ISSN : 0974-7419 Volume 12 Issue 9

Trade Science Inc.

Analytical CHEMISTRY

An Indian Journal

Full Paper

ACAIJ, 12(9) 2013 [347-351]

Composition of volatile oil of sambul-ut-teeb (*Nardostachys jatamansi* DC.), an endangered species

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ABSTRACT

The hydro-distilled volatile oil of *Nardostachys jatamansi* rhizome was analyzed using GC and GC-MS. The volatile oil were consists of large number of sesquiterpenes (76.65 %) and aliphatic components (16.29 %) while monoterpenes (5.11 %) and diterpenes (1.48 %) were present in fewer amounts. Among twenty eight sesquiterpenes (76.65 %), seven were sesquiterpene hydrocarbons (2.22 %), sixteen were sesquiterpene alcohols (34.31 %), one sesquiterpene ketone (36.71 %), two oxides (0.15 %) and one each sesquiterpene ester (1.76 %) and sesquiterpene aldehyde (0.50 %). Prominent sesquiterpenes were α-cadinol (22.67 %), α-eudesmol (3.00 %), 5-neo-cedranol (2.51 %), muurolol (1.37 %) and jatamansone or valeranone (36.71 %). Among fourteen aliphatic components (16.29 %), there were six aliphatic hydrocarbons (1.47 %), three were aliphatic alcohols (0.47 %), one aliphatic aldehyde (0.04 %) and two each aliphatic esters (12.74 %), and aliphatic acids (1.57 %). Hexadecanoic ethyl ester and tetradecanoic acid (1.51 %) were the predominent among aliphatic components.

KEYWORDS

Nardostachys jatamansi;
Volatile oil;
GC-MS;
Sesquiterpenes;
Jatamansone.

INTRODUCTION

Nardostachys jatamansi DC. (commonly known as Sambul-ut-Teeb in Unani system of medicine), is a small, perennial, dwarf, hairy, rhizomatous, herbaceous, endangered and most primitive species within family valerianaceae (Tribe- Patrinaeae). The species has very long history of use as medicine in Ayurveda, Unani, Homeopathy, ethno medicine and Indian System of Medicine (ISM) to modern medicine industry which is distributed in the Himalayas from Pakistan, India (Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim) to Nepal, Tibet and China between 3300 to 5000 m asl. It has been reported that the species has become critically endangered depending on habitats due to over-exploitation of rhizomes for medicinal use, habitat degradation and other biotic interferences[1]. There are two species, *N. jatamansi* and *N. chinensis* widespread throughout the northern part of alpine to sub alpine Himalayan region at an altitude of 3000- 5000 m. The rhizome is the source of Spikenard oil. Traditionally, jatamansi is used as tonic, stimulant and antiseptic and also used for the treatment of epilepsy, hysteria, convolutions, heart palpitation, intestinal colic and antiarrhythmic activities[2].

The principal constituents of *N. jatamansi* are essential oil (0.5-2%), rich in sesquiterpenes and coumarins[3]. Jatamansone or valeranone is the princi-

pal sesquiterpene[3,4]. Other sesquiterpenes include nardostachone, dihydrojatamansin, jatamansinol, jatamansic acid[5]; jatamansinone, jatamansinol, oroseolol, oroselone, seselin, valeranal, nardostachyin[6], spirojatamol, patchouli alcohol, jatamol A and B, jatamansic acid, nardostachone, nardol and other constituents are resin, sugar, starch, bitter extractive matter and gum[7]. Various extracts and volatile oil of *N. jatamansi* was reported to exhibit hypotensive action in dogs[8], antidepressant[9,10], antioxidant[11], GABA enhancing[12,13], cardio-protective and hypolipidemic[14,15], hepatoprotective[16], anticonvulsant[17,18], antiarthritic[19], antipyretic[20], antistress[21], antimicrobial, antifungal, insecticidal[22,23], gastrointestinal tract disorders[24], acetyl cholinesterase inhibitory[25], antiparkinson's[26], neuroprotective[27], fungistatic and fungitoxic[28] and tranquillizing activities[29]. The aim of this paper is to identify the chemical composition of the essential oil of *Nardostachys jatamansi* rhizomes by GLC and GC-MS analysis.

MATERIAL AND METHODS

Collection of plant material and authentication

The rhizomes of *Nardostachys jatamansi* were purchased from Samsi Dawakhana, Ballimaran, Delhi and authenticated by Dr. H.B. Singh, Scientist F and Head, Raw Materials Herbarium and Museum, National Institute of Science Communication and Information Resources (NISCAIR), New Delhi. Voucher specimen of drug was deposited in the Raw Materials Herbarium and Museum, National Institute of Science Communication and Information Resources (NISCAIR), New Delhi, with reference number Ref. NISCAIR/RHMD/consult/-2010-11/1705/05.

Isolation of volatile oil

The drug (200 gm) was hydro-distilled for six hours with Clevenger apparatus. The yield of volatile oil obtained was 0.7 % v/w. The light green coloured volatile oil was collected in the graduated tube. The collected volatile oil was dried over anhydrous sodium sulphate and stored at 4^0C in the dark.

GC analysis

The gas chromatographic analysis of the volatile oil was carried out on Shimadzu 2010 Gas Chromatograph (Japan) equipped with a flame ionization detector (FID) and AB-Innowax 7031428 WCOT fused capillary column (60 m x 0.25 mm x 0.25 μm). The injector and detector (FID) temperatures were maintain at 250 and 270 ºC, respectively. The carrier gas used was nitrogen at a flow rate of 1.21 mL/min with column pressure of 155.1 kPa. The sample (0.2 μl) was injected into the column with a split ratio of 80:1. Component separation was achieved following a linear temperature programmed from 60-230 ºC at a rate of 3 ºC/min and then held at 230 ºC for 9 min, with a total run time of 55.14 min. Percentage of the constituents were calculated by electronic integration of FID peak areas.

GC-MS analysis

The analysis of the volatile constituents were run on a Shimadzu QP-2010 GC-MS system equipped with AB-Innowax 7031428 WCOT column (60 m x 0.25 mm x 0.25 μm) directly coupled to the MS. The carrier gas was helium with a flow rate of 1.21 mL/min. oven temperature was programmed as 50 ºC for 1 min and subsequently held isothermal for 2 min. injector port: 250 ºC, detector: 280 ºC, split ratio 1:50, volume injected: 1 μL of the oil. The recording was performed at 70 eV, scan time 1.5 s; mass range 40-750 amu. Software adopted to handle mass spectra and chromatograph was a Chem station.

Identification

The individual peaks/constituents were identified by gas chromatography by comparison of their retention indices (R.I.) either with those of authentic compounds available in author's laboratory or with those of literature in close agreement to R.I.[30-36]. Further identification was made by comparison of fragmentation pattern of mass spectra obtained by GC-MS analysis with those stored in the spectrometer database of NBS 54 K.L, WILEY8 libraries and published literature[20-26]. Retention indices of the components were determined relative to the retention times of a series of n-alkanes relative to C_9-C_{20} on HPS and HP-20M columns.

RESULTS AND DISCUSSIONS

The volatile oil of *Nardostachys jatamansi* con-

sists of large number of sesquiterpenes (76.65 %) and aliphatic components (16.29 %) while monoterpenes (5.11 %) and diterpenes (1.48 %) were present in fewer amounts as given in the previous reports[3-5].

Among three monoterpenes, two were monoterpene hydrocarbons (0.38 %), α-pinene and γ-elemene and one monoterpene ester, eugenyl valerate (4.72 %). Among twenty eight sesquiterpenes (76.65 %), seven were sesquiterpene hydrocarbons (2.22 %), sixteen were sesquiterpene alcohols (34.31 %), one sesquiterpene ketone (36.71 %), two oxides (0.15 %) and one each sesquiterpene ester (1.76 %) and sesquiterpene aldehyde (0.50 %). The sesquiterpene hydrocarbons were consists of α-panasinsen (0.56 %), alloaromadendrene (0.38 %), aromadendrene (0.14 %),α-selinene (0.16 %), β-gurjunene (0.68 %), α-humulene (0.20 %) and patchaulene (0.10 %). Among sixteen sesquiterpene alcohols, there were α-cadinol (22.67 %), α-eudesmol (3.00 %), 5-neo-cedranol (2.51 %), muurolol (1.37 %), vomifoliol (1.10 %), epi-(E)-caryophyllene-9-ene-14-ol (0.83 %), ledol (0.59 %), spethulenol (0.42 %), cubenol (0.2 %), β-eudesmol (0.17 %) and the other sesquiterpene alcohol were found in very less amount e.g. nerolidol (0.08 %), globulol (0.09 %), α-bisabolol (0.03 %) and (2Z,6E)-farnesol (0.2 %). Jatamansone or valeranone (36.71 %) was the predominant sesquiterpene ketone of the volatile oil[37]. Sesquiterpene oxides were present in less amount, caryophyllene oxide (0.13 %) and himachalene oxide (0.02 %). The only one sesquiterpene ester and sesquiterpene aldehyde was (2Z,6E)-farnesyl acetate (1.76 %) and cis-farnesal (0.50 %), respectively.

Among fourteen aliphatic components (16.29 %), there were six aliphatic hydrocarbons (1.47 %), three aliphatic alcohols (0.47 %), one aliphatic aldehyde (0.04 %) and two each aliphatic esters (12.74 %), and aliphatic acids (1.57 %). Hexadecanoic ethyl ester and tetradecanoic acid (1.51 %) were the predominent among aliphatic components. The other aliphatic components were in fewer amounts *e.g.* hexadecanol (0.04 %), methyl heptadecane (0.11 %), n-pentadecanol (0.28 %), n-octadecane (0.06 %), 3-methyl octadecane (0.51 %), n-nonadecane (0.05 %), n-eicosane (0.63 %), octadecanol (0.06 %) and n-heneicosane (0.11 %). There were three diterpenes consisting of menoyl oxide (0.04 %), manool (0.37 %) and phytol (1.07 %). There were ten unknown (1.23 %) found in volatile oil.

TABLE 1 : Volatile oil constituents of *Sambul-ut-Teeb* (*Nardostachys jatamansi DC.*).

S. No	Components	Per cent (%)	Kovats index
1.	α-Pinene	0.07	933
2.	β-Patchoulene	0.10	1378
3.	β-Gurjunene	0.68	1413
4.	γ-Elemene	0.31	1433
5.	α-Humulene	0.20	1436
6.	Aromadendrene	0.14	1445
7.	Alloaromadendrene	0.38	1465
8.	α-Selinene	0.16	1473
9.	α-Panasinsen	0.56	1518
10.	Nerolidol	0.08	1561
11.	Ledol	0.59	1565
12.	Spathulenol	0.42	1575
13.	1-Caryophyllene oxide	0.13	1581
14.	Globulol	0.09	1585
15.	Himachelene oxide	0.02	1610
16.	Cubenol	0.20	1614
17.	β-Eudesmol	0.17	1630
18.	α-Cadinol	22.67	1641
19.	α- Eudesmol	3.00	1649
20.	Muurolol	1.37	1655
21.	Bulnesol	0.46	1664
22.	Jatamansone or Valeranone	36.71	1667
23.	Epi-(E)-caryophyll-9-en-14-ol	0.83	1673
24.	n-Tetradecanol	0.13	1679
25.	α-Bisabolol	0.03	1685
26.	Eudesma-3,5-dien-1-ol	0.46	1691
27.	5-neo-Cedranol	2.51	1699
28.	*cis*-Farnesal	0.50	1705
29.	Hexadecanal	0.04	1712
30.	(2Z,6E)-Farnesol	0.20	1715
31.	Eugenyl valerate	4.72	1718
32.	Methyl heptadecane	0.11	1734
33.	n-Pentadecanol	0.28	1776
34.	Tetradecanoic acid	1.51	1777
35.	n-Octadecane	0.06	1795
36.	(2Z,6E)-Farnesyl acetate	1.76	1824
37.	Vomifoliol	1.10	1837
38.	7-Hexadecenoic ethyl ester	1.49	1842
39.	3-Methyl octadecane	0.51	1873
40.	n-Nonadecane	0.05	1896
41.	Hexadecanoic acid	0.06	1923

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S. No	Components	Per cent (%)	Kovats index
42.	Hexadecenoic ethyl ester	11.25	1966
43.	Menonyl oxide	0.04	1998
44.	n-Eicosane	0.63	2001
45.	Octadecanol	0.06	2080
46.	n-Heneicosane	0.11	2102
47.	Manool	0.37	2105
48.	Unknown	0.35	-
49.	Phytol	1.07	2011
50.	Unknown	0.34	-
51.	Unknown	0.21	-
52.	Unknown	0.07	-
53.	Unknown	0.07	-
54.	Unknown	0.09	-
55.	Unknown	0.21	-
56.	Unknown	0.04	-
57.	Unknown	0.04	-
58.	Unknown	0.05	-
59.	Unknown	0.11	-

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