Available online at www.sciencedirect.com
ScienceDirect
Food Chemistry 101 (2007) 995–998
Food Chemistry
www.elsevier.com/locate/foodchem

Effects of drying methods on the quality and quantity of the essential oil of *Mentha longifolia* L. subsp. *Capensis*

O.T. Asekun [a], D.S. Grierson [b], A.J. Afolayan [b,*]

[a] *Department of Chemistry, University of Lagos, Lagos, Nigeria*
[b] *Department of Botany, University of Fort Hare, P/Bag X 1314, Alice 5700, South Africa*

Received 22 September 2005; received in revised form 23 February 2006; accepted 23 February 2006

Abstract

The effects of various methods of drying on the content and chemical quality of the essential oil of *Mentha longifolia* was studied. The most prominent component in both the air-dried and sun-dried leaf oils was menthone (47.9% and 38.3%, respectively), while oven-dried leaf oil had limonene as the major compound (40.8%), whereas pulegone was the major compound from the original fresh leaf oil. Menthone and pulegone were not detected in the oven-dried leaf oil. The essential oil underwent significant chemical transformation in its monoterpenoids when the leaves were dried by the three different methods. Due to the significant reduction of the potentially harmful pulegone and menthone by oven-drying, it is suggested that this herb should be oven-dried or cooked before consumption in order to reduce toxicity.

Keywords: *Mentha longifolia*; Essential oil; Menthone; Pulegone; Limonene; Drying methods

1. Introduction

Mentha longifolia L., also known as wild mint, is a fast-growing aromatic perennial herb that is widespread throughout the Eastern Cape province of South Africa. It is widely used in herbal medicine and believed to be particularly beneficial in building the immune system and fighting secondary infections. The plant is used for the treatment of coughs, colds and influenza. Externally, wild mint is used to treat wounds and swollen glands (Van Wyk, Outdtshoorn, & Gericke, 1997). The essential oil of this plant is partly responsible for the decongestant, antispasmodic and antibiotic effects reported by some workers (Van Wyk & Gericke, 2000).

The leaves of *M. longifolia* have a wide range of culinary usage in South Africa and, because of their colour, aroma and flavour, they are used in food preparation to enhance taste and appearance. When the leaves are rubbed onto the body and beddings, the strong smell keeps mosquitoes away (Hutchings & Van Staden, 1994). It has also been spread in granaries to keep rodents off the grain (Phillips & Foy, 1990).

The chief component of the essential oil of *M. longifolia* from South Africa appears to be the monoterpene ketone, menthone (Oyedeji & Afolayan, 2005). This is a different chemotype from to those in other parts of the world, which have carvone (Younis & Beshir, 2004), piperitone (Karousou, Lanaras, & Kokkini, 1998), and piperitenone and its oxide (Venskutonis, 1996) as the major constituents. These menthane monoterpene oxides give *M. longifolia* its characteristic odour. Some other significant constituents present in almost all the chemotypes are β-pinene, 1,8-cineole, pulegone, limonene, germacrene D and β-caryophyllene.

In vitro antimicrobial studies of the essential oil of this herb showed very strong antibacterial activity (Mimica, Bozin, Sokovic, Mihailovic, & Matavulj, 2003; Oyedeji &

* Corresponding author.
E-mail address: aafolayan@ufh.ac.za (A.J. Afolayan).

0308-8146/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodchem.2006.02.052

Afolayan, 2005). It was also found to be toxic when administered to mice.

The leaves of aromatic plants are often dried before extraction to reduce moisture content. During this process, many compounds which are dragged to the leaf surface by the evaporating water, are lost (Moyler, 1994). The method of drying usually has a significant effect on the quality and quantity of the essential oils from such plants. In the present study, the effect of different drying methods on the quality and quantity of the leaf oil of *M. longifolia* were investigated.

2. Materials and methods

2.1. Plant material

The shoots of *M. longifolia* were collected from the wild around Alice, in the Eastern Cape of South Africa in July, 2005. A voucher specimen (ASE1/05) was deposited in the herbarium of the University of Fort Hare. The remaining plant material was divided into three portions. One portion was dried to constant weight in the sun; another portion was left to dry in the laboratory under normal air and at room temperature conditions, while the third part was dried in the oven, which was kept at 40 °C.

2.2. Isolation procedure

About 100 g each of the fresh and dried leaves of the plant were separately subjected to hydrodistillation for 3 h, using a Clevenger-type apparatus (British Pharmacopoeia, 1980).

2.3. GC–MS analysis

GC–MS analyses were performed on a Hewlett–Packard HP 5973 mass spectrometer interfaced with an HP-6890 gas chromatograph. The following column and temperature conditions were used: initial temperature 70 °C, maximum temperature 325 °C, equilibration time 3 min, ramp 4 °C/min, final temperature 240 °C; inlet: split less, initial temperature 220 °C, pressure 8.27 psi, purge flow 30 ml/min, purge time 0.20 min, gas type helium; column: capillary, 30 m × 0.25 mm i.d., film thickness 0.25 μm, initial flow 0.7 ml/min, average velocity 32 cm/s; MS: EI method at 70 eV.

2.4. Identification of components

The components of the oils were identified by matching their mass spectra and retention indices with those of the Wiley 275 library (Wiley, New York) in the computer library and literature (Shibamoto, 1987). The yield of each component was calculated per kg of the plant material, while its percentage composition was calculated from summation of the peak areas of the total oil composition.

3. Results and discussion

The chemical compositions and yields of the oils obtained by the three drying methods differed significantly. Generally, the dried plant material yielded more essential oils than did the fresh leaf materials (Table 1). The total numbers of components of the oil in sun-dried, oven-dried, air-dried and fresh leaves were 26, 25, 22 and 19, respectively.

The monoterpenoids represented 92.6% of the total oil content in the oil from the fresh plant. Pulegone (35.0%), menthone (31.1%) and 1,8-cineole (13.0%) were the most abundant while the sesquiterpenoid content was low (3.3%).

In the air-dried oil, the monoterpenoid content increased to 93.3%. Menthone (47.6%), pulegone (18.4%) and 1,8-cineole (16.4%) were the most prominent components. Sesquiterpenoids represented only 5.1% of the oil content.

The sun-dried oil was also dominated by monoterpenoids (91.8%). The major components were menthone (38.3%), pulegone (20.2%) and 1,8-cineole (16.6%). Germacrene D (2.1%) dominated the sesquiterpenoid composition of the oil.

The monoterpenoid content of the oven-dried oil was 63.5%, limonene (40.8%) and α-pinene (15.0%), both monoterpenoid hydrocarbons, predominated. This was unlike the fresh, air-dried and sun-dried oils that were dominated by oxygenated monoterpenes. However the proportion of sesquiterpenoids corresponded to 24.7%, which was higher than in the other oils. Caryophyllene (9.7%), viridiflorol (3.3%) and caryophyllene oxide (3.1%) occurred in relevant quantities in the oven-dried oil.

The results showed that only oven drying brought about significant losses of the major compounds (menthone, pulegone and 1,8-cineole) in the essential oil when compared to the fresh plant material. This might be due to some chemical transformations during the process of drying.

The changes in the concentrations of the volatile compounds during drying depend on several factors, such as the drying method and the class of plant. Mint belongs to the Lamiaceae family of plants, which are known to store their essential oils on or near the leaf surfaces (Moyler, 1994). This might account for the loss of volatile compounds in *M. longifolia* leaves when oven-dried. Similarly, oven-drying of rosemary at 45 °C resulted in 7.25% loss in volatile components, while microwave-drying produced losses of 61.5% in the same plant (Jaganmohan, Meenakshi, Raghavan, & Abraham, 1998). However, rosemary, dried at ambient temperature, was similar in essential oil yield to the fresh plant (Ibáñez et al., 1999).

In this study, it may be suggested that menthone, pulegone, 1,8-cineole and some minor components, which were observed in the air-dried and sun-dried oils, were vapourised or converted to other compounds in the oven-dried leaf oil.

Table 1
Chemical composition of the essential oil from *Mentha longifolia* leaves using different drying methods

No.	Compound	Kovat index	Plant material (leaves)			
			Fresh	Air-dried	Oven-dried	Sun-dried
1	α-Pinene	941	0.8	0.7	15.0	1.9
2	β-Pinene	954	5.7	4.3	4.2	8.0
3	Limonene	1014	–	t	40.8	–
4	1,8-Cineole	1015	13.0	16.4	t	16.6
5	γ-Terpinene	1040	–	–	1.5	0.3
6	*cis*-Sabinene	1051	1.2	2.1	–	1.7
7	Terpinolene	1074	–	–	0.5	–
8	β-Thujone	1092	–	–	–	0.7
9	Terpinene-4-ol	1178	–	–	0.7	–
10	Menthone	1182	31.1	47.6	t	38.3
11	Borneol	1188	3.3	t	–	–
12	*cis*-Isopulegone	1192	–	1.1	–	–
13	α-Terpineol	1193	0.7	0.6	0.4	0.5
14	Linalyl propanoate	1271	–	–	–	0.7
15	Myrtenol	1226	–	–	–	0.1
16	Pulegone	1280	35.0	18.4	–	20.2
17	Piperitone	1284	1.8	1.5	–	1.5
18	Bornyl acetate	1306	–	–	0.2	–
19	Geraniol formate	1311	–	t	–	t
20	Piperitenone	1378	–	0.6	–	1.3
21	α-Terpinene	1382	–	–	0.2	–
22	α-Copaene	1417	–	–	1.7	–
23	β-Bourbonene	1428	0.1	0.2	–	0.1
24	β-Elemene	1437	0.1	0.1	–	0.1
25	*cis*-Jasmone	1446	0.2	0.2	–	0.2
26	β-Caryophyllene	1474	1.1	1.6	9.7	1.6
27	β-Cubenene	1482	t	–	–	t
28	(*Z*,*E*)-α-Farnesene	1489	–	–	0.3	
29	Alloaromadendrene	1493	–	–	0.3	–
30	β-Selinene	1499	–	–	0.2	–
31	α-Humulene	1511	0.1	0.1	1.8	t
32	Germacrene D	1513	1.1	2.5	–	2.1
33	Aromadendrene	1522	–	–	0.9	–
34	γ-Curcumene	1545	–	–	1.2	–
35	β-Pathoulene	1564	–	–	0.3	–
36	Bicyclogarmacrene	1568	0.1	0.3	–	0.4
37	Germacrene A	1575	–	–	0.6	–
38	γ-Cadinene	1601	t	t	0.8	t
39	γ-Selinene	1615	–	–	0.5	–
40	Caryophyllene oxide	1676	t	0.1	3.1	0.1
41	Viridiflorol	1692		–	3.3	–
42	Isospathulenol	1746	–	–	–	t
43	T-Muurolol	1769	–	–	–	t
	Yield (%v/w)		0.79	2.30	2.46	2.61

t, trace = less than 0.05%.

Pulegone is a major constituent of the essential oil obtained from this herb. This compound is reported to be a potent hepatotoxin, even at low concentrations. It is metabolised in the liver to menthofuran, a highly reactive metabolite which binds irreversibly to the components of liver cells in which metabolism takes place. It quickly destroys the liver (Chen, Lebetkin, & Burka, 2001; Gordon, Huitric, Seth, McClanahan, & Nelson, 1987) and can also destroy cytochrome P_{450} in rats (Moorthy, 1991). Due to the significant reduction of pulegone and menthone by oven-drying, it is suggested that this herb should be oven-dried or cooked before consumption in order to reduce toxicity. Eating of the raw plant should be discouraged, especially in patients with a history of liver disease or those taking cytochrome P_{450}-inducing drugs.

Acknowledgements

The financial support from the University of Fort Hare, South Africa and University of Lagos, Nigeria is gratefully acknowledged.

References

British Pharmacopoeia (1980). London, HMS Office, Vol. 2, pp. 109–110.

Chen, L. J., Lebetkin, E. H., & Burka, L. T. (2001). Metabolism of (R)-(+)-pulegone in F344 rats. *Drug Metabolism and Disposition, 29*(12), 1567–1577.

Gordon, W. P., Huitric, A. C., Seth, C. L., McClanahan, R. H., & Nelson, S. D. (1987). The metabolism of the abortifacient terpene, (*R*)-(+)-pulegone, to a proximate toxin, menthofuran. *Drug Metabolism and Disposition, 15*(5), 589–594.

Hutchings, A., & Van Staden, J. (1994). Plants used for stress-related ailments in traditional Zulu, Xhosa and Sotho medicine. Part 1: plants used for headaches. *Journal of Enthnopharmacology, 43*(2), 89–124.

Ibáñez, E., Oca, A., de Murga, G., López-Sebastián, S., Tabera, J., & Reglero, G. (1999). Supercritical fluid extraction and fractionation of different preprocessed rosemary plants. *Journal of Agriculture and Food Chemistry, 47*, 1400–1404.

Jaganmohan, R. L., Meenakshi, S., Raghavan, B., & Abraham, K. O. (1998). Supercritical fluid extraction and fractionation of different preprocessed rosemary plants. *Journal of Food Quality, 21*, 107–115.

Karousou, R. A., Lanaras, T. B., & Kokkini, S. (1998). Piperitone oxide-rich Essential oils from *Mentha longifolia* subsp. petiolata and *M. x villoso-nervata* grown wild on the Island of Crete (S Greece). *Journal of Essential Oil Research, 10*(4), 375–379.

Mimica, D. N., Bozin, B., Sokovic, M., Mihailovic, B., & Matavulj, M. (2003). Antimicrobial and antioxidant activities of three *Mentha* species essential oils. *Planta Medica, 69*(5), 413–419.

Moorthy, B. (1991). Toxicity and metabolism of *R*-(+)-pulegone in rats: its effects on hepatic cytochrome *P*450 in vivo and in vitro. *Journal of the Indian Institute of Science, 71*(1), 76–78.

Moyler, D. A. (1994). Spices – recent advances. In G. Charalambous (Ed.), *Spices, herbs and edible fungi* (pp. 1–70). Amsterdam: Elsevier.

Oyedeji, O. A., & Afolayan, A. J. (in press). Chemical composition and antibacterial activity of essential oil of the South African *Mentha longifolia*. *Journal of Ethnopharmacology*.

Phillips, R., & Foy, N. (1990). *Herbs*. London: Pan Books Ltd.

Shibamoto, T. (1987). Retention indices in essential oil analysis. In P. Sandra & C. Bicchi (Eds.), *Capillary gas chromatography in essential oils analysis* (pp. 259–274). New York: Huethig, A. Verlag.

Van Wyk, B., & Gericke, N. (2000). *People's plants*. Pretoria: Briza Publications, pp. 128.

Van Wyk, B., Outdtshoorn, B., & Gericke, N. (1997). *Medicinal plants of South Africa*. Pretoria: Briza Publications, pp. 174.

Venskutonis, P. R. (1996). Chemotype of *Mentha longifolia* L. from Lithuania rich in piperitenone oxide. *Journal of Essential Oil Research, 8*(1), 91–95.

Younis, Y. M. H., & Beshir, S. H. (2004). Carvone-rich essential oils from *Mentha longifolia* (L.) Huds. ssp. schimperi Briq. and *Mentha spicata* L. Grown in Sudan. *Journal of Essential Oil Research, 16*(6), 539–541.