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*COMMUNICATION*

# Volatile essential oil constituents of *Alpinia smithiae* (Zingiberaceae)

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**Abstract:** The composition of leaf and rhizome essential oils of *Alpinia smithiae* that grow wild in the Western Ghats of Kerala (South India) was analysed by gas chromatography. The major components were β-caryophyllene, sabinene, myrcene and 1,8-cineole in both samples, but variation in the yield of oil as well as the major components between the two plant parts was observed.

**Key words:** *Alpinia smithiae*, Zingiberaceae, essential oil, GC-MS, terpenoid.

*Alpinia smithiae* Sabu & Mangaly belongs to the family Zingiberaceae, which has only recently been reported and described from South India as an endangered species native to the evergreen forests in the Western Ghats of Kerala (Sabu and Mangaly 1991). It is a perennial rhizomatous herb growing in shady habitats at 300-400 m elevation and characterized by the possession of a tuberous and creeping rhizome with an aerial shoot (pseudostem) covered by sheathing leaf bases. In Kerala, tribal natives use the plant for making folk medicines and remedies for men and cattle (Sabu 1991). Most of the species of the genus *Alpinia* are economically important, since they are being used in the treatment of various ailments (Jitoe *et al.* 1992), in flavoring various food and curry preparations (Heywood 1993) and as ornamental plants (Criley 1988).

*Alpinia* species are characterized by a wide range of volatile compounds and have been the subject of numerous phytochemical studies (Fujita *et al.* 1994, De Pooter *et al.* 1995, Kuster *et al.* 1999). The present study is the first in which the volatile components of *A. smithiae* have been studied extensively.

Two germplasm collections were carried out in June and December 1996, from the Attappadi Hills, Palakkad District of Kerala, India. Voucher specimens were deposited in the herbarium of Sacred Heart College, Thevara, Cochin, Kerala, India (SHH 96-442). All individuals were grown in the experimental garden under same agro-climatic conditions.

The essential oil was obtained from dried, flaked and powdered rhizomes and leaves by hydro-distillation in a modified Clevenger apparatus for 3-4 h at 100ºC. For the isolated oil samples, the physico-chemical, qualitative and quantitative analyses were made. A Hewlett Packard 5890 series II GC equipped with a 30m x 0.25 mm id. glass capillary colum, DB-5 (J & W Scientific, Folsome,

California) and flame ionization detector was used for the analysis of samples. Results were reported on a HP 3396 Integrator. Analytical conditions were: split 1: 60; injector and detector temperature, 250ºC; oven temperature was programmed from initial 50ºC for 2 min, increased to 150ºC at 2º $min^{-1}$ and subjected to a final temperature of 280ºC for 10 min. Flow rates for the gases were: He, 17 mm $sec^{-1}$; $H_2$, 35ml $min^{-1}$; Air 350 ml $min^{-1}$.

For GC-MS analysis, a Hewlett Packard 5890 series II GC equipped with a Hewlett Packard 5970 MS was used. Conditions for the GC were the same as those described above. For MS: Scan mode from 50 to 300 amu; EI ionization voltage, 70eV; multiplier voltage 1600 V. Each compound tentatively identified by comparing retention indices and spectral data from those published in the literature (Adams 1995) and Wiley electronic libraries. For positive identification, standard compounds were used in some cases to match GC retention times and MS spectra.

The percentage yield of essential oil for rhizome was 0.83, whereas for leaves it was 0.33. The physico-chemical properties of the oil samples were as follows. For rhizome oil: $d^{25}$=0.8658; $\eta^{25}_D$=1.5217; solubility: in 2 volumes of 80% alcohol; color: yellowish to brown; odor: fresh green and spicy, woody odor with a medicinal top note; flavor: warm, bitter, harsh and spicy with an unpleasant aftertaste. For leaf oil: $d^{25}$=0.8462; $\eta^{25}_D$=1.4968; solubility: in 2 volumes of 80% alcohol; color: pale yellowish green; odor: fresh green, spicy and woody odor with a cineole top note; flavor: bitter, harsh, spicy and slightly irritating with an unpleasant aftertaste.

GC and GC-MS analysis of essential oil enabled us to identify fifty-five volatile components (Table 1) from both plant parts. In the volatile extract different group of terpenoid compounds were present, such as hydrocarbons, alcohols, aldehydes, ketones, esters and others. The monoterpenes are represented mainly by monocyclic compounds of the p-cymene group, such as limonene, terpinene, phellandrenes and the oxide 1,8-cineole. The bicyclic monoterpenes comprised mainly compounds of the camphane group, such as camphene, borneol, bornyl acetate, isobornyl acetate, the saturated ketone like camphor; carene, pinenes, together with sabinene. Acyclic monoterpenoids such as myrcene, geraniol, citronellol, linalool as well as their derivatives were also present in the genus *Alpinia*. Sesquiterpenes like bisabolene, zingiberene, cadinene, caryophyllene, caryophyllene oxide, humulene, germacrene-D and elemene were also present in the volatile oil.

Even though the main components of both oil samples were the same, there was variation in the percentage quantity for these components between the two samples. β-Caryophyllene (29.98%), α-pinene (5.22%), sabinene (9.28%), myrcene (14.36%) and 1,8-cineole (10.57%) were the major components of the rhizome oil and the oil is characterized by the presence of large amounts of monoterpene hydrocarbons (39.09%). Whereas β-Caryophyllene (27.22%), sabinene (7.35%), myrcene (8.64%), and 1,8-cineole (14.68%) along with camphor (6.30%) were the major components in the leaf oil. In the leaf essential oil monoterpene hydrocarbons, oxygenated monoterpenes and sesquiterpene hydrocarbons were almost present in equal amounts. Among the sesquiterpenoids, hydrocarbons were detected in higher concentrations than the oxygenated ones in both samples analyzed.

The medicinal properties and biological activities of plants are usually due to their chemical profile. Therefore, reports on medicinal, pharmacological and pesticidal activity of crude extracts of this plant have little value if the chemotype has not been determined. The information on essential oil profile can be used for the possible exploitation of this species for various research and pharmaceutical purposes. Moreover, the chemical data may give complementary information to the taxonomy of this species.

TABLE 1

*Volatile oil components identified in* Alpinia smithiae

| **Compound** | **Rhizome(%)** | **Leaf (%)** |
|---|---|---|
| Monoterpene hydrocarbons | 39.09 | 32.52 |
| α-Thujene* | 2.11 | 4.09 |
| α-Pinene* | 5.22 | 3.94 |
| Camphene* | 1.44 | 0.68 |
| Sabinene* | 9.28 | 7.35 |
| β-Pinene* | 0.64 | 0.52 |
| Myrcene* | 14.36 | 8.64 |
| α-Phellandrene | 1.82 | 0.94 |
| δ-3-Carene | 1.51 | 1.02 |
| α-Terpinene* | 1.46 | 3.41 |
| p-Cymene* | 0.31 | 0.36 |
| Limonene* | 0.50 | 1.48 |
| β-Phellandrene | 0.16 | 0.09 |
| cis-Ocimene | 0.12 | — |
| trans-Ocimene | 0.16 | — |
| Oxygenated monoterpenes | 24.29 | 31.43 |
| Linalool* | — | 1.27 |
| Camphor* | 1.21 | 6.30 |
| Borneol* | 0.61 | 0.25 |
| Terpinen-4-ol* | 2.15 | 1.87 |
| α-Terpineol* | 0.81 | 0.64 |
| Methyl chavicol | 0.81 | 0.12 |
| 1,8-Cineole* | 10.57 | 14.68 |
| Nerol | t | — |
| Citronellol | 0.21 | 0.07 |
| Neral | t | t |
| Geraniol* | 0.82 | 1.37 |
| Linalyl acetate* | 0.15 | 0.94 |
| Bornyl acetate* | 0.23 | 0.13 |
| Isobornyl acetate* | 0.23 | 0.17 |
| cis-Methyl cinnamate | 1.31 | 2.26 |
| Citronellyl acetate | t | t |
| trans-Methyl cinnamate | 3.87 | 0.54 |
| Geranyl acetate* | 0.31 | 0.82 |
| Chavicol acetate | t | t |
| Sesquiterpene hydrocarbons | 32.08 | 28.46 |
| δ-Elemene | 0.13 | 0.06 |
| α-Copane | 0.09 | 0.08 |
| β-Elemene | 0.24 | 0.16 |
| β-Caryophyllene* | 29.98 | 27.22 |
| α-Humulne* | 0.64 | 0.57 |
| Germacrene-D* | — | 0.15 |
| α-Zingiberene* | 0.54 | 0.11 |
| β-Bisabolene* | t | 0.11 |
| γ-Cadinene | 0.18 | — |
| δ-Cadinene | 0.28 | — |
| Oxygenated sesquiterpenes | 0.81 | 0.50 |
| β-Elemol | t | t |
| (*E*)-Nerolidol | t | t |
| Caryophyllene-oxide | 0.26 | 0.11 |
| T-cadinol | t | — |
| α-Cadinol | t | — |
| cis, cis-Farnesal | 0.42 | 0.17 |
| trans, cis-Farnesal | 0.13 | 0.22 |
| Others | 0.86 | 0.82 |
| Eugenol* | 0.64 | 0.82 |
| Eugenyl acetate | 0.07 | t |
| Hexadecane | 0.08 | — |
| Heptadecane | 0.07 | — |
| Octadecane | t | — |
| **Total** | **96.13** | **93.73** |

t: trace (<0.05%), —: not detected, *: identified with standard. Values are average of two samples.

## RESUMEN

La composición de los aceites escenciales de hojas y rizomas de *Alpinia smithiae*, que crece silvestre en Ghats Occidental de Kerala (sur de India), fue analizada por cromatografía de gases. Los principales componentes en ambas muestras fueron β-cariofileno, sabinero, mirceno y 1, 8-cinole, pero fue observada la existencia de variación entre las dos partes de la planta en la capa de aceite así como en los principales componentes.

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