Original Article

# Comparative essential oil composition of different vegetative parts of *Hedychium spicatum* Smith. from Uttarakhand, India

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The volatile essential oil constituents of leaves, rhizomes and roots of *Hedychium spicatum* Smith. from Uttarakhand, India, were analysed by gas chromatography (GC) and GC-mass spectrometry (MS). A total of 39 constituents accounting for 78.7–96.4% of the oils were identified. The essential oils of the roots and rhizomes were marked by the presence of high amount of oxygenated monoterpenoids (60.9% and 65.9%, respectively). The most abundant oxygenated monoterpenoid of these oils was 1,8 cineole (48.7% and 64.0%, respectively). However, leaf oils obtained from two distinct locations, viz. "Song" and "Bhowali" were rich in monoterpene hydrocarbons (β-pinene 40.9%, α-pinene 9.6%) and oxygenated monoterpenoids (1,8 cineole 34.2%), respectively.

**Key words:** β-Pinene, 1,8-cineole, composition, essential oil, *Hedychium spicatum*

## INTRODUCTION

The genus *Hedychium*, comprising more than 50 species, belongs to family Zingiberaceae (ginger family). *Hedychium spicatum* Smith. syn *Hedychium album* Buch-Ham. ex Wall. is a leafy plant, up to 2 m tall, having strong aromatic horizontal rhizomes. It is commonly known as "Spiked Ginger lily" and "Kapoorkachari" (Indian trade name). The plant grows wild in the Himalayan region of India and Nepal at altitude of 1800–2800 m.[1,2] It is also widely cultivated in India and Southeast Asian countries for its fragrant rootstocks. The rootstocks have been widely used in traditional medicines for treatment of skin diseases, liver complaints, asthma, bronchitis, pains, hiccough, vomiting, and as analgesic, anti-inflammatory, blood purifier, anti-emetic. It is also used as a laxative, stomachic, carminative, stimulant, tonic to the brain and in diarrhoea.[3-5] The rootstocks have bitter camphor-like taste and a strong aromatic odour, with a wide application in incense and fragrant preparations. The ethanolic extract of the rhizomes is reported to possess anti-inflammatory, analgesic and hypoglycaemic activities.[6,7] The essential oil of rhizomes also exhibit anthelmentic, antimicrobial and antioxidant activities.[8,9] Previously, a variety of terpenoids (monoterpenoids, sesquiterpenoids and diterpenoids) have been reported from *H. spicatum*.[9-16] Most of the studies conducted on this plant are based on rhizome volatile and nonvolatile fractions; however, information on leaves and roots is very scanty. Therefore, considering the commercial aspects, we report in the present communication the comparative terpenoid composition of the different plant parts, viz. leaves, roots and rhizomes of *H. spicatum* collected from Uttarakhand Himalaya, India.

## MATERIALS AND METHODS

### Plant Material

The fresh plant material of *H. spicatum* was collected from two distinct locations, viz. Song (Bageshwar) and Bhowali (Almora) of Himalayan region of Uttarakhand, India, during the end of August 2009. The leaves, rhizome and roots were separated, cleaned and chopped. The rhizome and roots were crushed, while leaves were used as such for extraction of essential oil. The plant material was identified at the botany department of the centre. The voucher specimens of *H. spicatum* (CIMPANT 811 and CIMPANT 841) were deposited in the Herbarium of CIMAP, Research Centre, Pantnagar.

### Isolation of the Essential Oil

The fresh plant materials, viz. leaves, roots and rhizomes (200 g each) were subjected to hydro-distillation using Clevenger-type apparatus.[17] The percentage content was calculated on the basis of fresh weight of plant materials. The oils were dried over anhydrous $Na_2SO_4$ and stored in sealed vials under refrigeration prior to analysis.

### Gas Chromatography and Gas Chromatography-mass Spectrometry Analysis

The gas chromatographic (GC) analysis of the oil samples



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**Received:** 07-11-2009; **Accepted:** 03-07-2010; DOI: 10.4103/0973-8258.74141

**Table 1: Essential oil composition of *H. spicatum* collected from two different regions of Uttarakhand hills**

| Compounds* | RI[a] | RI[b] | RI[c] | Song Root oil | Rhizome oil | Leaf oil | Bhowali Leaf oil |
|---|---|---|---|---|---|---|---|
| α-Thujene | 932 | 931 | 1034 | – | – | t | t |
| α-Pinene | 941 | 939 | 1026 | 2.6 | 0.7 | 9.6 | 2.4 |
| Camphene | 954 | 953 | 1065 | 2.1 | t | 1.6 | 0.2 |
| Sabinene | 978 | 976 | 1117 | t | t | t | 5.0 |
| β-Pinene | 982 | 980 | 1105 | 8.9 | 1.6 | 40.9 | 9.3 |
| β-Myrcene | 994 | 991 | 1158 | 0.5 | 0.1 | 0.4 | t |
| α-Phellandrene | 1009 | 1005 | 1161 | t | t | t | t |
| α-Terpinene | 1019 | 1018 | 1177 | t | t | t | 0.5 |
| *p*-Cymene | 1029 | 1026 | 1271 | t | 0.1 | 0.5 | 6.7 |
| Limonene | 1034 | 1031 | 1185 | 1.5 | 0.4 | 1.3 | t |
| β-Phellandrene | 1037 | 1031 | 1206 | t | 0.3 | t | t |
| 1,8-Cineole | 1038 | 1033 | 1196 | 48.7 | 64.0 | 11.9 | 34.2 |
| (*Z*)-β-Ocimene | 1042 | 1040 | 1234 | t | t | 0.1 | 0.1 |
| (*E*)-β-Ocimene | 1054 | 1050 | 1246 | t | 0.1 | t | t |
| Terpinolene | 1089 | 1088 | 1278 | t | t | t | – |
| Linalool | 1101 | 1098 | 1553 | t | 0.5 | 0.3 | 3.0 |
| *(Z)-p*-Menth-2-en-1-ol | 1123 | 1121 | 1638 | 0.4 | 0.7 | 0.2 | t |
| Camphor | 1147 | 1143 | 1507 | t | t | 0.1 | t |
| Borneol | 1167 | 1165 | 1695 | t | 0.1 | – | 2.0 |
| Terpinen-4-ol | 1180 | 1177 | 1606 | t | 0.1 | 0.5 | 3.0 |
| α-Terpineol | 1192 | 1189 | 1682 | 11.8 | 0.2 | 0.2 | 1.0 |
| Bornyl acetate | 1285 | 1285 | 1585 | t | t | – | 0.4 |
| α-Copaene | 1374 | 1376 | 1481 | 0.2 | – | t | t |
| β-Cubebene | 1147 | 1351 | 1549 | t | t | t | 0.2 |
| β-Caryophyllene | 1418 | 1418 | 1594 | t | 0.1 | t | 3.3 |
| α-Humulene | 1457 | 1454 | 1675 | 0.2 | 0.2 | 0.2 | 0.5 |
| (*E*)-β-Farnesene | 1459 | 1458 | 1662 | – | t | 1.8 | 0.8 |
| γ-Muurolene | 1479 | 1477 | 1680 | t | 0.1 | 0.1 | t |
| Germacrene D | 1481 | 1480 | 1701 | t | – | t | 0.2 |
| β-Selinene | 1489 | 1485 | 1725 | 3.5 | 2.3 | 1.2 | t |
| δ-Selinene | 1496 | 1494 | – | 1.9 | 4.4 | 1.7 | t |
| Curzerene | 1500 | 1496 | – | t | t | t | 2.0 |
| Germacrene D-4-ol | 1578 | 1574 | 2069 | t | 1.5 | 0.7 | 3.2 |
| Spathulenol | 1579 | 1576 | 2143 | 0.2 | t | 0.3 | 0.6 |
| Caryophyllene oxide | 1584 | 1581 | 2004 | 0.4 | 1.3 | t | 2.0 |
| 10-epi-γ-Eudesmol | 1622 | 1619 | 2112 | 3.1 | 3.0 | 1.5 | 6.4 |
| *epi*-α-Cadinol | 1643 | 1640 | 2185 | 0.2 | 1.1 | 0.6 | 1.2 |
| β-Eudesmol | 1652 | 1652 | 2258 | 2.2 | 2.2 | 1.8 | 2.3 |
| α-Cadinol | 1655 | 1653 | 2254 | 0.6 | 2.4 | 1.0 | 5.9 |
| Class composition | | | | | | | |
| Monoterpene hydrocarbons | | | | 15.6 | 3.3 | 54.4 | 24.2 |
| Oxygenated monoterpenes | | | | 60.9 | 65.6 | 13.2 | 43.6 |
| Sesquiterpene hydrocarbons | | | | 5.8 | 7.1 | 5.0 | 7.0 |
| Oxygenated sesquiterpenes | | | | 6.7 | 11.5 | 5.9 | 21.6 |
| Total | | | | 89.0 | 87.5 | 78.5 | 96.4 |
| Essential oil (%) | | | | 0.21 | 0.43 | 0.16 | – |

*Mode of identification: RI, MS (GC-MS); [a]RI = On Rtx-5 (30 m × 0.25 mm); [b]RI = Literature values (Adams, 1995); [c]RI = On CP-Wax 52 CB (30 m × 0.32 mm); t = trace (<0.1%), compounds higher than 5.0% are highlighted in boldface

was carried out using a Nucon 5765 gas chromatograph equipped with dual flame ionisation detector (FID), using two different stationary phases, Rtx-5 (30 m × 0.25 mm i.d., 0.25 μm film coating) and CP-Wax 52 CB (30 m × 0.32 i.d., 0.25 μm film thickness) fused silica columns. Nitrogen and hydrogen were the carrier gases at 1.0 ml/min in nonpolar and polar columns, respectively. Temperature programming was from 70°C to 230°C at 4°C/min (CP-Wax 52 CB) and from 60°C to 210°C at 4°C/min (Rtx-5) with the initial hold time of 2 min. The injector and detector temperatures were 210°C and 220°C, respectively. The injection volume was 0.02 μl neat or 0.1 μl in hexane and split ratio was

1:30. The GC-mass spectrometry (MS) analysis of the oil was carried out using a Finnigan MAT PolarisQ ion trap mass spectrometer fitted with Rtx-5 fused silica capillary column (30 m × 0.25 mm; 0.25 μm film coating). The column temperature was programmed from 60°C to 210°C at 3°C/min using helium as a carrier gas at 1.0 ml/min. The injector temperature was 210°C, injection size 0.1 μl prepared in *n*-hexane, split ratio 1:40. Mass spectra were taken at 70 eV with mass scan range of 40–450 amu.

**Identification of Compounds**

The identification was done on the basis of Retention Index [RI; determined with reference to homologous series of *n*-alkanes ($C_9$–$C_{24}$, Polyscience Corp., Niles, IL, USA) under identical experimental conditions], co-injection with standards (Sigma) and MS Library search (NIST and WILEY), by comparing with the MS literature data.[18] The retention times of standards/marker constituents of known essential oils were also used to confirm the identities of constituents. The relative amounts of individual components were calculated based on GC peak area (FID response) without using correction factor.

## RESULTS AND DISCUSSION

The essential oil content found in fresh roots, rhizomes and leaves of *H. spicatum* was 0.21, 0.43 and 0.16%, respectively. The essential oil composition of different vegetal parts of *H. spicatum* has been analysed by GC and GC-MS. Thirty-nine compounds which accounted for 78.5–96.4% of the total composition of the oils were identified [Table 1]. The essential oil from roots of *H. spicatum* was marked by the presence of monoterpenoids (76.5%) with oxygenated monoterpenoids (60.9%) represented by 1,8-cineole (48.7%) and α-terpineol (11.8%) as major constituents. Monoterpene hydrocarbons constituted 15.6% of the total oil with β-pinene (8.9%), α-pinene (2.6%) and camphene (2.1%) as representative constituents. Like root oil, the rhizomes essential oil was also dominated by monoterpenoids (68.9%) with oxygenated monoterpenoids (65.9%) represented by 1,8-cineole (64.0%) and monoterpene hydrocarbons (3.3%) represented by β-pinene (1.6%) as the single major constituents. In addition to this, the rhizomes oil also had a significant amount of sesquiterpene alcohol (11.5%) compared to only 6.6% in root oil. α-Terpineol (11.8%) reported as one of the major constituents of root oil is present in rhizome oil in a very small amount (0.2%). Although the essential oil from the rhizomes had uniform qualitative composition compared to roots, they differed quantitatively in significant level without any correlation to the fact that both of them were collected from same plants at same level of vegetative growth. In contrast to oils from roots and rhizomes, the leaf essential oil was found to be dominated by monoterpene hydrocarbons (54.4%). The high percentage of pinenes (50.5%), viz. β-pinene (40.9%), α-pinene (9.6%), is the unique feature of the leaf essential oil composition of *H. spicatum*. The leaf essential oil contained only 11.2% of 1,8-cineole which is very low compared to 48.7 and 64.0% of root and rhizome oils, respectively. Interestingly, the leaf oil composition of Bhowali collection was found to be quite different from the leaves collected from Song. The major components of this oil were 1,8 cineole (34.2%), β-pinene (9.3%), 10-*epi*-γ-eudesmol (6.4%) and α-cadinol (5.9%).

Although the essential oils of the roots, rhizomes and leaves have almost uniform qualitative composition, they differ quantitatively up to a considerable level leading to variation in the distribution pattern of components in the essential oils of different plant parts, viz. roots, rhizomes and leaf of *H. spicatum* growing wild in Kumaon Himalayas.

## ACKNOWLEDGMENTS

The authors are grateful to Director, CIMAP, Lucknow (UP), India, for continuous encouragement and providing necessary facilities. The authors are also thankful to CSIR for providing the financial support.

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**Source of Support:** CSIR for providing the financial support, **Conflict of Interest:** None declared.