Original Article

Constituents of essential oils from the leaf, fruit, and flower of *Decaspermum parviflorum* (Lam.) J. Scott

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Abstract

This paper reports the chemical constituents of essential oils from various parts of *Decaspermum parviflorum* (Lam.) J. Scott. (Myrtaceae) from Vietnam. The essential oils were obtained by hydrodistillation and analyzed by gas chromatography with flame ionization detection (GC-FID) and gas chromatography coupled to mass spectrometry (GC/MS). The main constituents of the oils were β-elemene (1.68–4.14%), caryophyllene (14.53–43.98%), humulene (3.99–10.74%), eudesma-4(14),(11)-diene (4.83–17.46%), α-selinene (3.65–13.60%), cadina-1(10),4-diene (1.0–3.17%), and seline-3,7(11)-diene (1.13–3.20%). Caryophyllene oxide (2.38–3.63%), ylangene (1.22–3.20%), guaia-3,9-diene(1.46–4.50%), eudesma-4(14)-en-11-ol (2.07–2.24%), neointermedeol (1.39–3.25%), aromadendrene oxide-(2) (1.05–1.65%), and naphthalene,1,2,3,4,4a,5,6,7-octahydro-4a,8-dimethyl-2-(1-methylethenyl)- (0.73–2.47%), which were identified only in the flower and fruit. Ocimene (11.87%) and γ-elemene (37.02%) were identified only in the flower. Copaene (8.27%) was identified only in the leaf. This is the first report of the chemical constituents of essential oils from the leaf, fruit, and flower of *D. parviflorum,* and these constituents differ from those reported for other *Decaspermum* oils.

Keywords: *Decaspermum parviflorum*, hydrodistillation, essential oil, monoterpenes, sesquiterpenes

Introduction

The genus *Decaspermum,* from the Myrtaceae plant family, consists of 2 species (Thailand, 1970), 7 species (China, 1984), or 3 species (Vietnam, 2000).[1-3] *Decaspermum parviflorum* (Lam.) J. Scott is a small tree with slender branches and rather leathery leaves with oil glands. The leaves are evergreen, opposite, and entire (i.e., without a toothed margin). The stamens are usually very conspicuous, brightly colored, and numerous. The *flowers are* simple, small, and *white, with* 4–5 *petals*, and 4 mm high. The flowers are mixed and form short convergence clusters at the axils of the leaves. The globular fruits are black and about 4–5 mm long. Flowering takes place in March to November, whereas fruiting occurs in November to March of the subsequent year. This species is native to Vietnam, Thailand, Myanmar, the Philippines, and Cambodia.[1]

The authors are not aware of any information on the biological potential or the non-volatile phytochemical constituents of this plant. No previous references in literature have mentioned the chemical composition of essential oils from this plant from Vietnam or elsewhere, and this prompted the present investigation of the volatile constituents of *D. parviflorum*. A previous Australian research study conducted to discover the properties of leaf oils in two indigenous species by GC and GC/MS indicated that the components of these two species (*D. struckoilicum* and *D. humile)* were nearly similar, with α-pinene present at the highest concentration.[4]

This is an extensive study into the chemical constituents of underutilized flora of Vietnam. We report the compounds identified in the essential oils obtained by hydrodistillation of the leaf, fruit, and flower of *D. parviflorum*.

Materials and Method

Plant collection

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Leaves, fruit, and flowers of *D. parviflorum* were collected from Ke Go Nature Reserve, Ha Tinh Province, Vietnam, in March 2018. Voucher specimen THK 268 was deposited at the Botany Museum, Vinh University, Vietnam. Plant samples were air-dried prior to hydrodistillation.

Hydrodistillation of the essential oils

Briefly, 500g of each of the pulverized samples was carefully introduced into a 5 L flask and distilled water was added to cover the sample completely. Hydrodistillation was carried out in an all-glass Clevenger-type distillation unit for 3 hours at normal pressure, according to the established procedure (Vietnamese Pharmacopoeia).[5] The volatile oils were distilled over water and were collected separately in the receiver arm of the apparatus into clean and previously weighed sample bottles. The oils were kept under refrigeration until the moment of analyses.

Analysis of the essential oils

Gas chromatography (GC) analyses of essential oils were carried on an Agilent Technologies HP 6890 Plus Gas Chromatograph equipped with a flame ionization detector and HP-5MS column. The dimension of the column is was 30 m × 0.25 mm (film thickness 0.25 m). The GC operating parameters, based on temperature programming, were as follows: oven temperature 40ºC, injection port 250ºC, and detector temperature 260ºC. The oven temperature program was 40ºC for 2 min, increased to 220ºC at 4ºC/min and then held isothermally for 10 min. The carrier gas was H_2 at a flow rate of 1 mL/min. The split ratio was 10:1, with 1.0 L of the diluted essential oil in hexane injected into the GC at inlet pressure was 6.1 kPa. Each analysis was performed in triplicate. The retention index (RI) value of each component was determined relative to the retention times of a homologous n-alkane series, with linear interpolation on the HP-5MS column. The relative amounts of individual components were calculated based on the GC peak area (FID response) without using correction factors.

An Agilent Technologies HP 6890N Plus Chromatograph fitted with a fused silica capillary HP-5MS column (30 m × 0.25 mm, film thickness 0.25 m) and interfaced with a mass spectrometer (HP 5973 MSD) was used for the GC/MS analyses, which were performed under the same conditions as those used for GC analysis, but with He (1 mL/min) as the carrier gas. The MS conditions were as follows: ionization voltage 70 eV; emission current 40 mA; acquisition scan for a mass range of 35–350 amu at a sampling rate of 1.0 scan/s.

Identification of the constituents

The constituents were identified based on the RI values determined by co-injection with reference to a homologous series of *n*-alkanes under identical experimental conditions. Further identifications were obtained by comparison of the mass spectra with those from NIST and a homemade MS library built up from pure substances and components of known essential oils, as well as by comparison of their RI values with literature values.[6, 7]

Results and Discussion

The yield of essential oils was 0.96% (v/w, leaf), 0.38% (v/w, fruit) and 0.66% (v/w, flower), calculated on a fresh weight basis. Oil samples were light yellow (fruit) or yellow (leaf and flower). Tables 1, 2, and 3 list the chemical constituents present in the oil from the leaf, fruit, and flower, respectively, as well as their percentages and retention times on the HP-5MS column. Sesquiterpenes represented the main classes of compounds present in the oils.

Table 1. Chemical constituents of *Decaspermum parviflorum* oil from the leaf

No	Compounds	RT[a]	%
1	Trans-β-Ocimene	10.04	0.79
2	Copaene	23.24	8.27
3	(-)-β-Bourbonene	23.37	1.33
4	β-Elemene	23.46	2.46
5	α-Gurjunene	23.75	0.58
6	Caryophyllene	23.96	43.98
7	τ-Elemene	24.08	1.30
8	Alloaromadendrene	24.24	0.91
9	τ-Muurolene	24.33	0.30
10	Humulene	24.49	10.74
11	Eudesma-4(14),7(11)-diene	24.72	1.70
12	Eudesma-4(14),(11)-diene	24.98	6.18
13	α-Selinene	25.07	6.41
14	τ-Cadinene	25.29	0.76
15	Cadina-1(10),4-diene	25.34	3.17
16	β-Cadinene	25.40	0.92
17	β-Maaliene	25.55	0.92
18	Valencene	25.62	2.11
19	Seline-3,7(11)-diene	25.69	1.85
20	Germacrene B	25.92	4.61
21	Caryophyllene oxide	26.22	0.70

[a]Retention time on HP-5MS column

The main classes of compounds identified in the leaf oil were caryophyllene (43.98%), humulene (10.74%), copaene (8.27%), α-selinene (6.41%), and eudesma-4(14),(11)-diene (6.18%). Germacrene B (4.61%) and cadina-1(10),4-diene (3.17%) were also present in sizeable quantities.

The main classes of compounds identified in the fruit oil were caryophyllene (23.44%), eudesma-4(14),(11)-diene (17.46%), α-selinene (13.60%), humulene (7.15%), and guaia-3,9-diene (4.50%). Caryophyllene oxide (3.63%), neointermedeol (3.25%), ylangene (3.20%), and selina-3,7(11)-diene (3.20%) were also present in sizeable quantities.

The main classes of compounds identified in the flower oil were γ-elemene (37.02%), caryophyllene (14.53%), ocimene (11.87%), eudesma-4(14),(11)-diene (4.83%), β-elemene (4.14%), humulene (3.99%), and α-selinene (3.65%).

Table 2. Chemical constituents of *Decaspermum parviflorum* oil from the fruit

No	Compounds	RT[a]	%
1	Ylangene	23.27	3.20
2	β-Bourbonene	23.41	0.24
3	β-Elemene	23.50	1.68
4	Aristol-9-ene	23.80	0.26
5	Caryophyllene	24.01	23.44
6	β-Copaene	24.15	0.39
7	Epi-β-caryophyllene	24.28	0.67
8	Humulene	24.55	7.15
9	Naphthalene,1,2,3,4,4a,5,6,7-octahydro-4a,8-dimethyl-2-(1-methylethenyl)-	24.80	2.47
10	Eudesma-4(14),11-diene	25.04	17.46
11	α-Selinene	25.14	13.60
12	γ-Amorphene	25.35	0.70
13	Cadina-1(10),4-diene	25.41	1.36
14	β-Guaiene	25.46	1.23
15	β-Maaliene	25.61	0.33
16	Guaia-3,9-diene	25.69	4.50
17	Selina-3,7(11)-diene	25.76	3.20
18	Germacrene B	26.00	0.61
19	Spathulenol	26.22	0.48
20	Caryophyllene oxide	26.31	3.63
21	(-)-Globulol	26.34	0.67
22	Elemol	26.47	0.58
23	Humulene epoxide II	26.65	0.65
24	Maaliol	26.74	0.92
25	Cubenol	26.84	0.79
26	α-Gurjunene	26.90	0.85
27	τ-Cadinol	27.02	0.55
28	Eudesma-4(14)-en-11-ol	27.20	2.07
29	Neointermedeol	27.23	3.25
30	Aromadendrene oxide-(2)	27.35	1.65
31	Eudesm-7(11)-en-4-ol	27.71	1.05
32	Isospathulenol	27.83	0.39

[a]Retention time on HP-5MS column

Table 3. Chemical constituents of *Decaspermum parviflorum* oil from the flower

No	Compounds	RT[a]	%
1	Ocimene	9.69	11.87
2	Elixene	22.49	0.28
3	Ylangene	23.27	1.22
4	β-Elemene	23.50	4.14
5	Caryophyllene	24.01	14.53
6	γ-Elemene	24.13	37.02
7	Humulene	24.55	3.99
8	Naphthalene,1,2,3,4,4a,5,6,7-octahydro-4a,8-dimethyl-2-(1-methylethenyl)-	24.80	0.73
9	8α,11-Elemadiol	24.92	0.60
10	Eudesma-4(14),(11)-diene	25.04	4.83
11	α-Selinene	25.13	3.65
12	α-Trans-bergamotenol	25.23	1.00
13	γ-Amorphene	25.35	0.45
14	Cadina-1(10),4-diene	25.41	1.00
15	β-Guaiene	25.46	0.60
16	β-Maaliene	25.61	0.34
17	Guaia-3,9-diene	25.69	1.46
18	Selina-3,7(11)-diene	25.76	1.13
19	Spathulenol	26.22	0.24
20	Caryophyllene oxide	26.30	2.38
21	(-)-Globulol	26.34	0.50
22	Elemol	26.46	0.32
23	Humulene epoxide II	26.66	0.40
24	Maaliol	26.74	0.30
25	Cubenol	26.84	0.48
26	α-Gurjunene	26.90	0.80
27	τ-Cadinol	27.02	0.34
28	Eudesma-4(14)-en-11-ol	27.20	2.24
29	Neointermedeol	27.23	1.39
30	Aromadendrene oxide-(2)	27.35	1.05
31	Eudesm-7(11)-en-4-ol	27.71	0.62
32	Isospathulenol	27.83	0.13

[a]Retention time on HP-5MS column

The authors identified a large proportion of caryophyllene (43.98%) and humulene (10.74%) in the leaf, caryophyllene (23.44%), eudesma-4(14),11-diene (17.46%) and α-selinene (13.60%) in the fruit, γ-elemene (37.02%), caryophyllene (14.53%), and ocimene (11.87%) in the flower.

The essential oil that made up the richest proportion was caryophyllene (43.98%) in the leaf, caryophyllene (23.44%) in the fruit, and γ-elemene (37.02%) in the flower. The authors are unaware of any previous study on the essential oils of *D. parviflorum*, so the present report may represent the first of its kind. However, relatively little information is available, apart from a report of the composition of volatiles from some other *Decaspermum* species growing in Australia[4]. In that other report, the major component in the oil of *D. struckoilicum* from Australia was α-pinene (37.5%) in an oil that contained similar amounts of monoterpenes and sesquiterpenes.[4] The major sesquiterpenes identified in the oil were β-caryophyllene (2.4%), α-humulene (2.2%), and α- and β-eudesmol (8.2% and 8.1%, respectively).[4]

Decaspermum humile was also reported to produce a leaf oil that contained either approximately equal amounts of monoterpenes and sesquiterpenes or had a majority of the latter components. The principal monoterpenes were a-thujene (0.1–13%) and α-pinene (0.2–21%). Other prominent monoterpenes identified were limonene (0.2–8%), myrcene (0.3–10%), β-phellandrene (0.1–5%), linalool (0.3–9%) and terpinen-4-ol (0.3–6%). 1,8-Cineole was usually absent from the oils. The main sesquiterpenes identified were β-caryophyllene (0.7–5%), aromadendrene (1–6%), viridiflorene (1–7%), δ-cadinene (0.4–14%), bicyclogermacrene (0.2–10%), globulol (1–9%), and, in some collections, 7-epi-α-selinene (trace–9%).[4] Notably, the essential oils of *Decaspermum* plants from all over the world exhibited chemical variability.

The observed major compounds of the leaf, fruit, and flower oils of *D. parviflorum* -namely, caryophyllene/humulene/copaene/α-selinene/eudesma-4(14),11-diene) in the leaf, caryophyllene/eudesma-4(14),11-diene/α-selinene/humulene in the fruit, and γ-elemene/caryophyllene/ocimene/eudesma-4(14),11-diene in the flower - have not been reported previously for any of the

studied *Decaspermum* essential oils from Vietnam or other parts of the world.

Each plant part is known to contain different phytochemical components. The variation between these results and those from other parts of the world may reflect ecological and climatic differences between these regions; as well as the age of the plants and their chemotypes. The observed compositional patterns may contribute to the biological activities of *Decaspermum* essential oils.[8]

Conclusion

The compositions of the leaf, fruit, and flower oils of *D. parviflorum* from Vietnam were reported. The essential oils were characterized by high contents of caryophyllene/humulene/copaene in the leaf, caryophyllene/eudesma-4(14),11-diene/α-selinene in the fruit, and γ-elemene/caryophyllene/ocimene in the flower. A comparative analysis of the chemical compositions of the studied oil samples with data on essential oils of other *Decaspermum* plants from Australia revealed a high chemical variation in this genus.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Abbreviation List

v/w: volume by weight; GC-FID: Gas chromatography with flame ionization detection; GC-MS: Gas chromatography coupled to mass spectrometry.

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