphellandrene (2.3%) prevailed in the first fraction, while in the second caryophyllene oxide (4.9%) was the most abundant. Carbonylic compounds (22.7%) were also present in quite high amounts; tetradecanal (7.3%) and tridecanal (5.8%) were the main substances in this fraction.

As regards essential oil from other *Gnaphalium* species, also the essential oil from *G. citrinum* (vira-vira) seems to be rich in palmitic acid [14].

The MIC and MBC values of the essential oils tested against ten selected microorganisms, both Gram+ and Gram–, showed no action against all the pathogens (MIC and MBC 100 μg/mL or >100 μg/mL). Only *Staphylococcus epidermidis* was a little affected by the oil (MIC 50 μg/mL, MBC 100 μg/mL).

Plant Material. Aerial parts of *Lasiopogon muscoides* (Desf.) DC. were collected at Brac (Croatia), 450 ms/l, in August 2007 (a voucher specimen was deposited in the Herbarium of the Department of Botany, Palermo University, Palermo, Italy (PAL 06/185).

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TABLE 1. Chemical Composition of the Essential Oil of *Lasiopogon muscoides* (Desf.) DC.

Compound	LRI[a]	LRI[b]	%	Compound	LRI[a]	LRI[b]	%
Phenyl acetaldehyde*	1048	1663	1.0	Tridecanoic acid*	1665	2620	1.7
Linalool*	1098	1553	0.3	Heptadecane*	1700	1700	0.1
Nonanal	1104	1389	0.4	Tetradecanoic acid*	1768	2672	1.9
Carvacrol*	1299	2239	2.1	β-Costol	1785		0.4
Undecanal	1305	1619	1.7	Hexadecanal	1815	2137	0.2
4-Vinyl guaiacol	1313	2180	0.9	Benzyl salicylate*	1844	2812	0.5
α-Cubebene	1352	1466	1.5	Hexahydrofarnesyl acetone	1845	2131	1.9
α-Ylangene	1372	1493	0.3	Pentadecanoic acid	1870	2822	0.4
α-Copaene	1377	1497	0.9	(*E-E*)-Farnesyl acetone	1919	2389	0.7
β-Cubebene	1382	1547	1.6	(*Z*)-Phytol	1950	2622	0.6
Dodecanal	1405	1724	2.1	Hexadecanoic acid*	1957	2931	13.7
Caryophyllene*	1418	1612	3.2	Octadecanal	2037	2388	0.8
epi-Bicyclosesquiphellandrene	1442	1489	2.3	3-Hydroxycalamenene	2075		0.4
Geranyl acetone	1454	1854	0.5	(*Z,Z*)-9,12-Octadecadienoic acid*	2122	3157	4.3
Germacrene D	1477	1726	1.5	(*Z,Z,Z*)-9,12,15-Octadecatrienoic acid*	2140	3193	7.8
(*E*)-β-Ionone*	1484	1958	0.3	Octadecanoic acid*	2172	3402	0.6
Tridecanal	1507	1831	5.8	Pentacosane	2500	2500	0.5
γ-Cadinene	1515	1776	3.9	Heptacosane	2700	2700	0.7
cis-Calamenene	1520	1839	0.7	Nonacosane	2900	2900	2.8
Cadina-1,4-diene	1538	1799	0.5	Triacontane	3000	3000	Tr.
α-Calacorene	1541	1942	0.6	Hentriacontane	3100	3100	0.7
β-Calacorene	1550	1942	0.4	Total			92.4
(*Z*)-3-Hexenyl benzoate	1565	2148	0.4	Oxygen-containing monoterpenes			0.3
Longipinanol	1572		1.0	Sesquiterpenes hydrocarbons			17.4
Caryophyllene oxide	1580	2008	4.9	Oxygen-containing sesquiterpenes			12.3
Longiborneol	1599		0.3	Carbonylic compounds			22.7
Humulene epoxide II	1605	2071	0.8	Fatty acids and esters			31.3
Cedrenol	1606	2133	0.9	Hydrocarbons			4.8
Tetradecanal	1624	1935	7.3	Phenols			3.0
T-Muurolol	1642	2209	3.6	Others			0.6

Compounds were identified by R_i, MS; *by R_i, MS, Co-GC.

LRI[a]: retention index on an HP-5 column; LRI[b]: retention index on an Innowax column; R_i = retention index identical to bibliography; MS = identification based on comparison of mass spectra; Co-GC = retention time identical to authentic compounds.

Tr. trace, less than 0.05%.

Antimicrobial Assay. The antibacterial activity was evaluated by determining the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) using the broth dilution method [19] as previously described [20]. Ten bacteria species, selected as representative of the class of Gram positive and Gram negative bacteria, were tested: *Bacillus cereus* (ATCC 11778), *Bacillus subtilis* (ATCC 6633), *Staphylococcus aureus* (ATCC 25923), *Staphylococcus epidermidis* (ATCC 12228), *Streptococcus faecalis* (ATTC 29212), *Escherichia coli* (ATCC 25922), *Proteus mirabilis* (ATCC 25933), *Proteus vulgaris* (ATCC 13315), *Pseudomonas aeruginosa* (ATCC 27853), and *Salmonella typhi Ty2* (ATCC 19430). Oil samples were tested in triplicate. Sterile distilled water and the medium served as a positive growth control. Gentamycin was used as standard antibacterial agent.

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