FLAVOUR AND FRAGRANCE JOURNAL
Flavour Fragr. J. 2000; **15**: 23–26

The essential oils of *Ocimum canum* Sims (basilic camphor) and *Ocimum urticifolia* Roth from Zimbabwe

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Received 30 September 1998
Revised 21 September 1999
Accepted 30 September 1999

ABSTRACT: Plant materials from *Ocimum canum* Sims (basilic camphor) and *Ocimum urticifolia* Roth (Labiatae) from Zimbabwe were collected from the wild and steam-distilled or hydrodistilled. The *O. canum* oil contained 25% (w/w) of precipitated camphor and the decamphorated oil contained camphor (39.5–39.8%), limonene (24.4–25.1%), β-caryophyllene (7.0–7.2%), camphene (6.5–6.7%) and estragole (6.4–6.6%) as the major components. The oil obtained from air-dried plant material contained camphor (57.6%), limonene (16.3%), β-caryophyllene (6.4%) and camphene (5.4%) as the main components. The oil obtained by steam distillation of the fresh and air-dried plant material from *O. urticifolia* contained α-farnesenes (8.1–21.7%), linalol (4.9–19.7%), β-ocimenes (6.5–15.2%), eugenol (2.3–20.0%), elemicine (1.3–12.5%), camphor (1.4–11.7%) and β-elemene/β-caryophyllene (11.8–15.8%) as the major components, whilst oil from the hydrodistilled plant material contained linalol (23.2%), β-elemene/β-caryophyllene (11.7%), α-farnesenes (12.2%) and elemicine (7.1%) as the major components. Plants belonging to the family Labiatae are chief sources of essential oils and offer potential for cultivation in rural agriculture. Neither species has been previously reported from Zimbabwe. Copyright © 2000 John Wiley & Sons, Ltd.

KEY WORDS: *Ocimum canum* Sims; *Ocimum urticifolia* Roth; Labiatae; wild plants; Zimbabwe; essential oil composition; GC–MS; camphor; limonene; linalol; eugenol; farnesene; ocimenes; elemicine

Introduction

Ocimum canum Sims (basilic camphor) (syn. *O. kilimandscharicum* Guerke) and *Ocimum urticifolia* Roth (Labiatae) are two *Ocimum* species growing wild in Zimbabwe and South Africa and are used in traditional medicine in Southern and Eastern Africa.[1–3] The genus *Ocimum* contains a number of species: *Ocimum basilicum*, *Ocimum canum* and *Ocimum gratissimum* L., and varieties which have become a source of numerous raw materials for the flavour/fragrance and pharmaceutical industries.[4] Chemotypic varieties, containing linalol, eugenol, estragole, camphor, methyl chavicol, methyl cinnamate, β-caryophyllene, *trans*-α-bergamotene, α-terpinoel, germacrene-D, thymol, fenchone, *p*-cymene and 1,8-cineol as major components, have been reported in India, East Asia, Europe, North, West and Central Africa and in America.[5–20] *O. canum* Sims (basilic camphor) has been reported in Somalia for its essential oils, flavones and triterpenic acids and is used for flavouring foods and in traditional medicine.[22,23] In South Africa, it is often referred to as camphor basil.[1] In Zimbabwe, its traditional uses range from flavour and fragrance, to insect repellant and as a preservative for corpses.[1–3,21] It is a resilient shrub unattacked by most plant pests and animal predators. *O. canum* is also grown in parts of India for the flavour and fragrance industry and as a source of natural camphor, since the plant was first introduced there from Kenya in the Second World War.[24] Camphor yields of 80.5% (v/w) have been reported in the Indian variety *O. kilimandscharicum* (Guerke). Studies of the total oil composition by hydrodistillation has been limited in the past due to subliming camphor depositing in condensers and collection vessels.

Ntezurubanza reported eugenol, methyleugenol and methylisoeugenol chemotypes in *O. urticifolia* from Rwanda.[25] In Zimbabwe, *O. urticifolia* is often found in

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Contract grant sponsor: IDRC.
Contract grant sponsor: University of Zimbabwe Research Board.

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Table 1. Percentage composition of the oil of *O. canum* Sims (basilic camphor)

No.	Component (GC–MS)	KI	A (%) Fresh material (3 batches)	B (%) Air-dried material (1 ×)*
1	Tricyclene	1005	0.2	0.2
2	α-Pinene	1032	1.9–2.2	1.7
3	**Camphene/α-thujene**	**1083**	**6.5–6.7**	**5.4**
4	β-Pinene/α-fenchene	1124	0.1	0.1
5	Sabinene	1130	tr–0.1	tr
6	Myrcene	1164	1.7–2.4	0.1
7	α-Terpinene	1182	0.2–0.3	1.4
8	**Limonene**	**1204**	**24.4–25.1**	**16.3**
9	1,8-Cineole	1228	0.6–0.7	–
10	(*E*)-β-Ocimene	1240	tr–0.1	–
11	γ-Terpinene	1248	0.5–0.6	0.4
12	(*Z*)-β-Ocimene	1260	tr–0.1	–
13	*p*-Cymene	1273	0.5–0.6	–
14	Terpinolene	1290	tr–0.1	1.1
15	**Camphor**	**1514**	**39.5–39.8**	**57.6**
16	Linalol	1557	0.1–0.2	0.2
17	**β-Caryophyllene**	**1596**	**7.0–7.2**	**6.4**
18	Terpinen-4-ol	1609	0.2–0.3	0.4
19	**Estragole**	**1650**	**6.4–6.6**	**4.2**
20	α-Terpineol	1690	0.4–0.5	1.2

tr = traces (⩽0.05%); A = decamphorated oil; B = full oil; *steam distillation with cohobation, Laboratoire des Huiles Essentielles de Clermont; KI = Kováts indices on CP WAX 52 CB capillary column.

similar habitats with *O. canum* Sims (basilic camphor) in the semi-arid regions but with relatively rich soils. The young plants from both species are often morphologically indistinguishable from each other. Mature plants of *O. urticifolia* may, however, grow up to 2 m high and have larger mint-scented purplish green leaves. The plant is often referred to in South Africa as *Zulu* basil.[1] We report on the essential oil composition of the two plants from Zimbabwe in a pilot study to domesticate and cultivate indigenous essential oil plants with commercial potential for the flavour/fragrance and pharmaceutical industries, and for use in aromatherapy.[26]

Experimental

Plant Material and Volatile Oil Isolation

The flowering and mature aerial plant materials of *O. canum* and *O. urticifolia* were collected from homestands of Chagonda village in Gutu in the summer between December and March. The plants were identified at the National Herbarium and Botanic Gardens in Harare and voucher specimens deposited. Initial hydrodistillation in an all-glass Clevenger-type apparatus of *O. canum* was abandoned because of the difficulty encountered in the quantitative recovery of the oil due to sublimation. The fresh aerial plant materials were steam distilled within 3 days of collection for 1.5–2 h using a custom-built laboratory pilot still capable of handling 8 kg of fresh/wet material. Typical batch loads were 5–7 kg. The distilled light yellow oils from *O. canum* were obtained with yields of 1.0% (v/w) and stored in a fridge overnight and the precipitated camphor filtered off and dried. The amount of crude camphor was 25% (w/w) of the total oil distilled. The decamphorated oil was analysed by GC and GC–MS. Physicochemical properties of the decamphorated oil were: d_{24}, 0.9106; n_D, 1.4689; acid value, 0.440; and ester value, 18.099. A sample of air-dried plant material was steam-distilled with cohobation for 2 h at Clermont, France. The sublimed camphor was washed down into the oil with ether, the excess ether was air-dried and the oil was analysed by GC and GC–MS (Table 1).

The oil yield was 4.1% (w/w). The oils from fresh and air-dried plant material from *O. urticifolia* were obtained using the pilot steam distillation unit and by steam distillation with cohobation (as in Table 2), dried over anhydrous magnesium sulphate and stored in a fridge (4°C). The golden yellow oils had a pleasant smell and were obtained in yields of 0.06–0.14% (v/w) from fresh plant material and of 0.5–0.7% (w/w) from dried plant material.

GC analysis was carried out on a DELSI 121C chromatograph fitted with a 25 m × 0.25 mm (film thickness 0.15 µm) CP WAX 52 CB capillary column with temperature programming from 40°C (5 min) to 220°C at 3°C/min. The injector and detector temperatures were set at 220°C and 240°C, respectively, and the split ratio was 1/60. The relative proportions of the essential oils constituents were expressed as percentages obtained by peak-area normalization, all relative-response factors being taken as one.

The GC–MS analysis was performed using a SIGMA 300 chromatograph coupled to an HP 5970 mass spectrometer fitted with a 50 m × 0.3 mm, film

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Table 2. Percentage composition of the oil of *O. urticifolia* Roth

No.	Component (GC–MS)	KI	Fresh plant material			Air dried A_4 (%) 2/98*
			A_1 (%) 6/97 St/D	A_2 (%) 2/98 St/D	A_3 (%) 4/98 H/D	
1	α-Pinene	1030	1.4	1.8	2.3	0.5
2	Camphene	1082	0.2	1.3	0.2	tr
3	*β*-Pinene	1124	1.1	1.4	1.0	0.4
4	Sabinene	1130	0.1	0.1	0.2	0.1
5	α-Phellandrene	1160	tr	0.1	tr	tr
6	Myrcene	1164	0.4	0.9	1.2	0.2
7	α-Terpinene	1182	tr	0.1	tr	tr
8	Limonene	1204	2.0	5.4	1.9	0.3
9	*β*-Phellandrene	1215	0.4	–	1.6	0.1
10	(*Z*)-*β*-Ocimene	1240	8.0	8.4	5.7	0.4
11	(*E*)-*β*-Ocimene	1260	7.2	5.2	2.9	6.1
12	6-Methylhept-5-en-2-one	1335	0.2	tr	0.3	0.2
13	*cis*-Linalol oxide	1415	tr	tr	tr	0.1
14	*p*-Cymenene	1425	tr	0.2	tr	0.2
15	Oct-1-en-3-ol	1430	0.1	0.1	1.9	0.1
16	α-Copaene	1519	0.4	0.5	tr	0.1
17	Camphor	1514	1.4	11.7	1.1	0.8
18	*β*-Bourbonene	1530	0.1	0.3	tr	0.2
19	*β*-Cubebene	1540	0.3	0.3	tr	0.5
20	**Linalol**	**1557**	**18.9**	**4.9**	**23.2**	**19.7**
21	Octanol	1589	0.3	0.1	0.2	0.2
22	***β*-Elemene**	**1596**	**7.5** }	**15.8**	**8.5** }	**9.7**
23	***β*-Caryophyllene**	**1596**	**4.3** }		**3.2** }	
24	Myrtenal	1640	0.1	0.5	0.1	0.1
25	*allo*-Aromadendrene	1662	2.5	1.0	1.2	1.5
36	α-Humulene	1675	2.5	4.4	2.5	2.6
27	Neral	1682	tr	–	–	tr
28	*β*-Chamigrene	1686	tr	tr	–	tr
29	α-Terpineol	1690	0.1	0.4	0.4	0.1
30	Germacrene-D	1708	0.8	2.0	0.3	tr
31	*β*-Selinene	1720	5.2	2.8	3.5	1.4
32	α-Selinene	1730	2.2	1.3	0.4	1.8
33	Bicyclogermacrene	1744	2.0	0.6	1.3	0.7
34	**(*Z,E*)-α-farnesene**	**1748**	**4.8**	**0.9**	**4.4**	**2.9**
35	**(*E,E*)-α-farnesene**	**1752**	**16.9**	**10.4**	**7.8**	**5.2**
36	Nerol	1761	0.1	0.1	0.2	0.2
37	Geraniol	1797	0.2	tr	0.3	0.2
38	(*E*)-Caryophyllene oxide	1965	0.1	0.1	0.4	0.3
39	*β*-Caryophyllene oxide	1984	1.8	0.5	6.4	2.6
40	Ledol	2014	tr	0.1	tr	0.1
41	Humulene-epoxide (II)	2048	0.4	0.2	1.1	0.9
42	*trans*-Nerolidol	2064	tr	tr	0.2	0.1
43	Elemol	2086	0.1	tr	0.1	tr
44	Spathulenol	2097	0.1	0.05	0.3	0.3
45	**Eugenol**	**2103**	**2.3**	**11.4**	**0.3**	**20.0**
46	*β*-Eudesmol	2233	0.1	0.2	0.2	0.2
47	**Elemicine**	**2260**	**2.9**	**1.3**	**7.1**	**12.5**

tr = traces (⩽0.05%); 6/97 = June 1997; H/D = hydrodistilled; St/D = steam dried; * S/D Coh = steam distillation with cohobation, Laboratoire des Huiles Essentielles de Clermont; A = batch; KI = Kováts indices on CP WAX 52 CB capillary column.

thickness 0.25 μm, CP WAX 52CB capillary column with temperature programmed from 60° to 240°C at 2°C/min, with ionization at 70 eV. All the components were identified by GC–MS and confirmed with those reported in the literature, as well as by co-injection with authentic compounds.

Results and Discussion

The steam-distilled fresh plant material from *O. canum* produced a light yellow oil in 1.0% (v/w) yield, which was stored overnight in a fridge. The cooled oil contained precipitated camphor, which was filtered off and dried in yield of 25% (w/w). The decamphorated oil contained camphor (39.5–39.8%), limonene (24.5–25.1%), *β*-caryophyllene (7.0–7.2%), camphene (6.5–6.7%) and estragole (6.4–6.6%) as the major components (Table 1). The oil from the air-dried plant material was pale yellow in colour, had a camphorous smell and was produced with a yield of 4.1% (w/w). The main components of the oil were camphor (57.6%), limonene (16.3%) and *β*-caryophyllene (6.4%). Camphene (5.4%), estragole (4.2%) and α-terpineol (1.2%) were notable minor constituents.

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The hydrodistilled and steam-distilled fresh plant material from *O. urticifolia* produced a pale yellow oil with a pleasant aroma in 0.10–0.14% (v/w) yield. The major components from the oils were linalol (4.9–24.2%), eugenol (0.3–11.4%), α-farnesenes (11.3–21.7%), β-elemene/β-caryophyllene (11.7–15.8%), β-ocimenes (8.6–15.2%), elemicine (1.3–7.1%) and camphor (1.1–11.7%) (Table 2). The dried plant material, which was steam-distilled with cohobation, produced a golden yellow oil with an intense aroma in 0.5% (w/w) yield. Its major components were eugenol (20.0%), linalol (19.7%), elemicine (12.5%) and α-farnesenes (8.1%). Pilot cultivations are in progress to assess the commercial potential of the two plants.

Acknowledgements — The authors would like to acknowledge the assistance of RRETC, Ottawa, Canada and the Department of Pharmacy, University of Zimbabwe, for initiating this work through the project 'Microwave Extraction of Flavours and Fragrances — Zimbabwe' with IDRC and the University of Zimbabwe Research Board financing. Technical support was obtained from E. Shito, S. Madzongwe and M. Muringayi. All laboratory pilot steam distillations were carried out in the Department of Pharmacy, and all GC and GC–MS at Laboratoire de Chimie des Huiles Essentielles, Université Blaise Pascal de Clermont-Fd, France.

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