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Chemical composition of essential oils of turmeric (*Curcuma longa* L.)

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The essential oils of leaves, flowers, rhizomes and roots of turmeric (*Curcuma longa* L., *Zingiberaceae*) were analysed by GC-MS. The major constituent of flower oil was *p*-cymene-8-ol (26.0%) while leaf oil was dominated by α-phellandrene (32.6%). The rhizomes and roots contained ar-turmerone (31.0% and 46.8%, respectively) as major constituents.

Keywords: *Curcuma longa* L. (*Zingiberaceae*), essential oil

Curcuma longa L. (*Zingiberaceae*) is an annual herb, the dried rhizomes of which are the commercial turmeric. It is widely used as a natural food colourant. The diaryl heptanoids present in the rhizomes are responsible for the colouring properties (1). The rhizomes exhibit a wide range of biological activities (2, 3) and are used in traditional medicines (4). The medicinal properties of rhizomes are related to the diaryl heptanoids and essential oil. The volatile and non-volatile constituents of rhizomes have been widely investigated (5–10). The composition of leaf oil originating from various geographic regions has also been reported by several authors (11–13). However, to the best of our knowledge, no information is available on the essential oil composition of flowers and roots of the plant. In this article, we report on the results of GC-MS analysis of the oils from flowers, leaves, rhizomes and roots of *Curcuma longa* L.

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EXPERIMENTAL

Flowers of *Curcuma longa* were collected from 4–5 months old plants grown at the experimental farm of the Indian Institute of Spices Research, Calicut (India), where a voucher specimen of the plant is available. Fresh flowers (340 g) were hydrodistilled at 100 °C in a Clevenger apparatus. The leaves, rhizomes and roots (100 g each) were collected from 7–8 months old plants and dried in shade up to a moisture content of 10% and then separately hydrodistilled. The essential oils obtained were collected and dried over anhydrous sodium sulphate and stored in a refrigerator till GC-MS analyses were carried out.

The component identification was achieved by the GC-MS analysis using a 5890-A GC (Hewlett-Packard, USA) equipped with a 5970-B mass selective detector. Helium was used as carrier gas and the sample was injected in splitless mode. Mass spectra were acquired over a 40–400 atomic mass units range. Compounds were identified by comparing the mass spectral data with those in the in-house library and with commercially available data (14).

Oil constituents were determined using an 8500 GC (Perkin-Elmer, USA) equipped with a FID detector. The oil sample was injected in splitless mode in a DB 5 column (30 m $\times$0.32 mm, 0.25 μm film thickness). Helium was used as carrier gas. The oven temperature was maintained at 40 °C for 5 min, then raised to 280 °C at a rate of 4 °C min^{-1} and maintained at 280 °C for 20 min.

RESULTS AND DISCUSSION

The yield and composition of the essential oils obtained from flowers, leaves, rhizomes and roots of *Curcuma longa* are given in Tables I and II, respectively. The roots yielded the highest concentration of oil (4.3%), followed by the rhizomes (3.8%).

As it is clear from Table II, there are remarkable quantitative differences in the composition of essential oils from different plant parts of turmeric. The essential oil from *Curcuma longa* flowers was composed of 60 constituents, of which 25 components, contributing to 48% of the oil, could be identified. The main constituent of the flower oil was *p*-cymen-8-ol (26.0%), followed by terpinolene (7.4%) and 1,8-cineole (4.1%). Two unidentified compounds contributed more than 5% of the oil.

Table I. Essential oil yield from Curcuma longa *L.*

Plant part	Essential oil yield (%)
Flowers[a]	0.3
Leaves[b]	1.3
Rhizomes[b]	3.8
Roots[b]	4.3

[a] Fresh mass basis
[b] Dry mass basis

Table II. Composition of essential oils of Curcuma longa *L.*

Component	Concentration(%)			
	Leaf	Flower	Root	Rhizome
α-Pinene	2.1	0.4	0.1	0.1
β-Pinene	2.8	0.1	0.1	tr
Myrcene	2.3	0.2	tr	0.1
α-Phellandrene	32.6	–	0.1	0.1
δ-3-Carene	1.1	0.6	–	–
α-Terpinene	1.3	0.1	–	–
p-Cymene	5.9	1.6	3.3	3.0
β-Phellandrene	3.2	tr	–	tr
1,8-Cineole	6.5	4.1	0.7	2.4
Z-β-Ocimene	0.2	–	–	–
E-β-Ocimene	0.4	–	–	–
γ-Terpinene	1.5	–	–	–
Terpinolene	26.0	7.4	0.1	0.3
Linalool	0.7	1.1	0.1	–
1,3,8-Paramenthatriene	0.2	0.3	–	–
p-Methylacetophenone	0.1	0.3	tr	tr
p-Cymen-8-ol	0.8	26.0	1.5	0.3
α-Terpineol	0.4	1.1	0.1	0.2
Thymol	0.3	–	0.1	–
Carvacrol	0.1	–	0.3	0.1
γ-Curcumene	0.1	tr	0.4	0.1
ar-Curcumene	0.2	1.9	7.0	6.3
α-Zingiberene	0.5	0.8	tr	tr
β-Bisabolene	–	0.9	2.3	1.3
β-Sesquiphellandrene	0.3	1.1	tr	2.6
E-Nerolidal	0.1	1.1	–	–
Dehydrocurcumene	–	–	4.3	2.2
ar-Turmerone	0.1	1.2	46.8	31.1
Turmerone	0.9	1.0	–	10.0
Curlone	0.2	0.3	0.6	10.6
Curcuphenol	tr	tr	0.6	0.5
6S,7R bisabolene	0.1	0.4	1.2	0.9
Other	9.0	48.0	30.3	27.8

Fifty-four components were detected in leaf oil, of which 30 compounds, which constituted 91% of the oil, could be identified. The major constituents found in the oil from leaves were α-phellandrene (32.6%), terpinolene (26.0%), 1,8-cineole (6.5%) and *p*-cymene (5.9%). The main constituent of the leaf oils from Nigeria (12), India (13), Vietnam (11) and Bhutan (10) chemotypes was α-phellandrene, although its relative content varied. The leaf oil of Nigerian origin contained a higher level of α-phellandrene (47.7%)

whereas the oils of Vietnam and Bhutan chemotypes had lower levels of α-phellandrene (24.5% and 18.2%, respectively). The terpinolene content of Nigerian oil (28.9%) was on par with our oil while that from Vietnam (5.5%) and Bhutan (11.6%) had lower levels. McCarron *et al.* (13) reported 56.7% α-phellandrene and 11.8% terpinolene from an Indian cultivar. The leaf oil from Vietnam and Bhutan, had higher contents of 1,8-cineole (15.9% and 14.6%, respectively), *p*-cymene (13.2% and 13.3%, respectively), and β-pinene (8.9% and 7.2%, respectively), in comparison with our oil. Our leaf oil contained the sesquiterpenes ar-turmerone, turmerone and curlone whereas these constituents were absent in the Nigerian chemotype.

The essential oil from roots contained 43 components, among which 24 compounds, accounting for 68.8% of the oil, were identified. The major portion of the oil was composed of ar-turmerone (46.8%), ar-curcumene (7.0%) and dehydro-curcumene (4.3%).

The essential oil from rhizomes was composed of 47 constituents of which, 24 compounds, contributing 70% of the oil, could be identified. The major components of rhizomes were ar-turmerone (31.1%), turmerone (10.0%), curlone (10.6%) and ar-curcumene (6.3%). Turmerone, one of the major constituents of rhizome oil was absent in roots whereas curlone was present in traces. δ-3-carene, α-terpinene, Z-β-ocimene, E-β-ocimene, γ-terpinene, 1,3,8-paramenthatriene and E-nerolidal could not be detected in the oils from rhizomes and roots.

CONCLUSIONS

This study showed more similarity in the composition of the essential oil from turmeric rhizomes and roots than in that from its leaves and flowers. However, *p*-cymene, 1,8-cineole, terpinolene, *p*-cymen-8-ol, α-terpineol, ar-curcumene, ar-turmerone, curlone and 6S,7R-bisabolene were present in varying levels in the oils from all parts of turmeric. It was seen that both the flower oil and leaf oil were dominated by monoterpenes while the major part of the oil from roots and rhizomes contained sesquiterpenes. It should be noted that this is the first report on the volatile oil composition of flowers and roots of *Curcuma longa* L. However, the minor constituents of flower and root oils still need to be characterised.

REFERENCES

1. V. Ravindranath and M. N. Satyanarayana, An unsymmetrical diarylheptanoid from *Curcuma longa*, *Phytochemistry* **19** (1980) 2031–2032.
2. N. M. Khanna, Turmeric – Nature's precious gift, *Curr. Sci.* **76** (1999) 1351–1356.
3. K. A. Saju, M. N. Venugopal and M. J. Mathew, Antifungal and insect repellent activities of essential oil of turmeric (*Curcuma longa* L.), *Curr. Sci.* **75** (1998) 660–662.
4. K. R. Kirtikar and B. D. Basu, *Indian Medicinal Plants*, Vol. IV, 3rd ed. (Eds. E. Blatter, J. F. Caius and K. S. Mhaskar) Goyl Offset Printers, Delhi 1984, pp. 2423–2426.
5. S. N. Garg, R. P. Bansal, M. M. Gupta and N. Sushilkumar, Variation in the rhizome essential oil and curcumin contents and oil quality in the land races of turmeric, *Curcuma longa* of North Indian Plains, *Flav. Fragr. J.* **14** (1999) 315–318.

6. J. H. Zwaving and R. Bos, Analysis of the essential oil of five *Curcuma* species, *Flav. Fragr. J.* **7** (1992) 19–22.
7. Y. Kisso, Y. Suzuki, Y. Oshima and H. Hikino, Stereostructure of curlone, a sesquiterpenoid of *Curcuma longa* rhizomes, *Phytochemistry* **22** (1983) 596–597.
8. S. D. Rakhunde, S. V. Munjal and S. R. Patil, Curcumin and essential oil contents of some commonly grown turmeric (*Curcuma longa* L.) cultivars in Maharashtra, *J. Food Sci. Tech.* **35** (1998) 352–354.
9. J. Ibrahim, A. S. Ahmad, N. A. M. Ali, A. R. Ahmad and H. Ibrahim, Chemical composition of rhizome oils of four *Curcuma* species from Malaysia, *J. Essent. Oil Res.* **11** (1999) 719–723.
10. R. K. Sharma, B. P. Misra. T. C. Sarma, A. K. Bordoloi, M. G. Pathak and P. A. Leclercq, Essential oils of *Curcuma longa* L. from Bhutan, *J. Essent. Oil Res.* **9** (1997) 589–592.
11. N. X. Dung, N. T. B. Tuyet and P. A. Leclercq, Constituents of the leaf oil of *Curcuma domestica* L. from Vietnam, *J. Essent. Oil Res.* **7** (1995) 701.
12. B. O. Oguntimein, P. Weyerstahl and H. M. Weyerstahl, Essential oil of *Curcuma longa* L. leaves, *Flav. Fragr. J.* **5** (1990) 89–90.
13. M. McCarron, A. J. Mills, D. Wittakar, T. P. Sunny and J. Verghese, Comparison of monoterpenes derived from green leaves and fresh rhizomes of *Curcuma longa* L. from India, *Flav. Frag. J.* **10** (1995) 355–357.
14. R. P. Adams, *Identification of Essential Oil Components by Gas Chromatography/ Mass Spectrometry*, Allured Publ. Corp., Carol Stream 1995.

SAŽETAK

Kemijski sastav eteričnih ulja kurkume (*Curcuma longa* L.)

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GC-MS metodom analizirana su eterična ulja listova, cvjetova, rizoma i korijena kurkume (*Curcuma longa* L., *Zingiberaceae*). Glavni sastojak cvjetova bio je *p*-cimen-8-ol (26.0%), a listova α-felandren (32.6%). Rizom i korijen sadržavali su ar-turmeron (31.0% odnosno 46.8%) kao glavni sastojak.

Ključne riječi: *Curcuma longa* L. (*Zingiberaceae*), eterično ulje

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