Chemical Composition of the Flower Oil of *Cinnamomum zeylanicum* Blume

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The steam-distilled oil of cinnamon (*Cinnamomum zeylanicum*) flowers was analyzed by GC and GC-MS. It consists of 23% hydrocarbons and 74% oxygenated compounds. A total of 26 compounds constituting ≈97% of the oil were characterized. (*E*)-Cinnamyl acetate (41.98%), *trans*-α-bergamotene (7.97%), and caryophyllene oxide (7.2%) are found to be major compounds. This is the first report on the chemical composition of the flower oil of *Cinnamomum zeylanicum*.

Keywords: *Cinnamomum zeylanicum; Lauraceae; (E)-cinnamyl acetate; volatile oil; mono- and sesquiterpene; GC-MS*

INTRODUCTION

Cinnamomum zeylanicum Blume is native to Sri Lanka and tropical Asia. The tree occurs in South India up to altitudes of 500 m but mostly below 200 m. The tree flowers in January and flowers ripen during May−August (The Wealth of India, 1992). Cinnamon leaf and bark are used as spices and in the production of essential oils. The leaves have a hot taste and emit a spicy odor when crushed. Senanayake et al. (1978) identified 57 constituents in cinnamon leaf oil with the major component eugenol (70%). The leaf oil has fragrant odor and very pungent taste. Major compounds present in stem-bark oil and root-bark oil are 75% cinnamaldehyde and 56% camphor, respectively (Senanayake et al., 1978). The bark oil is a flavoring ingredient used widely in confectionery, baked foods, pickles, meat seasonings, soft drinks (cola-type), pharmaceuticals, oral-care products, etc. (The Wealth of India, 1992). A total of 34 compounds have been previously identified in cinnamon fruit oil with (*E*)-cinnamyl acetate (42−54%) as the major component (Jayaprakasha et al., 1997). At present, the flowers and fruits are not being used for production of essential oils (Jagan Mohan Rao et al., 1997). The objective of the present study is to determine the chemical composition of the flower oil of *Cinnamomum zeylanicum*. This is the first report on the chemical composition of the flower oil of *Cinnamomum zeylanicum*.

MATERIALS AND METHODS

Plant Material. The flowers of *Cinnamomum zeylanicum* (*C. zeylanicum*) (synonym *Cinnamomum verum* J. S. Presl) were collected from Karkala (coastal Karnataka, India). The species was identified, and a voucher specimen was deposited at the Manasagangotri herbarium (MGH No. 2/96), Botany department, Mysore University, Mysore, India.

Equipment. ^{1}H NMR (90 MHz, $CDCl_3$) spectra was recorded on a Varian EM-390 instrument. TMS was used as the internal standard.

Isolation of Volatile Oil. Flowers (100 g) were subjected to hydrodistillation in a Clevenger-type apparatus for 4 h. The yield of oil was 0.5% (v/w). The oil was dried over anhydrous sodium sulfate and stored at 4 °C. The light yellow oil possessed a sweet floral odor.

GC Analysis. The GC analysis was carried out using a Shimadzu GC 15A chromatograph equipped with a FID detector, using an SE-30 column (3.0 m × 0.5 mm). The oven temperature was programmed from 60 °C for 5 min to 225 °C at the rate of 2 °C/min at which temperature the column was maintained for 3 min. The injector port temperature was 225 °C, the detector temperature was 250 °C, and nitrogen as carrier gas was 40 mL/min. Peak areas were computed by a Shimadzu C-R4A chromatopac data processor.

GC-MS Analysis. The oil was analyzed using a Shimadzu 17A-GC chromatograph equipped with a QP-5000 (quadrapole) mass spectrometer. The sample was diluted 25 times with acetone, and 1 μL was injected. A fused silica column SPB (30 m × 0.32 mm, film thickness 0.25 μm) coated with poly(dimethylsiloxane) was used. Helium was the carrier gas at a flow rate of 1 mL/min. The injector port temperature was 225 °C, the detector temperature was 250 °C, and the oven temperature was maintained at 60 °C for 2 min and then increased to 225 °C at the rate of 2 °C/min at which temperature the column was maintained for 5 min. The split ratio was 1:25, and the ionization voltage, 70 eV.

Retention indices for all the compounds were determined using *n*-alkanes as standards (Jennings and Shibamoto, 1980). The compounds were identified by comparison of retention indices with those reported in the literature (Jennings and Shibamoto, 1980; Davies, 1990), wherever possible, by co-injection with an authentic specimen and by matching their mass spectral fragmentation patterns with those stored in the spectrometer database, using the NIST62-Lib (Shimadzu Corp., Tokyo, Japan) MS library or comparison of MS data with those reported in the literature (Strenhagen et al., 1974; Jennings and Shibamoto, 1980; Ten Noever de Bravw et al., 1988; Adams, 1989).

RESULTS AND DISCUSSION

The chemical composition of the flower oil of *C. zeylanicum* is presented in Table 1. A total of 26 compounds were identified, which constitute ≈97% of the volatile oil. Shikimic acid and mevalonic acid metabolites account for 52% and 37%, respectively. A total of 9% contributed from straight chain compounds. Esters are present to an extent of 45%, viz. (*E*)-cinnamyl acetate and 2-phenylethyl benzoate. Other compounds from the shikimic acid metabolites are benzaldehyde, hydrocinnamaladehyde, (*E*)-cinnamaldehyde, and (*E*)-cinnamyl alcohol.

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Table 1. Chemical Composition of the Oil of *Cinnamomum zeylanicum* Flowers[a]

sl. no.	compound	peak area (%)	RI calcd	identification by
1	(*Z*)-hex-3-en-1-ol[b]	0.10		MS
2	benzaldehyde	0.35	940	MS, RI, CI
3	hydrocinnamaldehyde	0.18	1128	MS, RI
4	borneol	0.17	1150	MS, RI
5	α-terpineol	0.15	1179	MS, RI
6	(*E*)-cinnamaldehyde	0.38	1243	MS, RI, CI
7	(*E*)-cinnamyl alcohol	0.49	1300	MS, RI, CI
8	3−phenylpropyl acetate	1.99	1363	MS, RI
9	α-copaene	3.03	1381	MS, RI
10	*trans*-α-bergamotene	7.97	1424	MS, RI
11	(*E*)-cinnamyl acetate	41.98	1440	MS, RI, CI, ^{1}H NMR
12	α-humulene	2.40	1450	MS, RI
13	germacrene-D	1.31	1514	MS, RI
14	δ-cadinene	2.97	1529	MS, RI
15	nerolidol	0.95	1539	MS, RI
16	caryophyllene oxide	7.29	1574	MS, RI
17	globulol	3.80	1595	MS, RI
18	tetradecanal	5.05	1621	MS, RI
19	α-cadinol	6.35	1642	MS, RI
20	cadalene	1.39	1662	MS, RI
21	epi-α-bisabolol	0.73	1690	MS, RI
22	*n*-heptadecane	2.14	1718	MS, RI
23	benzyl benzoate	3.19	1741	MS, RI, CI
24	pentadecanol	0.71	1791	MS, RI
25	2-hexadecanone[b]	0.71	1805	MS
26	2-phenyethyl benzoate[b]	0.44	1818	MS

[a] RI = retention index, MS = mass spectra, and CI = co-injection with authentic sample. [b] Identified tentatively.

Sesquiterpenes were the major compounds (38%) among the mevalonic acid metabolites. The monoterpene portion was very low (<1%). α-Bergamotene, α-copaene, α-humulene, and δ-cadinenes were the major sesquiterpene hydrocarbons. α-Cadinol and globulol were the major sesquiterpene alcohols. Caryophyllene oxide was the only oxide and present in considerable percentage (7.3%). A minor monoterpene fraction contained alcohols (borneol and α-terpineol). Cadalene was the lone aromatic hydrocarbon, which may be from the mevalonic metabolites. Straight chain compounds are represented by four different classes of functional groups, viz. hydrocarbon (*n*-heptadecane), aldehyde (tetradecanal), ketone (2-hexadecanone), and alcohols ((*Z*)-hex-3-en-1-ol, pentadecanol).

A total of 15 compounds present in the fruit volatile oil (Jayaprakasha et al., 1997) are also found in the flower oil and constituted 74% of the oil. This indicates that the formation of the representative or character impact volatile compounds started during the flowering stage.

Synthetic (*E*)-cinnamyl acetate is widely used in perfumery because of its excellent sensory and fixative properties. It is used frequently in blossom compositions such as lilac, jasmine, and lily of the balsamic and oriental notes to the fragrances. In addition, it is used as a modifier in berry, nut, and spice flavor systems (Ash and Ash, 1995). It is also used in baked foods (15 ppm), meat products (3 ppm), soft candy (17 ppm), etc. (Howe-Grant, 1993). Obviously, natural (*E*)-cinnamyl acetate from flowers of *C. zeylanicum* could be used for these purposes. Hence, a process has been developed for the isolation of ≈96% pure (*E*)-cinnamyl acetate from the cinnamon fruits and flowers (Jagan Mohan Rao et al., 1997). The structure of the compound was further confirmed by ^{1}H NMR spectra.

CONCLUSIONS

The flower oil *C. zeylanicum* contained (*E*)-cinnamyl acetate as the major compound. This is different from oils of other plant parts, since the major compounds of other parts of the same species were eugenol in the leaf oil, (*E*)-cinnamaldehyde in stem bark oil, and camphor in the root-bark oil. But there are some similarities, as it contains many other compounds that are present in other oils as well. The major compound, i.e., (*E*)-cinnamyl acetate, could be used for the replacement of synthetic (*E*)-cinnamyl acetate in perfumery because of its excellent sensory and fixative properties. The results of the present study are indicative of the utilization of flowers having no commercial application in perfumery so far.

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