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VOLATILE CONSTITUENTS OF *Siliquamomum tonkinense* FROM VIETNAM

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The aim of the present study was to report the chemical compounds identified in the essential oil obtained from the leaf and rhizome of *Siliquamomum tonkinense* Baill. (Zingiberaceae) grown in Vietnam. This is in continuation of an extensive research aimed at the characterization of the volatile compounds of Vietnamese Flora [1–3]. *Siliquamomum* is a genus of plants in the Zingiberaceae. It has two known species, native to Vietnam and southern China [4].

Siliquamomum tonkinense is an herbaceous plant about 0.8 to 1.2 m high. It usually grows on mountain humus soil moisture, along streams, 800–1500 m high under the forest canopy. The stem and roots of this species are used to ameliorate stomach pain, gastric diseases, hemorrhage, and also as medicine for women after childbirth [5]. However, until now, the authors are unaware of any literature report on the biological activity of extracts of *S. tonkinense* or the chemical compounds present in them.

Leaves and rhizomes of *S. tonkinense* were collected from Pu Mat National Park, Nghe An Province in August 2014. A voucher specimen LTH 465 was deposited at the Botany Museum, Vinh University, Vietnam. Plant samples were air-dried prior to extraction. Essential oils were by hydrodistillation of the air-dried plant samples (500 g each) in a Clevenger-type apparatus according to Vietnamese Pharmacopoeia specifications [6].

Gas chromatography (GC) analysis was performed on an Agilent Technologies HP 6890 Plus gas chromatograph (HP-5MS column, 30 m × 0.25 mm, film thickness 0.25 μm). Temperature parameters: column oven 40°C, injection pot 250°C, detector 260°C. Time programming: 40°C for 2 min, then rise to 220°C (10 min hold) at 4°C·min^{-1}, carrier gas H_2 (1 mL·min^{-1}), split ratio 10:1, volume injected 1.0 μL. Inlet pressure, 6.1 kPa. Each analysis was performed in triplicate. The retention indices (RI) of each component was determined relative to the retention times of a homologous *n*-alkane series with linear interpolation on the HP-5MS column. Gas chromatography-mass spectrometry (GC/MS) was performed on an HP 5973 MSD mass spectrometer with HP 6890N Plus GC (HP-5 MS, 30 m × 0.25 mm, film thickness 0.25 μm). MS conditions: ionization voltage 70 eV; emission current 40 mA; acquisitions scan mass range of 35–350 amu, sampling rate 1.0 scan·s^{-1}. Peaks were identified as described previously [1–3].

The yields of essential oils were 0.12% and 0.16%, respectively for the leaves and rhizomes, calculated on a dry weight basis. Oil samples were light yellow in color. Table 1 indicated the percentages and identities of compounds present in the oils. A total of 29 and 39 components were identified from the leaf and rhizome oils, respectively. Twenty-one compounds were common to both oil samples. The dominant class of compounds identified in the leaf oil were the monoterpene hydrocarbons (79.9%), while the rhizome oil consisted mainly of monoterpene hydrocarbons (58.8%) and oxygenated counterpart (21.9%). Sesquiterpenes occurred in lower quantities as hydrocarbons (9.7%) and oxygenated counterparts (7.6%). The quantities of sesquiterpenes in the rhizomes were hydrocarbons (9.5%) and oxygenated counterparts (6.1%). The major compounds of the leaf oil were β-pinene (29.3%), α-pinene (15.7%), and sabinene (14.6%). On the other hand, 1,8-cineole (19.1%), γ-terpinene (14.9%), *o*-cymene (14.0%), and α-pinene (12.5%) were the main compounds present in the rhizomes.

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TABLE 1. Chemical Composition of Essential Oil of *Siliquamomum tonkinense*[a]

Compound[b]	RI[c]	RI[d]	Leaves	Rhizomes	Compound[b]	RI[c]	RI[d]	Leaves	Rhizomes
α-Thujene	930	926	0.7	1.6	δ-Elemene	1340	1337	–	0.1
α-Pinene	939	932	15.7	12.5	β-Elemene	1391	1389	–	0.3
Camphene	953	946	1.4	1.3	β-Caryophyllene	1419	1417	2.5	0.5
Sabine	976	964	14.6	0.3	γ-Elemene	1437	1434	0.7	0.4
β-Pinene	980	876	29.3	8.8	Aromadendrene	1441	1439	0.7	0.2
β-Myrcene	990	988	1.2	1.2	α-Amorphene	1485	1484	–	0.4
α-Phellandrene	1006	1004	–	0.7	β-Selinene	1486	1486	–	2.9
α-Terpinene	1017	1014	–	2.8	Ledene (= Viridiflorene)	1487	1489	1.0	0.4
o-Cymene	1024	1021	0.3	14.0	α-Selinene	1493	1494	–	1.7
Limonene	1032	1030	4.2	–	Bicyclogermacrene	1500	1500	2.5	–
1,8-Cineole	1034	1032	–	19.1	(*E*,*E*)-α-Farnesene	1508	1513	–	0.3
(*E*)-β-Ocimene	1052	1044	–	0.2	α-Panasinsene	1518	1523	–	1.0
γ-Terpinene	1061	1056	3.2	14.9	δ-Cadinene	1525	1522	0.9	–
α-Terpinolene	1090	1087	1.1	0.5	Elemol	1550	1548	–	0.1
Linalool	1100	1100	0.6	0.6	Germacrene B	1561	1559	–	1.0
Borneol	1167	1167	–	0.3	(*E*)-Nerolidol	1563	1561	0.5	1.0
Terpinen-4-ol	1177	1174	1.0	0.4	Spathulenol	1578	1577	1.6	–
α-Terpineol	1189	1187	–	0.4	Caryophyllene oxide	1583	1581	1.6	0.2
Methyl chavicol	1204	1196	0.8	0.4	α-Cedrol	1601	1601	–	0.2
Fenchyl acetate[e]	1228	1228	0.8	–	Isospathulenol	1640	1638	1.2	–
(*Z*)-Citral	1242	1249	0.7	–	(*E*,*E*)-Farnesol	1718	1722	–	4.1
Bornyl acetate	1289	1289	0.9	0.4	α-Cadinol	1654	1652	0.7	0.5
Carvacrol	1298	1307	–	0.3	γ-Neoclovene	1754	1754	2.0	–
Bicycloelemene	1327	1337	1.4	0.3	Total			94.0	96.3

[a]SD (±) values were insignificant and removed from the Table to avoid congestion; [b]elution order on HP-5 MS column; [c]retention indices on HP-5 MS column; [d]literature retention indices; [e]correct isomer not identified; –: not identified.

The authors are aware of only one report on the volatile constituents of the rhizomes of *S. tonkinense* in which 1,8-cineole (31.78%), (*E*,*E*)-farnesol (10.62%), and myrtenal (8.10%) were the compounds occurring in higher quantity [7]. The volatile constituents of the leaf oil are being reported here for the first time. However, except for the contents of 1,8-cineole, other major compounds present in the investigated rhizome oil, such as α-pinene, γ-terpinene, and *o*-cymene, were found in lower amounts in the previous study. Also, myrtenal was not detected in this study, while the quantity of (*E*,*E*)-farnesol was lower when compared with the previous study [7].

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