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Comparison of Essential oil Composition of Three Ginger Cultivars from Sub Himalayan Region

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ABSTRACT

Objective: To investigate and compare the essential oil constituents of three most popular cultivars from sub Himalayan region namely, gorubathane, shingboi and thingria. **Methods:** Volatile oils were isolated using Clevenger trap and characterized by analytical gas chromatography and gas chromatography–mass spectroscopy. **Results:** Eighty one constituents accounting for 95.24%, 97.1% and 97.03% of the gorubathane, shingboi and thingria oils respectively, were identified. **Conclusions:** The major compounds of gorubathane oil were zingiberene (32.2%) and β -sequiphellandrene (10.9%). The main constituents in thingria oil were zingiberene (12.58%) and ar-curcumene (9.89%) and of shingboi oil were geranial (20.07%) and neral (9.44%). This is the first report on the essential oils composition of three Sub Himalayan ginger cultivars.

1. Introduction

The Ginger (*Zingiber officinale* Rosc) is an herbaceous perennial aromatic plant belongs to the family Zingiberaceae, mostly distributed in East Asia and tropical Australia, the rhizomes of which are used as a spice [1]. Dried and fresh ginger has been used in Indian traditional medicine for relief from arthritis, rheumatism, sprains, muscular aches and pains, congestion, coughs, sinusitis, sore throats, diarrhoea, indigestion, loss of appetite, fever, flu, etc. The oil of *Z. officinale* has been studied for chemical and pharmacological activities and it was reported that zingiberene, β -sesquiphellandrene and ar-curcumene are the major constituents in most of the rhizome oils. These ginger oils showed good anticancer and antiinflammatory properties [2–5]. Some ginger species are high in sesquiterpene hydrocarbons and relatively low in monoterpene hydrocarbons while others have the opposite proportions. Another study on the ginger essential oil showed that it is rich in monoterpenoid compounds with camphene, geranial and geranyl acetate as main constituents [6]. The species under study is Sub Himalayan ginger cultivars namely gorubathane, shingboi and thingria,

the chemical composition of these gingers not yet studied so far.

2. Materials and Methods

2.1. Plant material

The ginger cultivars were collected through Sikkim Marketing Federation (SIMFED) and Horticultural department (Sikkim). The specimens were deposited in the herbarium (NIIST) and the voucher numbers are G.10234, 10235, and 10236.

2.2. Isolation of volatile oil

The rhizomes of three ginger cultivars were separately scrubbed and washed to remove the sand and other foreign particles and dried in the oven at $48^{\circ}\text{C} \pm 2^{\circ}\text{C}$ to a moisture content of 10%. Rhizomes were carefully milled to 20–40 mesh size particles and the samples (50 g) were hydro-distilled for 5 hrs in a Clevenger-type apparatus to get the oils. After drying over anhydrous sodium sulphate the oils were analyzed by GC and GC–MS. Analysis was carried out in triplicate.

2.3. GC analysis

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The GC analysis was carried out in a Hewlett–Packard GC (model 5890–II) equipped with an electronic integrator. Methyl silicone column (50 m x 0.2 mm, 0.17 μ m) was used for the analysis. The conditions used were as follows: temperature programming from 80–200°C at the rate of 5°C/min, held at 200°C for 15 min, flame ionisation detector(F.I.D) temperature 300°C, injection temperature 250°C, carrier gas: nitrogen at a flow rate of 1 mL/min, split ratio of 1:75.

2.4. GC–MS analysis

GC–MS analysis was carried out in a Hewlett–Packard GC (Model No 5995) coupled with mass spectrometer under the following conditions: GC column and conditions were the same as in the capillary GC analysis. MS conditions were as follows: electron impact, ionizing voltage 70 eV, source temperature 150°C, electron multiplier at 2000 eV, scan speed 690 amu/s and scan 40–500 amu.

2.5. Identification of compounds

Table 1.

Chemical composition of three ginger cultivars from sub Himalayan region.

Sl No	Component	Gorubathane(%)	Shingboi (%)	Thingria (%)	RI a	Identification
1	Tricyclene	0.03	–	0.1	926	MS b, RI
2	α –pinene	1.04	1.21	0.8	943	MS, RI
3	Camphene	2.5	2.54	1.9	954	MS,RI
4	2–heptanol	–	Tr c	–	957	MS,RI
5	Sabinene	0.99	1.42	1.58	976	MS,RI
6	Octenal	0.1	0.06	0.5	978	MS,RI
7	β –Myrcene	0.4	0.1	0.1	986	MS,RI
8	6–Methyl–5–hepten–2–one	0.2	0.3	–	994	MS,RI
9	α –phellandrene	0.24	1.02	1.5	1000	MS,RI
10	δ –3–carene	0.1	0.1	0.76	1003	MS,RI
11	α –terpinene	0.4	0.4	0.4	1008	MS,RI
13	p–cymene	0.2	1.09	1.34	1019	MS,RI
14	β –phellandrene	0.2	2.53	1.4	1021	MS,RI
15	1,8 cineole	–	0.2	0.5	1027	MS,RI
16	d–limonene	–	0.79	–	1030	MS,RI
17	γ –terpinene	Tr	0.82	0.7	1057	MS,RI
18	Trans–Linalool oxide	0.1	Tr	Tr	1081	MS,RI
19	Linalool	Tr	0.1	0.5	1089	MS,RI
20	2–nonanol	Tr	0.1	0.4	1092	MS,RI
21	Undecanone	Tr	Tr	Tr	1100	MS,RI
22	Citronellol	Tr	Tr	0.1	1117	MS,RI
23	Citronellal	Tr	1.3	0.67	1125	MS,RI
24	Camphor	Tr	0.5	0.3	1133	MS,RI
25	Sabinol	Tr	0.1	0.2	1137	MS,RI
26	Iso borneol	–	0.1	Tr	1154	MS,RI
27	Borneol	0.1	0.2	0.1	1164	MS,RI
28	Terpinen–4–ol	Tr	0.2	Tr	1174	MS,RI
29	α –terpineol	0.5	0.5	0.5	1184	MS,RI
30	Myrtenol	Tr	–	–	1196	MS,RI
31	Nerol	0.4	1.1	1.5	1218	MS,RI
32	Neral	2.64	9.44	3.62	1227	MS, RI
33	Carveol	Tr	1.02	Tr	1231	MS,RI
34	Geraniol	0.62	1.06	1.13	1240	MS,RI
35	Linalyl acetate	–	0.85	0.97	1244	MS,RI
36	Geranial	5.86	20.07	6.72	1255	MS, RI

Compounds were identified by comparing retention indices/ comparing mass spectra of each compound with those of authentic samples and library (NIST), and literature [7,8].

3. Result

The yield of essential oil from the gorubathane, shingboi and thingria cultivars were 3.8%, 3% and 1.8% respectively. The chemical composition of ginger oils were shown in Table 1. The major constituents of shingboi ginger oil were geranial (20.07%), neral (9.44%) and ar–curcumene (6.56%). The gorubathane oil was rich in zingiberene (32.2%), β –sequiphellandrene (10.9%) and geranial (5.86%). Whereas thingria oil mainly contains zingiberene(12.58%), ar–curcumene(9.89%), β –sesuiphellanrene(9.4%) , β –bisabolene(7.18%)and geranial(6.72%). classifications of compounds in the volatile oils shown in Table 2.

37	Bornyl acetate	Tr	0.4	–	1268	MS,RI
38	2-undecanone	Tr	0.3	0.65	1276	MS,RI
39	Undecanal	Tr	0.2	–	1284	MS,RI
40	Neric acid	0.25	0.5	–	1316	MS,RI
41	Neryl acetate	0.5	1.69	2.89	1342	MS,RI
42	Geranic acid	0.1	–	–	1362	MS,RI
43	Geranyl acetate	0.1	0.1	0.1	1367	MS,RI
44	δ -elemene	0.2	Tr	0.81	1384	MS, RI
45	α -copaene	0.1	Tr	–	1400	MS,RI
46	β -elemene	0.2	0.1	0.31	1403	MS,RI
47	γ -elemene	0.3	0.1	0.2	1423	MS,RI
48	α -bergamotene	1.3	0.5	3.04	1436	MS,RI
49	(E)- β -farnesene	2.2	0.8	1.1	1447	MS,RI
50	Thujopsene	0.3	0.3	0.1	1451	MS,RI
51	α -guaiene	0.3	0.2	0.1	1456	MS,RI
52	ar-curcumene	4.7	6.56	9.89	1472	MS,RI
53	germacrene-d	0.5	0.1	–	1479	MS, RI
54	Zingiberene	32.2	5.74	12.58	1487	MS,RI
55	α -muurrolene	1.2	Tr	0.6	1490	MS,RI
56	(E,E)- α -Farnesene	7.02	6.29	2.74	1497	MS,RI
57	β -bisabolene	1.3	5.91	7.18	1504	MS,RI
58	β -sesquiphellandrene	10.9	6.17	9.4	1515	MS,RI
59	δ -cadinene	0.2	0.8	0.2	1523	MS,RI
60	Z-nerolidol	1.5	1.06	1.34	1526	MS, RI
61	Elemol	1.1	1.20	0.8	1540	MS,RI
62	Eudesma-3,7(11)-diene	0.9	1.89	Tr	1542	MS,RI
63	E-nerolidol	0.9	1.00	1.34	1553	MS,RI
64	Cubenol	0.51	0.4	0.86	1560	MS,RI
65	β -guaiacol	0.3	Tr	0.61	1599	MS,RI
66	Sesquisabinene hydrate	0.9	Tr	0.1	1605	MS,RI
67	epi- α -cedrenol	0.3	0.2	0.1	1609	MS,RI
68	Cedre-8-en-13-ol	0.4	0.1	0.2	1612	MS,RI
69	Zingerone	0.3	0.1	0.6	1625	MS,RI
70	α -muurolol	0.64	0.2	0.92	1630	MS,RI
71	β -bisabolol	0.3	0.9	1.14	1650	MS,RI
72	Eudesma-7(11)-en-4-ol	0.7	0.1	0.57	1655	MS,RI
73	Z- α -bergamotol	0.77	0.3	0.57	1692	MS,RI
74	Z,Z-farnesol	0.5	1.15	0.92	1693	MS,RI
75	Z,E-farnesol	1.78	1.0	1.12	1699	MS,RI
76	E,E,Farnesol	0.67	0.9	0.6	1749	MS,RI
77	Tras- α -bisabolene epoxide	0.73	0.1	0.87		MS
78	Farnesene epoxide	0.54	0.3	0.77		MS
79	(Z)-lanceol	0.55	0.1	0.3	1763	MS,RI
80	Curcumenyl acetate	0.4	–	–	1801	MS,RI
81	Cinnamyl cinnamate	0.06	–	0.03	2057	MS,RI
	Total	95.24%	97.10%	97.03%		

a: Retention Index, b: Mass Spectra, c: Trace (<0.1%)

Table 2.

Classifications of compounds in the volatile oils of ginger cultivars

Classes of compounds	Gorubathane(%)	Shingboi(%)	Thingria (%)
Monoterpene hydrocarbons	6.1	12.02	13.73
Oxygenated monoterpenes	11.47	40.39	21.35
Sesquiterpene hydrocarbons	63.82	35.46	48.25
Oxygenated sesquiterpenes	13.85	9.23	13.73

4. Discussion

The ginger oil from different places had their on similarities

and variations. The oil from Ghana, Thailand, Poland, Nigeria, Australia and India reported zingiberene as the main compound along with other sesquiterpene hydrocarbons [9], whereas the oil from Cuba and Brazil contained ar-

curcumene as the main compound [10]. A recent study on Sikkim ginger cultivars namely bhaisa and majulay showed that variation in volatile oil composition between two. The bhaisa oil had major compounds geranyl acetate (18.8%), zingiberene (16.3%) and geranial (8.2%) and Majulay oil rich in zingiberene (19.8%) and geranial (16.5%). The Bhaisa oil had higher content of oxygenated compounds (43.1%) than the other one [11]. The geographic origin, the maturity at harvest and the agro climatic conditions influence the chemical composition of different ginger varieties. Ginger cultivars growing in different areas generally named as the localities where they are grown. Some of the prominent indigenous cultivars in India are Maran, Kuruppampadi, Ernad, Wynad, Himachal and Nadia.

The three of ginger cultivars (gorubathane, shingboi and thingria) from sub Himalayan region had their own unique composition. The % of yield of essential oil was highest in gorubathane cultivar lowest in thingria. The most abundant compound in the shingboi cultivar was geranial and that of gorubathane and thingria was zingiberene. The geranic acid and curcumenyl acetate were only present in gorubathane oil. One of the important constituent of ginger oils, viz α -limonene found only in shingboi ginger oil even though it is present in lesser amounts. The contents of nerol, geranial, β -bisabolene, 2-undecanone, neryl acetate are more in shingboi and thingria oils compared to gorubathane oil. In the case of epoxides 1, 8- cineole is absent in gorubathane oil and present in other two cultivars (shingboi) and (thingria). The farnesene epoxide was present in all three cultivars in amounts less than 1%. The monoterpene ketone, camphor is present in shingboi (0.5%) and thingria oils (0.3%) but only a trace amount in gorubathane oil (<0.1%).

The sesquiterpene alcohols such as farnesols, nerolidols and eudesmol found in all the three ginger cultivars. The total farnesol content between the three cultivars varies in the order shingboi>gorubathane>thingria. Farnesol has been suggested to function as a chemopreventative and anti-tumour agent [12]. The % of nerolidols (Z&E) content was more in thingria oil (2.68%) than gorubathane (2.4%) and shingboi (2.06%). Gorubathane ginger oil had highest amount of eudesma-7(11) en-4-ol (0.7%) and Z- α -bergamotol(0.77%) compared to other two cultivars.

The three ginger cultivars were rich in sesquiterpene hydrocarbons, especially gorubathane and thingria cultivars. But the shingboi oil mainly contained oxygenated derivatives of mono terpene hydrocarbon (Table 2). It is observed that more than 75% of gorubathane ginger oil composed of sesquiterpene compounds while 52.5% of shingboi oil is constituted of monoterpene compounds. Thingria ginger oil has 62% sesquiterpene compounds. The monoterpene compounds was maximum (52.4%) in shingboi oil and lowest in gorubathane oil (17.5%). The odour profile of ginger oils also varies as per composition. The three sub Himalayan ginger cultivars showed some deviation and similarities in their volatile oil composition.

Conflict of interest statement

We declare that we have no conflict of interest.

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