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A COMPARISON OF ESSENTIAL OIL CONSTITUENTS OF BARK, LEAF, ROOT AND FRUIT OF CINNAMON (*CINNAMOMUM ZEYLANICUM* BLUM) GROWN IN SRI LANKA.

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Abstract: The essential oils of the bark, leaf, root and fruit of Cinnamon were analyzed by capillary GC and GC/MS. The major constituents of Cinnamon fruit oil, were δ- and γ- cadinene (36.0%) and T- cadinol (7.7%) and β- caryophyllene (5.6%). About 84% of Cinnamon fruit oil comprised sesquiterpenes while other parts of Cinnamon contained less than 9% of this group of compounds. Phenyl propanoids were the major constituents of Cinnamon bark and leaf oils while root oil had monoterpenes as the major constituents (95%).

Key words: cadinene, camphor, *Cinnamomum zeylanicum*, cinnamaldehyde, essential oil, eugenol, Lauraceae.

INTRODUCTION

Cinnamon (*Cinnamomum zeylanicum* Blum) an endemic plant popularly known as "Kurundu" in Sri Lanka belongs to the genus *Cinnamomum* of the plant family Lauraceae.[1] It is also found in the southern parts of India, China, Burma and Indonesia. Cinnamon bark is used as a spice to improve flavor of local food preparations. Cinnamon bark and leaf oils are used as flavor ingredients and also in cosmetics and pharmaceutical preparations.[2,3]

Previous studies have shown that Cinnamon bark, leaf and root oils differ significantly in their chemical composition with cinnamaldehyde, eugenol and camphor being the major constituents respectively.[4] This unique property of Cinnamon has given rise to much interest in the biosynthetic pathways of their chemical constituents. Thus Cinnamon offers a variety of oils with different aroma characteristics and compositions to the flavor industry. The root bark was reported to have camphor as the main constituent[5], but it does not seem to have commercial value unlike the leaf and bark oils. The fruits of the Cinnamon plant are also aromatic and possess a sweet spicy aroma. It was reported that the fruits of Cinnamon grown in different regions in India are of two types[6,7], one having β-caryophyllene and (E)-cinnamyl acetate as the major constituents and the other having α-pinene, β-caryophyllene, δ-cadinene and α-muurolol as the major constituents in the oils

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investigated.[6,7] The volatile constituents of fruits of Cinnamon grown in Sri Lanka have not been studied previously and we now report the identification of Cinnamon fruit oil constituents and compare it with the root, bark, and leaf oils.

METHODS AND MATERIALS

Sample preparation: Fresh fruits, bark, leaves and roots of Cinnamon were collected from an estate in Hikkaduwa, Sri Lanka. Air-dried samples were hydrodistilled using a Clevenger light oil apparatus and a modified Likens and Nickerson apparatus.[8]

GC; FID-GC: Bonded phase Supelcowax 10 and SPB-1 fused silica capillary columns, 30 m x 0.32 mm; 0.25 μm film thickness. The column was programmed as follows: 50°C (2min), 50°C -210°C at 2°C/min, 210°C (30min) with a Helium carrier gas. The injector and detector temperatures were 250°C and 0.1 μl of the oil was injected using a Grob sampler in splitless mode with a sampling time of 0.5 min. Area percentages for the components were obtained with a data processor.

GC/MS; GC conditions were as above with He as carrier gas; direct interface at 250°C; ionization voltage 70 eV, ion source temp. 250 °C. Individual constituents were identified by comparison of their mass spectra and retention indices with literature data. The experimental work was carried out in triplicate.

RESULTS

The hydrodistillation of the bark, leaf, root and fruit of Cinnamon separately gave pale yellow oils with a pleasant, spicy odor. The yields were 1.2%, 0.75%, 2.0% and 0.5% respectively.

The components, identified by GC/MS and relative retention times in the essential oils of Cinnamon bark, leaf, root and fruit oils are listed in Table 1. At least 37 compounds were detected in Cinnamon bark oil of which 35 were identified. Most of the compounds have been reported previously[4] in Cinnamon bark oil but α-ylangene (0.7%) is reported for the first time. In Cinnamon leaf oil of the 32 compounds detected, 29 were identified. At least 46 compounds were detected in the root oil of which 37 compounds were identified. Sabinol, citronellyl formate, P-cymene-7-ol and methoxy eugenol are reported as new compounds in Cinnamon root oil.

Cinnamon fruit oil, not previously studied in Sri Lanka, contained 57 detectable compounds of which 49 were identified. The major constituents δ and γ cadinene accounted for around 36% of the oil. The oil was also rich in sesquiterpenes containing 67% sesquiterpene hydrocarbons and 17% sesquiterpene alcohols. Phenyl proponoids, the major constituents in bark and leaf oils were present only in small

amounts (1%). Twenty one sesquiterpenes (83.6%), eighteen monoterpenes (6.7%) and seven phenyl proponoids (0.9%) were identified in fruit oil.

Amounts of monoterpenes, sesquiterpenes and phenyl proponoids fractions in bark, leaf, root and fruit oils are given in Table 2. The phenyl proponoid fraction was prominent in leaf and bark oils, amounting to 85.4% and 64.8% respectively but present in very low levels in root and fruit oils (2.2% and 0.9% respectively). On the other hand Cinnamon fruit oil was found to be rich in sesquiterpenes (83.6%) while Cinnamon root oil contained more than 95% of monoterpenes.

Table 1: Constituents of Cinnamon fruit, bark, leaf and root oils

Compound	Relative abundance			
	Fruit	Bark	Leaf	Root
α-Pinene	2.19	3.34	0.73	5.70
Unknown	-	1.10	0.08	0.57
Camphene	0.29	0.63	0.29	2.77
β- Pinene	1.61	0.61	0.26	3.45
Sabinene	-	0.26	-	1.51
α- Phellandrene	0.43	0.14	0.65	4.92
Myrcene	-	2.70	0.77	0.43
α- Terpenene	0.08	1.30	1.10	1.05
Limonene	1.0	1.2	0.3	6.2
β- Phellandrene	0.07	-	-	2.09
(Z)-β-Ocimene	0.03	0.14	-	0.28
γ- Terpenene	0.05	0.16	-	0.57
(E)-β- Ocimene	0.02	0.13	-	0.94
p-Cymene	0.01	1.91	0.92	1.38
Terpinolene	0.30	0.21	0.61	0.47
Linalool	0.08	3.70	2.77	0.13
Terpinen-4-ol	0.27	0.40	0.11	1.90
α- Terpineol	0.64	0.70	0.28	3.94
α-Fenchyl alcohol	0.41	-	-	-
Isoborneol	0.70	0.08	-	0.68
Sabinol*	-	-	0.20	-

Cont .....

Compound	Relative abundance			
	Fruit	Bark	Leaf	Root
1,8-Cineole	0.05	4.60	0.51	6.39
Methyl chavicol	-	-	-	0.19
P-Cymen-7-ol	-	-	-	0.06
Cinnamyl alcohol	-	0.16	0.09	0.12
2-Phenylethyl alcohol	-	0.47	-	-
Coumarin	-	0.36	-	-
Benzaldehyde	0.50	0.61	0.14	-
Hydrocinnamaldehyde	-	0.80	0.12	0.09
Camphor	-	-	-	47.42
Piperitone	-	-	-	0.24
2-Phenylethyl acetate	-	0.18	-	0.05
3-Phenylpropyl acetate	-	0.38	-	0.03
Cinnamaldehyde	0.3	50.5	2.7	0.1
Methyl cinnamate	-	0.27	0.09	0.10
(Z)-Cinnamyl acetate	0.10	8.78	1.00	0.12
Benzyl benzoate	-	1.10	4.01	0.16
Eugenyl acetate	1.00	0.40	0.64	0.10
Linalyl acetate	-	-	-	0.60
Eugenol	0.45	4.15	76.74	0.21
Methyl isoeugenol*	0.22	-	-	-
Isoeugenol*	0.32	0.08	0.07	0.04
Safrole	0.32	0.08	0.08	1.32
Methyl eugenol	1.79	0.15	-	0.12
Methoxy eugenol	-	-	-	0.17
α- Cubebene	0.20	-	-	0.68
α- Ylangene	2.71	0.70	0.14	0.03
β- Caryophyllene	5.63	8.00	3.47	0.62
α-Humulene	1.41	1.30	0.57	0.12
β- Cubebene	1.08	-	-	-
β- Farnesene*	1.58	-	-	-
α- Gurjujene	2.32	-	-	-

Cont .....

Compound	Relative abundance			
	Fruit	Bark	Leaf	Root
β- Cadinene	2.78	-	-	-
β- Gurjujene	0.70	-	-	-
α- Muurolen	4.40	-	-	-
δ- Cadinene and γ- Cadinene	36.00	-	-	-
Cadina-1,4-diene	1.59	-	-	-
α- Cadinene	5.64	-	-	-
Calamenene*	0.17	-	-	-
Bisabolol*	0.35	-	-	-
Nerolidol*	0.84	-	-	-
α- Cadinol	1.12	-	-	-
Elemol	0.13	-	-	-
Sequiphellandrol*	0.30	-	-	-
T-Cadinol	7.70	-	-	-
T-Muurolol	1.05	-	-	-

* Correct isomer not identified

Table 2 : Relative abundance of monoterpene, phenyl proponoid and sesquiterpene fractions in Cinnamon bark, leaf, root bark and fruit oils.

Fraction	Bark	Leaf	Root	Fruit
Monoterpenes	25.3	6.7	95.2	6.7
Phenyl propanoids	64.8	85.4	2.2	0.9
Sesquiterpenes	8.7	4.7	0.7	83.6

DISCUSSION

Two columns of different polarity were used to analyze the essential oils of *C. zeylanicum* (Supelcowax-10 and SPB-1). Though the major components were identified on both columns, the resolution of constituents was generally better on the supelcowax-10 column.

The modified Likens and Nickereson apparatus was used to trap low volatile constituents of the essential oils. Most of the constituents of the essential oils are terpenes, consisting of monoterpenes, sesquiterpenes and phenylproponoids. Most

of the terpenoids identified among the leaf, bark and root oils were also detected in the previous studies of the essential oil of *C. zeylanicum.*[5]

The composition of Cinnamon fruit oil is widely different from Cinnamon leaf, bark and root oils. The oil does not contain high concentrations of components such as eugenol, (E)-cinnamaldehyde and camphor that are major constituents of the leaf, bark and root oils of Cinnamon. The intense, characteristic aroma of Cinnamon fruit oil is therefore most probably due to its sesquiterpene fractions, particularly the major components δ and γ- cadinene, cadinol and β- caryophyllene.

The fruit oil of Cinnamon grown in India was investigated by Jayaprakasha et al and Mallavarapu et al.[6,7] They reported that the oil from two locations had different compositions. The major constituents of the oil obtained from Kerala region were β- caryophyllene, and (E)-cinnamyl acetate whereas the oil from Bangalore were α-pinene, β-pinene, β- caryophyllene, α-muurolene, δ and γ - cadinene, and α-muulol. The present study indicates that the fruit oil of cinnamon grown in Sri Lanka has a different composition and in particular none of the earlier analyses has indicated δ and γ - cadinene (36%), cadinol (7.7%) and β- caryophyllene (5.6%) as the major constituents.

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