Chemical Composition of the Essential Oils of *Clausena lansium* from Hainan Island, China

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Z. Naturforsch. **59 c**, 153–156 (2004); received October 13/November 7, 2003

The essential oils of wild *Clausena lansium* collected in Hainan Island, China were extracted from leaves, flowers, sarcocarps and seeds, and then analyzed by using GC/MS. The main constituents of the essential oils were: β-santalol (35.2%), bisabolol (13.7%), methyl santalol (6.9%), ledol (6.5%) and sinensal (5.6%) in the leaves; β-santalol (50.6%), 9-octadecenamide (17.2%) and sinensal (4.1%) in the flowers; β-santalol (52.0%), α-santalol (15.5%), farnesol (5.2%) and sinensal (4.0%) in the sarcocarps; and phellandrene (54.8%), limonene (23.6%), and *p*-menth-1-en-4-ol (7.5%) in the seeds.

Key words: Clausena lansium, Essential Oils, GC/MS

Introduction

Clausena lansium Skeels (wampee) is a tropical species of the Rutaceae family and has been commonly cultivated in southern China, Southeast Asia (especially from northern to central Vietnam) and North America for a long time. The fully ripe and peeled *C. lansium* is regarded as a famous fruit that is eaten for its sweet or subacid flavor. In Southeast Asia, people produce a kind of carbonated beverage by fermenting the fruit of *C. lansium* with sugar and straining off the juice or prepare it as spicery. Chinese people always exploit it as one of the traditional pharmaceutics to treat bronchitis, and its leaf decoction can also be used as shampoo for hair-care (Morton, 1987).

Several studies of the clausenamide in *C. lansium* and their pharmacological effects have been reported during the past decade (Liu *et al.*, 1996; Zhang and Lin, 2000). Recently, the extraction of seeds from *C. lansium* has also shown that it possesses antifungal and antiproliferative activities (Ng *et al.*, 2003). However, there is no literature of components of essential oils from *C. lansium*, yet the essential oils of some other species of *Clausena* such as *C. dunniana* have been detected to have an insecticidal activity (Xu *et al.*, 1994). Therefore, the aim of this paper is to analyze the essential oils from the different parts of *C. lansium* by using GC/MS.

Materials and Methods

Plant materials

The samples of *C. lansium* were collected from Bawangling National Nature Reserve for Black-crested Gibbon (18° 53′ ~ 19° 30′ N, 109° 0′ ~ 109° 17′ E) in Changjiang County, Hainan, China. The leaf and flower samples were collected in January, 2003 and the sarcocarps together with the seeds in June, 2003. The samples were identified and a voucher was deposited in the MOE Laboratory for Biodiversity Science and Ecological Engineering, Fudan University. All samples were dried and stored at room temperature as well as cut into small pieces for the experiment.

Extraction of essential oils

The samples were cleaned from impurities in the laboratory. Each of them was ground or crushed, and then steam-distilled in triplicate with a Clevenger-type apparatus for about 3 h. The essential oils were collected and then stored with anhydrous sodium sulfate in Eppendorf tubes at 4 °C.

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,

0939–5075/2004/0300–0153 $ 06.00

0.25 μm film thickness). A 1 μl-aliquot of oil was injected into the column using a 10:1 split injection with temperature set to 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 and 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 in 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, leaves, sarcocarps, and seeds of *C. lansium* yielded clear and yellowish essential oils. Their contents are about 0.08% dry wt (v/w) of flowers, 0.1% (v/w) of leaves, 0.13% (v/w) of sarcocarps, and 0.5% (v/w) of seeds, respectively. The chemical constituents identified by GC/MS in the essential oils of the flowers, leaves, sarcocarps, and seeds of *C. lansium* are listed in Table I.

For the leaf sample, a total of thirty-two components (about 96.4% of the leaf oil) were identified. Twenty-seven components (95.1% of the flower oil), seventeen components (86.4% of the sarco-

Table I. Constituents of the essential oils from different parts of *Clausena lansium.*

Compound	Leaf (%)	Flower (%)	Sarcocarp (%)	Seed (%)
n-Caproaldehyde	0.1			
2-Hexenal	0.7			
3-Hexenol	0.4			
Thujene				0.3
α-Pinene			0.1	1.3
Phellandrene			0.1	54.8
β-Pinene				0.8
Myrcene			0.2	*tr*
Carene				0.4
Cymene				0.5
Limonene	*tr*		0.2	23.6
Ocimene	0.1			
Dodecane	*tr*			
Terpinen				1.2
Acetophenone		0.1		
Terpineol				2.9
Unidentified		0.1		
n-Dodecane		0.1		
Methyl isopropenyl-cyclohexen-1-ol				0.8
Borneol			0.1	
p-Menth-1-en-4-ol		0.1	0.3	7.5
1-(3-Methylphenyl)-ethanone		*tr*		
p-Menth-1-en-8-ol		*tr*	0.1	0.5
Unidentified		0.1		
Linalool	0.1	0.1		
n-Pentadecane		0.1		
Butyl octanol		*tr*		
Nerol acetate				0.1
Zingiberene	0.1			
Geraniol acetate				0.1
Unidentified		0.3		0.2
Santalene	0.1			0.1
Sesquiphellandrene	0.1			
Caryophyllene	0.6	0.2		0.7
β-Caryophyllene	0.2	*tr*		0.1
Farnesene	1.1	0.3		
Liongipinene	0.8			

Table I (continued).

Compound	Leaf (%)	Flower (%)	Sarcocarp (%)	Seed (%)
Cadinene				0.1
Germacrene D				0.4
Unidentified	0.4	1.2		0.2
Cadina-1(10),4-diene				0.1
Epiglobulol	2.0			
Unidentified		0.5		0.6
Nerolidol	5.0	0.5	0.9	
Denderalasin	0.8	0.2		
Ledol	6.5	0.5		
Spathulenol	1.3	0.1	0.3	
Caryophyllene oxide	1.1	0.1	2.2	
Unidentified	0.6		8.3	
Cadinol		0.2		
Bisabolol	13.7			
Farnesal	0.2			
α-Santalol		1.6	15.5	1.8
Bergamotol	4.4	3.2		0.1
Sinensal	5.6	4.1	4.0	
β-Santalol	35.2	50.6	52.0	0.2
Farnesol	2.7		5.2	
Unidentified		6.7	3.5	
Methyl lanceol	0.6			
Lanceol		0.7		
Methyl santalol	6.9			
Unidentified		1.3		
Palmitic acid	0.4			
Hexadecanoic acid		1.2	3.9	
Phytol	0.3		0.6	
Linoenic acid methyl ester	0.2			
Octadecadienoic acid		0.2		
9-Octadecenamide	3.8	17.2		
Stearic acid			0.7	
Unidentified	0.3		2.1	
Palmitamide		1.9		
Stearamide		1.0		

% Percentage of the content of each constituent in total essential oil.
tr: Trace quantities (< 0.1%).

carp oil) and twenty-four components (98.4% of the seed oil) of the total oil components were identified from the flowers, sarcocarps, and seeds, respectively. The main constituents identified in the leaf oil of *C. lansium* were β-santalol (35.2%), bisabolol (13.7%), methyl santalol (6.9%), ledol (6.5%) and sinensal (5.6%); in the flower oil β-santalol (50.6%), 9-octadecenamide (17.2%) and sinensal (4.1%); in the sarcocarp oil β-santalol (52.0%), α-santalol (15.5%), farnesol (5.2%) and sinensal (4.0%); and in the seed oil phellandrene (54.8%), limonene (23.6%) and *p*-menth-1-en-4-ol (7.5%).

Recent studies have indicated that β-santalol, which is the main constituent of the essential oils from leaves, flowers and sarcocarps of *C. lansium*, has an effect on the central nervous system in mice, *i.e.* antinociceptive, thus it can be considered as a neuroleptic (Okugawa and Ueda, 1995). Both α- and β-santalol have also reported to affect some tumors. In particular, α-santalol may prevent skin tumor development in SENCAR mice (sensitive to carcinogenesis) (Dwivedi *et al.*, 2003; Johnson *et al.*, 2001; Natarajan *et al.*, 2003). Phellandrene, which is the main constituent of the seed oil of *C. lansium*, can be used as an effective compound to kill insects (Tsoukatou *et al.*, 2001). Our study provides useful information for commercial cultivation and potential medicinal uses of *C. lansium* in China.

Acknowledgements

We would like to thank Professor Suhua Shi, Mr. Cairong Zhong, and Mr. Shaowei Chen for their help in fieldwork. This study was partially supported by the Chinese National Key Project for Basic Research (973) (2002 CB 512801) and the Postdoctoral Foundation of China (2003033270).

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