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Essential oil composition of aerial parts of *Pelargonium graveolens* at different growth stages

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ABSTRACT

The chemical composition of the essential oils of Pelargonium graveolens aerial parts, harvested at three different growth stages, pre-flower budding, budding and flowering were analyzed by GC-MS. Amounts of oil (w/w) found were -in pre-flower budding (0.29), budding (0.14) and flowering (0.47%) stages of the plants. Fifty three compounds were identified in the oils. Forty one, forty three and forty seven compounds were identified at each stage, representing 87.0, 92.7 and 91.3% of the oils. The main compounds were citronellol (58.9, 52.4 & 52.9), citronellyl formate (7.1, 11.0 & 8.5), menthone (3.5, 5.0 & 4.4), 6,9-guaiadiene (2.6, 3.5 & 4.1), 10-epi-?-eudesmol (0.0, 6.3 & 4.7), citronellyl tiglate (1.7, 1.9 & 2.0), geraniol (1.4, 1.5 & 1.5) and citronellyl butanoate (1.1, 1.4 & 1.5%).

INTRODUCTION

Pelargonium (Fam.Geraniaceae) is a large genus of herbs/ shrubs or under-shrubs distributed in South Africa, Syria and Australia. *P. graveolens* is a fragrant bushy plant,1m height. It grows mainly in Reunion, Algeria, Southern France, Spain, Morocco, Madagascar, Congo and Russia for geranium oil. In India, *P. graveolens* is cultivated in different parts. Reports indicated that its leaves contain 0.17-0.2% oil with citronellol and geraniol as main compounds (1&2). The chemical composition of the oil is affected by climate and soil fertility, shading, storage and weeds (3,4,5,6,7,&8).

the period, study was carried out on the plant material at different growth stages and determine the yield of the oil and chemical composition. The yield of the essential oils and their chemical compositions are presented and the major compounds reported earlier are compared.

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MATERIALS AND METHODS

Experimental Procedure: The plant materials were harvested from a farm in Ukhrul, Manipur for commercial cultivation at different growth stages during 2008. Voucher specimens have been deposited in the Herbarium of Institute of Bioresources and Sustainable Development, Imphal and maintained in the Germplasm Bank.

Fresh aerial parts of *P. graveolens* were collected in the different growth stages namely, pre-flower budding (700g), budding (700g) and flowering (500g) and cut into small pieces and subjected to hydrodistillation for 4 h, in a Clevenger-type apparatus. The distillates were extracted with diethyl ether, the ethereal layers were dried over anhydrous sodium sulphate and ether was removed on gently heated water bath. The yield of the oil obtained from pre-flowering, flower budding, and flowering materials was found to be 0.29, 0.14 and 0.47 % and were stored at 40°C.

GC-MS Analysis: The volatile oil was analyzed using GC-MS ,Varian 2000 equipped with a Varian C.SVA-5MS capillary column (30 m X 0.25 mm i.d., film thickness 0.25mm). Chromatographic conditions were: helium as carrier gas at a flow-rate of 2 ml/min (split mode); injection volume was 0.5 l; injector temperature was 250 °C. The column temperature was held at 60 °C for 5 min., and programmed at 3°C/min to 180°C and then 20°C/min to 280°C and held for 10 minutes. The column was coupled directly to the quadrupole mass spectrometer at EI mode at 70eV with the mass range of 28-400 a.m.u. range at 1 scan/s. Kovats retention indices

were calculated using co-chromatographed standard hydrocarbons.

The individual compounds were identified by mass spectra and their identity was confirmed by comparing their retention indices relatives to C_8-C_{32} n-alkanes. Identification of individual compound was carried out by matching mass fragmentation pattern with those from the available authentic samples as well as with from NIST98 Library and literature (9).

RESULTS AND DISCUSSION

The essential oil obtained from the aerial parts of *P. graveolens* at three different growth stages, as pre-flower budding, budding and flowering by hydro-distillation were identified and chemical compounds have been given in Table 1. The major compounds identified earlier have been compared (Table 2). A total of fifty three compounds were identified in the oils and 41, 43 and 47 compounds, constituting 87.0, 92.7 and 91.3% of the oil were identified at its pre-flower budding, budding and flowering stages, respectively. The main compounds in the oils were citronellol (58.9, 52.4, 52.9), citronellyl formate (7.1, 11.0, 8.5), menthone (3.5, 5.0, 4.4), 6,9-guaiadiene (2.6, 3.5, 4.1), 10-epi-γ-eudesmol (0.0, 6.3, 4.7), citronellyl tiglate (1.7, 1.9, 2.0), geraniol (1.4, 1.5, 1.5) and citronellyl butanoate (1.1, 1.4, 1.5%). In the oil obtained from the plant collected at pre-budding stage, forty one compounds were identified and main compounds were citronellol (58.9), citronellyl formate (7.1), menthone (3.5), 6,9-guaiadiene (2.6), citronellyl tiglate (1.7), geraniol (1.4) and citronellyl butanoate (1.1) including thirty two minor and two compounds in trace amount (less than 0.06%).

Similarly, forty three compounds were identified in the oil obtained from the plant collected during the budding state and citronellol (52.4%), citronellyl formate (11.0), menthone (5.0), 6,9-guaiadiene (4.1), 10-epi-γ-eudesmol (6.3), citronellyl tiglate (1.9), geraniol (1.5) and citronellyl butanoate (1.4) were main compounds with twenty seven minor and eight trace compounds.

Likewise in the oil collected during the flowering stage, forty seven compounds were identified and main compounds were citronellol (52.9%), citronellyl formate (8.5), menthone (4.4), 6, 9-guaiadiene (4.1), 10-epi-γ-eudesmol (4.7), citronellyl tiglate (2.0), geraniol (1.5) and citronellyl butanoate (1.5) together with thirty three minor and six trace compounds. In this analysis, it was found that at flowering stage it gives maximum oil yield (0.47%) followed by pre-flower budding (0.29%) and minimum at budding (0.14.0%) stages. Comparing the chemical composition of the analyzed oils, citronellol was found to be a major compound in all oils but 10-epi-γ-eudesmol was only detected at pre-budding stage and found absent at budding and flowering stages. Two compounds, citronellol and citronellyl formate were identified as main compounds instead of citronellol and geraniol as reported earlier (8).

Essential oil composition was found to be similar to the previous studies (Table 2) but the quantity of citronellol (52.4-58.9%) in analyzed oils was found to be higher and that of geraniol was lesser than previous reports (2&8) which could be due its cultivation in different geographical locations besides other reason. Comparing (Table 2) the oil yields and chemical compositions of the analyzed oil at three growth stages, showed that oil yield was found in higher amount at flowering (0.47) and lower at budding (0.14) stages while citronellol (58.9%) content was found higher at pre-budding stage with no significant difference on geraniol content at any stages.

Thus, it is concluded that harvesting at different growth stages has considerable effect on the yield of essential oil and citronellol content. The flowering stage was found to be better stage for harvesting to obtain maximum oil content as compared to pre-flower budding and budding stages.

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Table 1. Composition of essential oil at different growth stages of *P. graveolens*

Sr. No.	Compound	RI	Area (%)		
			Pre-flower budding	Budding	Flowering
1	3-Hexen-1-ol	859	0.3	nd	t
2	α-Pinene	939	0.1	t	0.1
3	6-Methyl-5-hepten-2-one	985	nd	t	nd
4	Myrcene	992	nd	t	t
5	α-Phellandrene	1006	0.1	t	t
6	p-Cymene	1024	t	t	t
7	Limonene	1032	0.3	0.3	0.3
8	Benzene acetaldehyde	1042	nd	nd	t
9	*Cis*-linalool oxide	1076	0.1	0.1	0.1
10	*Trans*-linalool oxide	1090	t	0.1	0.1
11	Linalool	1100	0.8	0.7	0.6
12	*Cis*-rose oxide	1108	0.2	0.4	0.4
13	Trans rose oxide	1126	0.1	0.15	0.2
14	Isopulegol	1149	nd	nd	0.1
15	Menthone	1153	3.5	5.0	4.4
16	Menthol	1172	0.2	0.2	0.2
17	α-Terpineol	1192	0.5	0.3	0.3
18	Citronellol	1226	58.9	52.4	52.9
19	Piperitone	1252	nd	0.7	0.8
20	Geraniol	1254	1.4	1.5	1.5
21	Geranial	1269	0.3	0.5	0.6
22	Citronellyl formate	1274	7.1	11.0	8.5
23	Geranyl formate	1298	0.3	0.3	0.3
24	Citronellic acid	-	nd	0.3	0.6
25	α-Cubebene	1348	nd	nd	t
26	Citronellyl acetate	1353	0.4	0.5	nd
27	Eugenol	1361	0.6	0.2	0.2
28	α-Copaene	1380	0.1	0.1	0.1
29	β-Bourbonene	1388	0.1	t	0.3
30	β-Caryophyllene	1419	0.1	0.1	0.1
31	α-Guaiene	1440	0.2	0.1	0.2
32	6,9-Guaiadiene	1444	2.6	3.5	4.1
33	α-Humulene	1454	nd	nd	0.1
34	Citronellyl propanoate	1446	1.1	t	nd
35	*Allo*-aromadendrene	1460	nd	nd	0.1

36	Geranyl propanoate	1478	0.3	0.3	0.3
37	Germacrene D	1486	0.4	0.4	0.4
38	δ-Cadinene	1523	0.4	0.4	0.5
39	Citronellyl butanoate	1532	1.1	1.4	1.5
40	Agarofuran	1550	0.3	0.6	0.3
41	Geranyl butanoate	1564	0.2	0.3	0.2
42	Phenylethyl tiglate	1580	0.8	1.0	0.9
43	1,10-di-*epi*-Cubenol	1619	0.3	t	nd
44	10-*epi*- γ-Eudesmol	1624	nd	6.3	4.7
45	Citronellyl pentanoate	1626	0.5	0.7	0.7
46	1-*epi*-Cubenol	1629	0.2	nd	nd
47	γ-Eudesmol	1632	0.3	0.3	0.2
48	Hinesol	1642	0.4	0.4	0.3
49	β-Eudesmol	1651	0.3	nd	nd
50	Valerianol	1658	nd	nd	1.2
51	Citronellyl tiglate	1668	1.7	1.9	2.0
52	Geranyl tiglate	1696	0.4	0.3	0.3
53	Hexadecanoic acid	-	nd	nd	0.6

RI - Retention index; nd -not detected; t -lesser than 0.06%

Table 2.Compounds identified in the essential oil of *P. graveolens* with earlier reports

Compound	Amount (in %)								
	R_2					R_8	PFBS	BS	FS
Linalool	3.5	16.0	9.4	6.7	6.3	10.4	0.8	0.7	0.6
Menthone	1.1	0.1	0.2	0.1	0.4	6.0	3.5	5.0	4.4
isomenthone	6.4	7.6	11.3	7.9	7.6	nd	nd	nd	nd
Citronellol	36.8	21.9	42.4	26.7	29.4	33.6	58.9	52.4	52.9
Geraniol	7.8	18.3	19.4	nd	nd	26.8	1.4	1.5	1.5
Citronellyl formate	10.0	11.6	nd	8.2	6.9	6.9	7.1	11.0	8.5
6,9-guaiadiene	nd	2.3	nd	nd	nd	nd	2.6	3.5	4.1
Citronellyl butanoate	nd	0.3	nd	nd	nd	nd	1.1	1.4	1.5
10-*epi*-γ-eudesmol	0.2	nd	nd	7.6	6.3	nd	nd	6.3	4.7
Citronellyl tiglate	0.8	nd	nd	1.5	1.9	nd	1.7	1.9	2.0

PFBS-Pre-flower budding stage; BS- budding stage; FS-flowering stage; nd-not detected

R_2=Agarwal, 2008; R_8=Rana *et al.*, 2002