Chemical Composition of the Essential Oils of Two *Alpinia* Species from Hainan Island, China

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The essential oils of two *Alpinia* species, *i.e. A. hainanensis* and *A. katsumadai*, from Hainan Island, China were analyzed by using GC-MS. The major constituents in the leaf oil of *A. hainanensis* were ocimene (27.4%), β-pinene (10.1%), 9-octadecenoic acid (6.5%), *n*-hexadecanoic acid (5.8%), 9,12-octadecadienoic acid (5.4%), and terpinen (4.3%). The oil constituents obtained from the flowers of *A. hainanensis* were ocimene (39.8%), β-pinene (17.7%), terpinene (5.5%), *p*-menth-1-en-ol (4.9%), caryophyllene (4.9%), and phellandrene (4.4%). In *A. katsumadai*, the major constituents in the leaf oil were *p*-menth-1-en-ol (22.0%), terpinen (19.0%), 4-carene (9.1%), 1,8-cineole (8.3%), and camphor (5.6%). The major constituents in the flower oil were *p*-menth-1-en-ol (21.3%), 1,8-cineole (20.2%), terpinen (12.6%), phellandrene (7.0%), 4-carene (6.4%), and β-pinene (5.2%).

Key words: Alpinia hainanensis and *katsumadai*, Essential Oil, GC-MS

Introduction

The galangal genus of *Alpinia* with about 250 species in the ginger family Zingiberaceae is distributed mainly in China, India, East Indies, and Polynesia (Lemmon and Sherman, 1964; Lötschert and Beese, 1983). The *Alpinia* plants have thick fragrant rootstocks, resembling the scent of ginger, from which the new shoots sprout in the spring, and their leaves are lance-shaped with fringed borders and they are produced on reedy stems. They can grow up to 10 feet high with a 3-foot spread. Many *Alpinia* species are appreciated for their medicinal properties; they have a long history of use in traditional medicine as a spasmolytic, hypotensive or diuretic due to their strong cardiovascular, anti-emetic, anti-oxidant, anti-inflammatory, bacteriostatic, or fungistatic effects in China, India and other regions (Jitoe *et al.*, 1992; Habsah *et al.*, 2000; Shin *et al.*, 2002; Miyazawa and Hashimoto, 2002; Ficker *et al.*, 2003). Currently, the compositions of essential oils from *A. galanga* including 1,8-cineole, β-pinene, and camphor (Raina *et al.*, 2002; Mallavarapu *et al.*, 2002), *A. speciosa* including limonene, 1,8-cineole, and terpinen-4-ol (Zoghbi *et al.*, 1999), *A. purpurata* including β-pinene, 1,8-cineole, and α-pinene (Zoghbi *et al.*, 1999), *A. smithiae* including β-caryophyllene, sabinene, myrcene, and 1,8-cineole (Joseph *et al.*, 2001), and *A. zerumbet* including terpinen-4-ol, 1,8-cineole, and β-pinene (Ali et al., 2002) are investigated in detail.

Hainan Island (Hainan Province) is one of the major distribution regions of *Alpinia* plants in China. For example, the type specimens of *A. katsumadai* and *A. hainanensis* were collected from the island. In recent years, about 80% of annual production of Chinese *A. katsumadai* used as a famous Chinese traditional medicine were also from Hainan Island. However, the chemical composition of essential oils of *Alpinia* plants in this region has not been reported yet. Therefore, the chemical constituents of essential oils from leaves and flowers of *A. hainanensis* and *A. katsumadai* in Hainan Island were analyzed using GC-MS.

Materials and Methods

Plant materials

The leaves and flowers of *A. hainanensis* and *A. katsumadai* used in this study were collected from Bawangling National Nature Reserve for Black-crested Gibbon (18° 53′ ~ 19° 30′ N, 109° 0′ ~ 109° 17′ E), Changjiang County in Hainan Island in January 2003. The voucher specimens were deposited at the MOE Lab for Biodiversity Science and Ecological Engineering, School of Life Sciences, Fudan University.

Extraction of essential oils

The fresh flowers (250 g) and dry leaves (100 g) of *A. hainanensis* and *A. katsumadai* were subjected to steam distillation for 3 h using a Clevenger-type apparatus. The essential oils were collected in a lighter than water oil graduated trap and dried over anhydrous sodium sulfate.

GC-MS analysis

The GC-MS analysis was performed on a combined GC-MS instrument (Finnigan Voyager, San Jose, CA, USA) using a HP-5 fused silica gel capillary column (30 m length, 0.25 mm diameter, 0.25 μm film thickness). A 1 μl aliquot of oil was injected into the column using a 10:1 split injection, which temperature was set up at 250 °C. The GC program was initiated by a column temperature set at 60 °C for 2 min, increased to 250 °C at a rate of 10 °C/min, held for 10 min. Helium was used as the carrier gas (1.0 ml/min). The mass spectrometer was operated in the 70 eV EI mode with scanning from 41 to 450 amu at 0.5 s, and mass source was set at 200 °C. The compounds were identified by matching their mass spectral fragmentation patterns with those stored in the spectrometer database using the National Institute of Standards and Technology Mass Spectral database (NIST-MS, 1998).

Results and Discussion

The steam distillation of the flowers and leaves of *A. hainanensis* and *A. katsumadai* yielded clear and yellowish essential oils. They were about 0.08% v/w and 0.1% v/w in the flowers of *A. hainanensis* and *A. katsumadai*, and about 0.14% v/w and 0.11% v/w in the leaves of *A. hainanensis* and *A. katsumadai*, respectively. The chemical constituents identified by GC-MS in the essential oils of leaves and flowers of *A. hainanensis* and *A. katsumadai* are listed in Table I.

In *A. hainanensis*, a total of 34 and 36 compounds (about 93.6% and 98.7% of the oils) were identified from leaves and flowers, respectively. The major constituents identified in the leaf oil of *A. hainanensis* were ocimene (27.4%), β-pinene (10.1%), 9-octadecenoic acid (6.5%), *n*-hexadecanoic acid (5.8%), 9,12-octadecadienoic acid (5.4%),

Table I. Chemical constituents of the essential oils from *A. hainanensis* and *A. katsumadai* in Hainan Island, China.

Compound	*A. hainanensis*		*A. katsumadai*	
	Leaf	Flower	Leaf	Flower
3-Hexenol		0.2		
Hexanol		0.1		
2-Heptanol	*tr*	0.1	0.7	0.2
Thujene		0.1		
Cyclofenchene	*tr*	2.1		
Camphene	*tr*	1.4	1.2	0.7
Phellandrene	2.1	4.4	0.7	7.0
β-Pinene	10.1	17.7	2.7	5.2
Myrcene			1.3	1.3
4-Carene	*tr*	0.7	9.1	6.4
m-Cymene	1.0	1.8		
Limonene		1.9	2.0	1.8
1,8-Cineole	*tr*	0.5	8.3	20.2
Ocimene	27.4	39.8		
Terpinen	4.3	5.5	19.0	12.6
Terpineol	0.2	0.4	2.7	1.1
p-Mentha-1,4-diene	*tr*	0.6	4.2	3.4
Unidentified	*tr*	0.1		
Linalool	0.3	0.1		
1-Menthyl-4-isopropyl-2-cyclohexenol			1.2	1.8
Dimethyl octatetraene	*tr*	0.1		
Camphor	2.8	3.4	5.6	3.5
Trimethyl norbornanol	*tr*	0.1	0.1	0.1
Borneol	*tr*	0.1	0.2	0.2
p-Menth-1-en-ol	3.0	4.9	22.0	21.3
Benzylacetone			0.7	*tr*
2-Isopropyl-5-methyl-3-cyclohexenone	0.1	0.2	0.4	0.1
Nonenal			*tr*	0.2
Unidentified			0.3	0.1
Unidentified			0.1	*tr*
Dodecane	*0.4*	*tr*		
Copaene		0.1		
Santalene	*tr*	0.2	0.1	0.9
Caryophyllene	3.0	4.9	2.3	1.7
Dimethyl-6-methylpentenyl-2-norpinene			1.1	0.5
Unidentified	*tr*	0.1		
(Z)-β-Farnesene			0.3	0.2
β-Caryophyllene	2.1	1.9	0.6	0.6
Cubebene	0.1	*tr*		
Tetramethyl hexahydro-benzocycloheptene			0.2	0.1
Germacrene D	1.5	2.1	1.5	1.8
Eudesma-4,11-diene			0.7	0.1
Chamgrene			0.8	0.2
α-Farnesene	0.4	0.7		
Longipinene			0.8	0.6
Eudesma-3,7-diene			0.1	0.2
Cadina-1,4-diene	*tr*	0.1		
Ledol			0.7	
n-trans-Nerolidol			1.5	1.1
Denderalasin			0.1	*tr*
Spathulenol		0.4	0.1	*tr*

Table I. (cont.)

Compound	*A. hainanensis* Leaf	*A. hainanensis* Flower	*A. katsumadai* Leaf	*A. katsumadai* Flower
Caryophyllene oxide	0.6	0.5	0.2	0.1
Unidentified	*tr*	0.2		
Dodecadienol acetate			0.1	*tr*
Cadinol	0.8			
Bisabolol			0.2	0.1
Unidentified			1.2	0.9
Tetradecanioc acid	0.4			
Benzyl benzoate	0.3	*tr*		
Sinensal			0.5	
Hexahydrofarnesyl acetone	0.5	0.2		
Unidentified	0.4	0.7		
trans-Bergamotol			0.1	*tr*
9-Hexadecenoic acid	1.0			
n-Hexadecanoic acid	5.8	0.5	0.4	1.0
Myristamide	0.8		0.1	
Isopropyl palmitate	0.9			
trans-Farnesyl actate	0.2	*tr*		
n-Heptadecanoic acid	0.4			
Unidentified	0.6		0.2	
Phytol			0.5	0.1
9,12-Octadecadienoic acid	5.4			
9-Octadecenoic acid	6.5			
Unidentified	3.4			
Hexadecanamide	4.0	*tr*	0.5	0.3
n-Tricosane	1.3			
9-Octadecenamide	2.0	0.9	1.1	2.2
Octadecanamide	1.8			
n-Pentacosane	2.1		0.1	

* Numbers represent the percentage of each constituent in total essential oil.

tr: Trace quantities (< 0.1%).

and terpinen (4.3%). The major constituents identified in the flower oil were ocimene (39.8%), β-pinene (17.7%), terpinene (5.5%), *p*-menth-1-en-ol (4.9%), caryophyllene (4.9%), and phellandrene (4.4%).

In another species, *A. katsumadai*, a total of 44 and 36 compounds (about 96.8% and 98.5%) were identified from leaves and flowers, respectively. The major constituents identified in the leaf oil of *A. katsumadai* were *p*-menth-1-en-ol (22.0%), terpinen (19.0%), 4-carene (9.1%), 1,8-cineole (8.3%), camphor (5.6%). The major constituents in the flower oil were *p*-menth-1-en-ol (21.3%), 1,8-cineole (20.2%), terpinen (12.6%), phellandrene (7.0%), 4-carene (6.4%), and β-pinene (5.2%).

Of the major constituents of essential oils in *A. hainanensis* and *A. katsumadai*, four constituents, *i.e.* β-pinene, 1,8-cineole, *p*-menth-1-en-ol, and ocimene, have strong antimicrobial activities (Juliani *et al.,* 2002; Faleiro *et al.,* 2003; Kim *et al.*, 2003) and 1,8-cineole has also cardiovascular effects (Lahlou *et al.,* 2002). However, the main components were diversified, which led to different effects in some *Alpinia* species (Zoghbi *et al.*, 1999; Raina *et al.*, 2002). On the other hand, the composition variations of essential oils in *Alpinia* species have chemotaxonomic implications. Although some authors suggested that the four *Alpinia* species, *i.e. A. hainanensis*, *A. katsumadai*, *A. henryi*, and *A. kainantensis*, should be merged into one species *A. hainanensis* based on morphological characters (Wu, 1997). Our study shows that there are significant differences between the chemical constituents from essential oils of *A. hainanensis* and *A. katsumadai*. It is obvious that further comparative studies of chemical constituents of essential oils in *Alpinia* are necessary.

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