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Essential Oils Leaf of *Cinnamomum glaucescens* and *Cinnamomum verum* from Vietnam

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Abstract

In this paper, compounds identified in the essential oils obtained by hydrodistillation of the leaves of *Cinnamomum glaucescens* (Nees) Hand.-Mazz and *Cinnamomum verum* J.S. Presl (Lauraceae family) of Vietnam origin are reported. The chemical analyses were performed using gas chromatography-flame ionisation detector (GC-FID) and gas chromatography coupled with mass spectrometry (GC-MS). The significant compounds of *C. glaucescens* were geraniol (36.2%) and terpinen-4-ol (19.7%). On the other hand, *C. verum* comprised of linalool (22.0%) and bicyclogermacrene (11.2%). The present results may represent new chemotypes of the essential oils of *C. verum* and *C. glaucescens*.

Keywords

Cinnamomum verum, *Cinnamomum glaucescens*, Essential Oil, Terpenes

1. Introduction

Cinnamomum glaucescens (Nees) Hand.-Mazz is an evergreen tree where the buds are enclosed in overlapping scales. The leaves are about 7 - 10 cm long placed on stalks which is about 1 - 2 cm long. The inflorescences are covered with brown hairs. The fruits are 3 cm long [1] [2]. The major compounds present in the fruit oil of *C. glaucescens* [3] were 1,8-cineole (13%) and methyl cinnamate (14%), while 1,8-cineole (56%) and α-terpineol (10%) were found in the pericarp oil. In another report, methyl (*E*)-cinnamate (40.5%) and 1,8-cineole (24.5%) were also identified in the fruit oil of *C. glaucescens* [4]. 1,8-Cineole

(43.6%) and elemicin (92.9%) were described in the fruit [5] and leaf [6] oils respectively. The nematicidal, termiticidal, mosquito larvicidal [4], insecticidal, antifungal, antiaflatoxin, antioxidant [5] and antibacterial [7] activities of essential oils of *C. glaucescens* have been reported.

Cinnamomum verum J.S. Presl is an evergreen tree that grows up to 18 m tall. The fruits are black when ripe and surrounded by the enlarged perianth at the base [1]. The various ethanol extracts of *C. verum* were reported to possessed high analgesic [8], antifungal [9] [10] [11] [12], anti-tuberculosis [13], antioxidant [8] [14] [15] and antihyperglycaemic [16] properties. 2-Methoxycinnamaldehyde, a component of *C. verum* was described as a potential anticancer agent [17] [18]. The chemical constituents characterized from the methanolic extracts [9] of *C. verum* were *trans*-cinnamaldehyde (20.28%), (*E*)-3-(2-methoxyphenyl)-2-propenoic acid (40.41%) and 4-vinyl benzoic acid (10.54%).

Various authors have described different main compounds (chemotypes) of essential oils of *C. verum.* These include eugenol type [19] [20] [21] [22], safrole type [23], cinnamaldehyde and isomers type [21] [23]-[29], (*E*)-cinnamaldehyde/eugenol/linalool type [30], cinnamyl acetate type [31] and benzyl benzoate type [32]. The essential oils of *C. verum* were reported to displayed antibacterial [24] [33] [34] [35] [36], nematicidal [31], antifungal, anti-elastase and anti-keratinase [37] and anti-rot [38] activities. Cinnamaldehyde, one of major compounds of *C. verum* oil exhibited antibacterial [25] and anthelmintic [39] properties. The biofungicides action [27] and the efficacy of *C. verum* essential oil as an acaricidal agent against *Rhipicephalus microplus* larvae was reported [32]. The oil had a protective effect on experimental S*treptococcosis iniae* infection in tilapia [29]. Moreover, the oil showed mosquito knock-down and adulticidal activities against *Culex quinquefasciatus* [40].

In the present paper, the results of our studied on the phytochemicals in the essential oils of Vietnamese species of *C. verum* and *C. glaucescens* were reported. Previously, the phytochemical constituents of some other plants have been characterized and reported [41].

2. Materials and Methods

2.1. Plant Samples

The leaf samples of *C. glaucescens* and *C. verum* were collected from Bến En National park, Thanh Hóa Province, Vietnam, in August 2013. Voucher specimens HVC 377 and HVC 04 respectively were deposited at the HN, Vietnam. The drying of the plant samples was accomplished by exposure to air under laboratorys shade for two weeks.

2.2. Hydrodistillation of Essential Oils

Aliquots of 500 g air-dried and pulverized samples individually subjected to hydrodistillation process which was carried out in an all glass Clevenger-type distillation unit designed according to the established specification [43]. The distillation

time was 3 h and conducted at normal pressure. The volatile oils distilled over water and were collected in the receiver arm of the apparatus into clean and previously weighed sample bottles. The oils were kept under refrigeration (4˚C) until the moment of analyses as previously described [41].

2.3. Gas Chromatography (GC) Analysis

The GC analysis was carried out on HP 6890 Plus Gas chromatograph (Agilent Technologies) equipped with a flame ionization detector (FID). The column used was HP-5MS column with the dimension 30 m × 0.25 mm (film thickness 0.25 μm). Temperature programming parameters: column oven—40˚C, injection pot—250˚C, detector—300˚C. Time programming: 40˚C for 2 min, temperature raised to 220˚C (10 min hold) at 4˚C/min. Carrier gas used was H_2 (flow rate of 1 mL/min), split ratio 10:1, volume injected—1.0 μL. Inlet pressure was 6.1 kPa. Retention indices (RI) value of each component was determined relative to the retention times of a homologous *n*-alkane series (C_4-C_{32}) with linear interpolation on the HP-5MS column. Relative percentage amounts were computed from GC peak areas without FID response factor correction as previously described [41].

2.4. Gas Chromatography/Mass Spectrometry (GC/MS) Analysis

The GC/MS experiment was performed on Mass spectrometer (HP 5973 MSD) combined with HP 6890N Plus GC. The system was fitted with HP-5 MS capillary column of 30 m × 0.25 mm having film thickness of 0.25 μm. All operating conditions were similar to that of GC except that He (1 mL/min) was the carrier gas. The Mass Spectrometer was operated on the following conditions: ionization voltage (70 eV), emission current (40 mA) and acquisitions scan (mass range of 35 - 350 amu). The sampling rate was 1.0 scan/s as previously described [41].

2.5. Identification of Constituents of Essential Oils

The compounds present in the oil samples were identified by comparing the individual relative retention indices with standards obtained from pure compounds. In addition, comparison was made with values from literature under the similar experimental conditions [44] and as previously described [41].

3. Results and Discussion

The percentage yields of essentials oils obtained from the extraction processes were 0.42% (v/w, *C. glaucescens*) and 0.45% (v/w, *C. verum*). The colours of the essential oils were determined as light yellow. The compounds that were identified in the samples could be seen in **Table 1** with detailed analysis of their retention indices and percentage compositions. Monoterpene hydrocarbons (25.9%) and oxygenated monoterpenes (64.3%) were determined as the dominant class of compounds of *C. glaucescens* oil. the main constituents of the oil were geraniol

Table 1. Volatile compounds present in the essential oils of *C. galucescens* and *C. verum.*

Compounds[a]	RI (Cal.)	RI (Lit.)	*C. galucescens*	*C. verum*
Tricylene	926	921	-	0.1
α-Thujene	930	926	3.2	-
α-Pinene	939	932	6	0.5
Camphene	953	946	0.3	2.5
Sabinene	976	964	6	0.4
β-Myrcene	990	988	0.7	0.3
α-Phellandrene	1006	1004	0.3	0.5
α-Terpinene	1017	1014	0.9	0.1
O-cymene	1024	1020	1	1.5
Limonene	1032	1024	5.2	3.5
(*Z*)-β-Ocimene	1044	1032	0.1	1.0
(*E*)-β-Ocimene	1052	1044	-	0.6
γ-Terpinene	1061	1056	1.6	0.1
trans-Sabinene hydrate	10766	1073	0.8	-
Linalool oxide	1080	1079	-	3.8
α-Terpinolene	1090	1089	0.6	-
Linalool	1100	1095	1.6	22
allo-Ocimene	1128	1128	-	1.4
Terpinen-1-ol	1139	1134	0.1	-
trans-Pinocarveol	1146	1142	-	0.1
Borneol	1167	1167	0.3	-
Terpinen-4-ol	1177	1177	19.7	-
α-Terpineol	1189	1187	0.9	1.4
Verbenone	1205	1204	-	0.3
trans-Piperitol	1210	1208	0.1	-
trans-Carveol	1217	1217	-	0.1
(*Z*)-2-Decenal	1253	1265	0.2	-
Geraniol	1259	1267	36.2	0.2
Geranila	1270	1269	1.6	0.4
Bornyl acetate	1289	1287	-	0.3
(*Z*)-Citral	1318	1318	0.5	0.2
Bicycloelemene	1327	1337	0.2	-
Eugenol	1353	1359	0.1	0.1
α-Copaene	1377	1374	0.1	-
Geranyl acetate	1381	1378	2.4	-
β-Elemene	1391	1387	0.3	-
α-Gurjunene	1407	1401	0.3	-
Methyl eugenol	1412	1410	-	0.7
β-Caryophyllene	1419	1417	0.9	-

Continued

α-Santalene	1420	1424	-	1.0
γ-Elemene	1437	1434	0.1	-
α-Humulene	1454	1452	0.2	0.1
Germacrene D	1485	1484	0.2	-
α-Amorphene	1485	1485	-	0.3
β-Selinene	1486	1486	0.2	-
Eudesma-4,11-diene	1490	1489	-	0.1
Bicyclogermacrene	1500	1500	0.3	11.2
α-Muurolene	1500	1501	-	1.5
β-Bisabolene	1506	1503	0.5	7.7
(E,E)-α-Farnesene	1508	1505	-	2.0
g-Cadinene	1514	1512	-	4.0
b-Himachalene	1518	1515	0.1	-
δ-Cadinene	1525	1522	0.2	1.2
Selina-4(15), 7(11)-diene	1534	1534	0.2	-
Calacorene	1546	1544	-	0.9
Elemol	1550	1548	-	1.7
(*E*)-Nerolidol	1563	1561	0.6	1.3
Spathulenol	1578	1577	-	2.0
Caryophyllene oxide	1583	1581	0.2	5.6
Longiborneol	1599	1597	-	1.1
α-Guaiol	1600	1601	-	0.8
β-Oplopenone	1608	1607	-	0.5
Caryophyllenol	1611	1610	-	0.2
β-Eudesmol	1651	1651	-	0.3
α-Cadinol	1654	1652	-	1.0
cis-a-Santalol	1677	1677	-	3.3
Valerenol	1711	1711	-	0.9
b-Santalol	1713	1715	-	0.1
Farnesol	1718	1722	0.3	-
Benzyl benzoate	1760	1759	0.2	-
		Total	**95.5**	**90.8**
		Monoterpene hydrocarbons	**25.9**	**12.5**
		Oxygenated monoterpenes	**64.3**	**29.5**
		Sesquiterpene hydrocarbons	**3.8**	**30.0**
		Oxygenated sesquiterpenes	**1.3**	**18.8**
		Non-terpenes	**0.2**	**-**

[a]Compounds order of elution from HP-5MS column; RI (cal.) Calculated retention indices of each compounds on HP-5MS column; RI (Lit.) Literature retention indices; -not identified.

(36.2%) and terpinen-4-ol (19.7%). α-Pinene (6.0%), sabinene (6.0%) and limonene (5.2%). Sesquiterpne compounds were present in amount < 1%. Except for α-terpineol, all other known compounds such as 1,8-cineole and methyl cinnamate [3] [5], α-terpineol [3], (*E*)-cinnamate [4] and elemicin [6] that were previously identified in the essential oil of *C. glaucescens* were not present in the present oil sample. On the other hand, the present oil sample contained large quantities of geraniol and terpinen-4-ol which were not identified in previously studied oil samples of *C. glaucescens*.

In the present study, sesquiterpene hydrocarbons (30.0%), oxygenated monoterpenes (29.5%), oxygenated sesquiterpenes (18.8%) and monoterpene hydrocarbons (12.5%) were the classes of compounds present in *C. verum*. The major constituents of the oil were mainly linalool (22.0%) and bicyclogermacrene (11.2%). Additionally, β-bisabolene (7.7%), caryophyllene oxide (5.6%) and γ-cadinene (4.0%) were also present in the oil in significant amount.

A comparative analysis of the present oil of *C. verum* and previous studies [20] [21] [22] [24] [25] [26] [27] [28] [30] [31] [32] indicated great variations in their chemical compositions. Several of the compounds that were present in the previously investigated oil samples were not identified in the present oil sample and vice versa. For example, the present oil of *C. verum* contained lower quantity of eugenol and benzyl benzoate when compared with previous results [20] [21] [22] [32]. In addition, compounds such as (*E*)-cinnamaldehyde [21] [24] [25] [26] [27] [28] [30] and cinnamyl acetate [31] that were described previously as main compounds of *C. veum* oil, were not obtained in the oil sample. However, the amount of linalool in the present *C. veum* oil was in agreement with previously investigated oil sample [31]. A noteworthy observation is that bicyclogermacrene, a main compound in the present *C. veum* oil was not described to be a significant compound in previously investigated samples of *C. verum* oils.

Several reports describing the chemical compositions of essential oils from some Vietnamese species of *Cinnamomum* have been published. In summary, each of the essential oils possessed compounds that were different from the other oil samples. The main compounds in the essential oil of *C. sericans* [41] were spathulenol (14.5%) and caryophyllene oxide (9.3%), while ρ-cymene (15.6%), limonene (13.9%) and α-phellandrene (9.2%) were found *C. durifolium* [41]. However, bicyclogermacrene (33.9%) and β-caryophyllene (25.5%) make up the composition of *C. magnificum* [41]. The essential oil of *C. iners* [41] consisted mainly of β-caryophyllene (35.9%) and caryophyllene oxide (12.6%). The leaf oil of *C. curvifolium* contained high contents of benzyl cinnamate and benzyl benzoate [42]. Interestingly, α-selinene ((24.5%) and β-caryophyllene (23.0%) were the major volatiles of *C. rigidifloim* [42].

From the chemotaxonomy point of view, *C. verum* in the present study contained linalool which was also found to be the dominant compound of essential oils of *C. damhaensis* and *C. cambodianum* from Vietnam [42]. However, the essential oils of most *Cinnamomum* species from Vietnam possessed low content

of (*E*)-cinnamaldehyde [41] [42] when compared with other samples analyzed from other parts of the world.

4. Conclusion

The paper reported the compounds identified in the essential oils of *C. verum* and *C. glaucescens* grown in Vietnam. The significant compounds of *C. glaucescens* were geraniol and terpinen-4-ol whil, *C. verum* comprised of linalool and bicyclogermacrene. In addition, a comparative analysis of the composition of the essential oils was performed with results from other species reported from Vietnam as well as *Cinnamomum* plants grown in other parts of the world. More studied will be required in order to be able to delineate the various chemotypes of essential oils of *Cinnamomum* plants in various parts of the world.

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