Essential Oils from Three *Curcuma* Species Collected in Thailand

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Abstract

The essential oils extracted by hydrodistillation from the rhizomes of *Curcuma xanthorrhiza,* *Curcuma aromatica* and *Curcuma aeruginosa* (Zingiberaceae) grown in Thailand were analyzed by capillary GC and GC/MS. The major volatile components from *C. xanthorrhiza* were 1,8 cineol (37.58%) and curzerenone (13.70%) whereas camphor (26.94%), ar-curcumene (23.18%) and xanthorrhizol (18.70%) were found in the essential oil of *C. aromatica*. For *C. aeruginosa,* β-pinene (7.71%), 1,8-cineol (9.64%) and curzerenone (41.63%) appeared to be the major constituents.

INTRODUCTION

Curcuma Linn. is a large genus belonging to the family Zingiberaceae. It comprises about 70 species of rhizomatous herbs distributed mostly in Southeast Asia as wild and cultivated plants (Sastri et al., 1950). According to the Thai Plant Names, a book issued by the Royal Forest Department, at least thirteen *Curcuma* species have been found in Thailand (Smithinand, 2001). The plants have long been used as medicines, spices and food colorants.

Previous phytochemical studies on *Curcuma* species revealed the presence of diarylheptanoids, of which the significant antioxidative yellow pigments, curcuminoids, are among the common ones. The genus also produces essential oils predominantly occurring in the rhizomes. *Curcuma* oils have been reported to possess many interesting pharmacological activities such as antitumor, anti-inflammatory, antifungal (Apisariyakul et al., 1995), gastroprotective (Kitsupa and Kiatying-Angsulee, 2002) and choleretic properties (Ozaki and Masatoshi, 1984; Ozaki and Liang, 1988).

As a part of our continuing interest in searching for biologically active substances in the essential oils from zingiberaceaous species indigenous to Thailand, selected *Curcuma* species possessing significant ethnomedical uses have been investigated for their essential oil constituents. *C. xanthorrhiza* Roxb. (Wan Chak Mod Luk), *C. aromatica* Salisb. (Wan Nang Kum) and *C. aeruginosa* Roxb. (Wan Maha Mek) are the candidate *Curcuma* species in our research project. *C. xanthorrhiza* and *C. aeruginosa* have been used in Thai traditional medicine for the treatment of inflammations, postpartum uterine and peri-menopausal bleeding while *C. aromatica* has been employed for the treatment of prurigo, bruise, arthritis and gastrointestinal disorders (Pongboonrod, 1979).

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MATERIALS AND METHODS

Plant Material

Rhizomes of *C. xanthorrhiza*, *C. aromatica* and *C. aeruginosa* from Nongkai province, Thailand were purchased at the Demonstration of Thai Traditional Medicine in January 2001.

Preparation of the Essential Oil

The oils were obtained by hydrodistillation of the fresh rhizomes for 5h in a Clevenger-type apparatus.

The oils were analyzed by capillary GC and GC/MS. GC analysis was performed using either a Fisons gas chromatograph Model 8000 series equipped with a FID detector and a DB-5 capillary column (30 m x 0.25 μm; film thickness 0.25 μm) or a Shimadzu GC17A gas chromatography equipped with a DB-Wax capillary column (60 m x 0.5 mm; film thickness 1μm). The operating conditions were as follows; (Fisons 8000) carrier gas: helium with a flow rate of 2 ml/min; column temperature: 50-220°C at 4°C/min: injector and detector temperatures: 230°C, (Shimadzu GC17A) carrier gas Helium, flow 5 ml/min, column temperature 50-220°C at 3°C/min, injector and detector temperatures: 220°C.

GC/MS analysis was performed on a V Quattro mass spectrometer operating at 70 eV ionization energy, equipped with a DB-wax column (60 m x 0.3 mm x 0.25 μm). The oven temperature was programmed from 35°C (5 min) to 220°C (45 min) at 3°C/min, with helium as carrier gas. The identification of the oil components was accomplished by comparison of their GC retention indices as well as their mass spectra with corresponding data of authentic compounds or published spectra (Heller and Milne, 1978, 1980, 1983; Adams, 2001).

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of the essential oils of the three *Curcuma* species. The different essential oils can be characterized as follows:

C. xanthorrhiza, yield 0.19% (fresh weight basis); 25 constituents accounting for 78.56% of total oil were identified and high amounts of 1,8-cineole (37.58%) and curzerenone (13.70%) were observed.

C. aromatica, yield 0.18% (fresh weight basis); 22 constituents accounting for 92.49% of total oil were identified and high amounts of camphor (26.94%) , ar-curcumene (23.18%), and xanthorrhizol (18.70%) were observed.

C. aeruginosa, yield 0.19% (fresh weight basis); 37 constituents accounting for 80.67% of total oil were identified and high amounts of curzerenone (41.63%), 1,8-cineole (9.64%) and β-pinene (7.71%) were observed.

Concerning the composition of the essential oils of *C. aromatica* and *C. aeruginosa*, our results showed good consistency with the data of the previous studies. Ar-curcumene (18.60%) and xanthorrhizol (25.70%) were the predominant components in the oil of *C. aromatica* from other origin (Zwaving and Bos, 1992). In addition, the essential oil of *C. aeruginosa* grown in China was characterized by high content of curzerenone.

As to the amount of xanthorrhizol, the essential oil from *C. xanthorrhiza* in our study contained no xanthorrhizol. Contrastingly, the essential oil from this plant found in Indonesia contained xanthorrhizol about 21.51% (Zwaving and Bos, 1992). Analyses of the essential oils of *C. xanthorrhiza* and *C. aeruginosa* showed the presence of similar primary components but in differing proportions.

A literature search on biological activities of the main components of three *Curcuma* species revealed the significant pharmacological properties of xanthorrhizol including antibacterial activity against *Streptococcus mutans* as well as antitumor effect. Essential oils with high content of xanthorrhizol might be regarded as a promising source of natural anticariogenic agents. The results of our study showed the interesting chemical profile of *C. aromatica* due to its high content of xanthorrhizol. Further investigation on essential oil constituents from *C. aromatica* of different sources should be continued on in order to find the variety with high xanthorrhizol content.

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Tables

Table 1. Percentage composition of the essential oils of *Curcuma* species.

Compounds	*C. xanthorrhiza*	*C. aromatica*	*C. aeruginosa*
α-pinene	0.78	0.53	1.46
camphene	0.17	2.03	0.34
β-pinene	0.72	0.15	7.71
δ- 3-carene	-	0.26	-
sabinene	-	-	0.22
myrcene	0.63	0.35	0.13
limonene	1.45	0.44	0.65
1,8-cineol	37.58	0.27	9.64
β-ocimene	0.10	-	-
p-cymene	2.33	-	-
terpinolene	3.11	-	-
2-heptanol	-	-	0.21
2-nonanone	-	-	1.10
α-p-dimethyl styrene	0.72	-	-
2-decanone	-	-	0.21
camphor	1.39	26.94	-
2-nonanol	0.70	-	2.04
linalool	-	0.56	0.23
trans-α-bergamotene	-	0.13	-
α-elemene	0.13	0.36	1.68
β-caryophyllene	0.36	-	0.32
α-farnesene	-	1.11	-
2-undecanone	-	-	0.76
terpinen-4-ol	0.84	-	-
myrtenol	-	-	0.43
β-elemene	-	0.14	0.21
trans-pinocarveol	-	-	0.19
humulene	-	1.91	0.28
isoborneol	0.44	2.27	0.58
α-terpineol	0.38	-	0.29
α-curcumene	-	0.80	-
α-terpineol	2.02	-	1.31
borneol	0.76	1.72	0.48
germacrene-D	-	-	0.50
β-bisabolene	-	-	0.22
δ-cadinene	-	-	0.42
β-sesquiphellandrene	-	-	0.57
β-curcumene	-	3.89	
ar-curcumene	-	23.18	1.01
germacrene B	-	0.94	0.51
p-cymene-8-ol	4.26	-	-
curzerene	-	1.38	1.08
caryophyllene oxide	1.03	-	0.32
humulene oxide	2.64	-	-
germacrone	0.25	0.31	0.99
T-cadinol	-	-	0.86
T-muurolol	-	-	1.15
curzerenone	13.70	3.82	41.63
α-cadinol	-	-	0.83
xanthorrhizol	-	18.70	-