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Effects of Drying Methods on the Chemical Composition of Essential Oil from *Felicia muricata* Leaves

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Abstract: The effect of various methods of drying on the content and chemical quality of the essential oil of this herb was studied. The most prominent components in the fresh, air-dried, sun-dried and oven-dried oils extracted by hydrodistillation were the monoterpenes, α-pinene (9.1, 7.4, 10.2 and 6.8%), β-pinene (3.5, 3.6, 9.6 and 7.0%), myrcene (18.7, 18.4, 22.0 and 16.4%), limonene (26.5, 26.5, 24.4 and 27.4%), cis-ocimene (2.2, 1.9, 2.8 and 2.0%), trans-ocimene (4.8, 5.6, 12.4 and 11.6%) and α-terpineol (3.4, 2.7, 2.2 and 3.2%). Methyl-eugenol, β-caryophyllene, trans-farnesene and bicyclogermacrene were the major sesquiterpenes and all were in minute quantity. Cis-lachnophyllum ester (16.2, 18.1, 19.2 and 16.1%, respectively), was the dominating non-terpenoid polyacetylinic compound. The different drying methods have no significant effect on the quality and composition of essential oil from *F. muricata*.

Key words: *Felicia muricata*, essential oil, drying methods, monoterpenes, sesquiterpenes, cis-lachnophyllum ester

INTRODUCTION

The members of the genus *Felicia* are mostly perennial aromatic herbs belonging to the family Asteraceae. The genus is widely distributed in southern Africa with about 90 species of herbs and shrubs. It also extends to the northern tropical Africa as far as Nigeria and Ethiopia and indeed, Saudi Arabia (Ortiz, 2007). Among the members of this group, *Felicia muricata* Thunb. is one of the most commonly used for medicinal purposes. The plant is a small drought resistant perennial aromatic herb growing up 20 cm in height. The leaves are arranged in alternate fashion and are characterized by long and cylindrical non-glandular trichomes, tapering into a sharp point, all running parallel to the surface of the leaves in the direction of the leaf apex (Ashafa *et al*., 2008a). Its name was derived from muricate (rough, with sharp tubercles or protuberances). The species is regarded as an indicator of desertification, becoming increasingly invasive in grassland regions (Jordaan and Kruger, 1993). In the Eastern Cape of South Africa, the rural dwellers use the plant in the management of headache, pains, inflammation (Hutchings, 1989; Hutchings and Van Staden, 1994; McGaw *et al*., 1997), as well as stomach catarrh and cancer. According to McGaw *et al*. (1997), aqueous extracts from the plant showed 80-90% inhibitory activity against cyclooxygenase, which is an important enzyme in the prostaglandin biosynthesis pathway; this may be responsible for the anti-inflammatory activity of this plant. *In vitro* antimicrobial activity of the extracts from this herb showed strong antibacterial and antifungal activity (Ashafa *et al*., 2008b). Recently, its essential oil was found to be rich in limonene, α-pinene, β-pinene, myrcene and cis-lachnophyllum ester (Ashafa *et al*., 2008c). These compounds have been reported to exhibit strong anticancer and antimicrobial activity (Sokmen *et al*., 2003; Deba *et al*., 2008). At the beginning of this study, no information was available in the literature on the effects of drying methods on the essential oil composition of this species. This study was to investigate the effects that different drying methods could have on the yield and composition of the essential oil from *Felicia muricata*.

The leaves of aromatic plants are often dried before extraction to reduce moisture content. Drying is important for preserving product quality and until recently, herbs are commonly dried at 40-60°C (Tambunan *et al*., 2001). It has been reported that drying plant materials before distillation could affect the yield and composition of its essential oil considerably (Díaz-Maroto *et al*., 2003; Omidbaigi *et al*., 2004; Asekun *et al*., 2007a). During this process, many compounds which are dragged to the leaf surfaces by the evaporating water are lost (Moyler, 1994). In this study, we report the chemical composition of the essential oils obtained from *F. muricata* and the effect of drying methods on the yield and quality of the oils.

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MATERIALS AND METHODS

Plant material: Plants used for this study were collected in February 2008 from a single population of *F. muricata* growing within the premises of the Alice campus of the University of Fort Hare. A voucher specimen (AshafaMed, 2008/1) was prepared and deposited in the Giffen Herbarium of the University. The plant material was divided into three portions of about 200 g each. One portion was left to dry in the laboratory under normal air at room temperature; another portion was dried to a constant weight in the sun, while the last portion was dried in the oven at 40°C.

Extraction and analysis of essential oils: About 150 g of the fresh and dried leaves of *F. muricata* were subjected to hydrodistillation for 3 h, using a Clevenger-type apparatus in accordance with the method described by Asekun *et al.* (2007a).

Each oil was analyzed using Hewlett Packard 6890 Gas Chromatograph linked with Hewlett Packard 5973 mass spectrometer system which was equipped with a HP5-MS capillary column (30 m × 0.25 mm, film thickness 0.25 μm, Agilent Technologies Wilmington, DE, USA). The oven temperature was programmed from 70 to 240°C at a rate of 5°C min^{-1}. The ion source was set at 240°C with ionization voltage of 70 eV. Helium was used as a carrier gas. Spectra were analyzed using the Hewlett-Packard Enhanced Chem Station G1701 programme for Windows.

The components of the oils were identified by matching their spectra and retention indices with those of the Wiley 275 library (Wiley, New York) in the computer library and literature. Percentage composition was calculated using the summation of the peak areas of the total oil composition.

RESULTS AND DISCUSSION

The yields and chemical compositions of the oils obtained from *F. muricata* were slightly affected by the method of moisture removal from the plant material. A total of 38, 40, 33 and 30 compounds were identified in the oils of the fresh, air-dried, sun-dried and oven-dried plant materials, respectively. In general, the dried plants yielded more essential oils than the fresh ones (Table 1). The air dried, sun-dried and oven-dried plants yielded 0.84, 0.66 and 0.59% of the essential oils, respectively, while the oil was 0.62% in the fresh plant materials.

The monoterpenoids dominated the total oil content from the fresh plant. α-pinene (9.1%), α-pinene (3.5%), myrcene (18.7%), limonene (26.5), cis-ocimene (2.2%), trans-ocimene (4.8%), 1,3,8-para-menthriene (2.7%) and α-terpineol (3.4%) were the most represented. The sesquiterpiniod content was very low with trans-farnesene (1.7%) as the most prominent while cis-lachnophyllum ester (16.2%) was the major non-terpenoid polyacetylenic compound in the fresh plant oil.

The composition of the oil from the air-dried plants followed the same pattern as in the oil from the fresh plants with monoterpenes as the most dominant group of compounds. α-pinene (7.4%), β-pinene (3.6%), myrcene (18.4%), limonene (26.5), cis-ocimene (1.9%), trans-ocimene (5.6%) and α-terpineol (2.7%) were the most represented. In the sesquiterpinenes, trans-farnesene slightly increased from 1.7% in the fresh plant to 2.1% in the air-dried plant while cis-lachnophyllum ester increased from 16.2 to 18.1%.

The sun-dried oil displayed a slight increment in the composition of major components compared to other drying methods employed in this study. α-pinene (10.2%), β-pinene (9.6%), myrcene (22.0%), limonene (24.4%), cis-ocimene (2.8%), trans-ocimene (12.4%) and α-terpineol (2.2%) were the most represented monoterpene hydrocarbons while non-terpenoid polyacetylenic compound, cis-lachnophyllum ester increased to 19.2% compared to 16.2, 18.1 and 16.1% in the fresh, air-dried and oven-dried plants.

The monoterpenes hydrocarbons, α-pinene (6.8%), β-pinene (7.0%), myrcene (16.4%), limonene (27.4%), trans-ocimene (11.6%) and α-terpineol (3.2%) remained the dominating components in the oven-dried plant materials. Trans-farnesene and cis-lahnophyllum ester were the major sesquiterpene and non-terpenoid polyacetylinic compounds.

The volatile compounds produced by plants and other biological species comprise a large number of organic substances, including isoprene and isoprenoid compounds, alkanes, alkenes, carbonyl compounds, alcohols and esters. These volatiles are responsible for various interactions between plants and other organisms, such as pollinating animals, herbivores and the predators (McCaskill and Croteau, 1998; Robles-Zepeda *et al*., 2006). Furthermore, because some volatile compounds have antipathogenic properties, they are produced and emitted by plants as a defence mechanism against attack by herbivores (Robles-Zepeda *et al*., 2006).

In general, the drying methods caused some variations in the proportions of the chemical components of the essential oils; however, there was no major or sharp difference in the composition of the main components of the oils in *F. muricata* which could be ascribed to the different drying methods. Similar observations have been reported by Omidbaigi *et al.* (2004), Veskutonis (1997), Sefidkon *et al.* (2006) and Asekun *et al.* (2007a). The results from the study suggest that the major

Table 1: Volatile compounds hydrodistilled from the fresh, air-dried, sun-dried and oven-dried leaves of *F. muricata*

Compounds	KI value	Fresh (%)	Air-dried (%)	Sun-dried (%)	Oven-dried (%)
Cis-3-hexenol	929	0.5	-	-	-
Trans-2-Hexenal	931	-	0.2	0.4	-
α-pinene	1022	9.1	7.4	10.2	6.8
Camphene	1031	-	-	0.7	0.6
β-pinene	1065	3.5	3.6	9.6	7.0
Myrcene	1103	18.7	18.4	22.0	16.4
Limonene	1161	26.5	26.5	24.4	27.4
Cis-ocimene	1168	2.2	1.9	2.8	2.0
Trans-ocimene	1174	4.8	5.6	12.4	11.6
γ-terpinene	1178	0.1	0.2	0.3	0.3
Cis-sabinene hydrate	1181	0.1	0.1	0.1	0.1
α-terpinolene	1193	1.1	1.0	1.0	1.4
Phenol, 2, 3, 5, 6- tetramethyl- (cas)	1204	0.1	-	-	-
Linalool	1206	0.5	0.6	0.4	0.2
Nonyl aldehyde	1209	0.1	-	-	-
2-methoxy-3-isopropyl pyrazine	1212	-	Tr	-	-
3-methyl-2-(2-methyl-2-buthyl)-flu	1215	-	0.1	0.1	
D-fenchyl alcohol	1221	0.7	0.6	0.4	0.5
Nonanal	1224	-	0.1	0.1	-
1, 4-cyclohexadiene	1229	1.0	-	-	-
1, 3, 8- para-menthtriene	1242	2.7	-	-	-
2, 4, 6-octatriene	1247	0.2	-	-	-
1-borneol	1273	0.3	0.2	-	-
p-mentha-1,5,8-triene	1261	-	1.3	1.0	-
p-mentha-E-2,8(9)-diene-1-ol	1265	-	0.1	-	-
Neo -allo-ocimene	1271	-	0.1	1.2	1.2
Exo-methyl-camphenilol	1282	-	0.1	0.1	0.1
Terpinen-4-ol	1285	0.4	0.4	0.3	0.3
Endo-borneol	1301	-	-	0.1	0.1
α-terpineol	1309	3.4	2.7	2.2	3.2
2,3-dimethoxytoluene	1314	-	0.1	-	-
3-cyclohexene-1-ol	1315	-	-	0.2	-
Thymyl methyl ether	1344	0.3	0.4	0.1	0.1
2-cyclohexen-1-one	1354	Tr	-	-	-
Bicyclo(2.2.1)haptene-2-ol	1377	-	0.7	1.3	1.2
α-Fenchyl acetate	1398	1.0	-	-	-
α-Terpinene	1465	0.1	Tr	-	0.1
Eugenol	1474	0.1	0.1	0.2	0.3
Neryl-acetate	1478	-	0.1	-	-
Geranyl propionate	1480	Tr	-	-	-
1,2,4-methenoazulene	1487	-	Tr	-	-
β-elemene	1509	-	0.1	-	-
Cis-jasmone	1519	Tr	0.1	-	-
Methyl eugenol	1525	0.4	0.5	0.2	0.3
β-caryophyllene	1541	0.2	0.2	0.1	0.1
Geranyl acetone	1567	-	-	-	0.6
Trans- farnesene	1583	1.7	2.1	0.3	1.3
Germacrene D	1609	0.4	0.4	Tr	0.2
Zingiberene	1618	-	0.1	-	-
Bicyclogermacrene	1625	0.4	0.4	0.1	0.4
Cis-lachnophyllum ester	1689	16.2	18.1	19.2	16.1
Nerolidol	1700	-	0.2	0.2	0.1
Farnesol	1709	0.1	-	-	-
α-cadinol	1798	Tr	-	-	-
Mintsulfide	1885	0.2	0.3	0.1	0.2
Hexadecanoic acid	2104	0.2	-	-	-
9-octadecanoic acid	2261	0.2	-	-	-

Tr: Trace amount < 0.1, -: not detected. KI: Kovat index value. %: Percentage composition

compounds in *Felicia muricata* were not stored on or near the leaf surface. Compounds stored on or near leaf surfaces have been reported to be considerably affected by the drying methods (Asekun *et al*., 2007b).

Limonene, which was a major component of the oil, has been shown to inhibit mammary carcinogenesis in rats (Robles-Zepeda *et al*., 2006). α-pinene, β-pinene and lachnophyllum esters possess strong antibacterial and antifungal activities (Sokmen *et al*., 2003; Deba *et al*., 2008). Plant essential oils and extracts have been used for thousands of years in food preservation, pharmaceuticals, alternative medicine and natural therapies (Reynolds, 1996; Lis-Balchin and Deans, 1997). They are potential sources of novel antimicrobial compounds (Meurer-Grimes *et al*., 1996; Rabe and Van Staden, 1997).

CONCLUSION

The oil from *F. muricata* could make a promising group of natural compounds for the development of safer antibacterial, antifungal, antioxidant and anticancer agents. It could also be a good candidate in the perfumery and flavouring industries. The results from the study suggest that the major compounds in *F. muricata* were not stored on or near the leaf surface, since the different drying methods do not have any significant effects on the major component of the essential oil.

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REFERENCES

Asekun, O.T., D.S. Grierson and A.J. Afolayan, 2007a. Characterization of essential oils from *Helichrysum odoratissium* using different drying methods. J. Applied. Sci., 7: 1005-1008.

Asekun, O.T., D.S. Grierson and A.J. Afolayan, 2007b. Effects of drying methods on the quality and quantity of the essential oil of *Mentha longifolia* L. subsp. Capensis. Food Chem., 107: 995-998.

Ashafa, A.O.T., D.S. Grierson and A.J. Afolayan, 2008a. Foliar micromorphology of *Felicia muricata* Thunb. Pak. J. Biol. Sci., 11: 1713-1717.

Ashafa, A.O.T., D.S. Grierson and A.J. Afolayan, 2008b. Antimicrobial activity of extracts from *Felicia muricata* Thunb. J. Biol. Sci.

Ashafa, A.O.T., D.S. Grierson and A.J. Afolayan, 2008c. Composition and antibacterial activity of essential oil from *Felicia muricata* leaves. J. Biol. Sci., 8: 784-788.

Deba, F., T.D. Xuan, M. Yasuda and S. Tawatu, 2008. Chemical composition and antioxidant, antibacterial and antifungal activities of the essential oils from *Bidens pilosa* Linn. var. Radiata. Food Control, 19: 346-352.

Díaz-Maroto, M.C., M. Soledad Pérez-Coello, M.A. González Viñas and M. Dolores Cabezudo, 2003. Influence of drying on the flavor quality of spearmint (*Mentha spicata* L.). J. Agric. Food Chem., 51: 1265-1269.

Hutchings, A., 1989. A survey and analysis of traditional medicinal plants as used by the Zulu, Xhosa and Sotho. Bothalia, 19: 111-123.

Hutchings, A. and J. Van Staden, 1994. Plants used for stress related ailments in traditional Zulu, Xhosa and Sotho medicine. Part 1: Plants used for headaches. J. Ethnopharmacol., 52: 89-124.

Jordaan, A. and H. Kruger, 1993. Pollen wall ontogeny of *Felicia muricata* (Asteraceae). Ann. Bot., 71: 97-105.

Lis-Balchin, M. and S.G. Deans, 1997. Bioactivity of selected plant essential oils against *Listeria monocytogenes*. J. Applied Bacteriol., 82: 759-762.

McCaskill, D. and R. Croteau, 1998. Some caveats for bioengineering terpenoid metabolism in plants. Trends Biotech., 16: 349-355.

McGaw, L.J., A.K. Jager and J. Van Staden, 1997. Prostagladin inhibitory activity in Zulu, Xhosa and Sotho medicinal plants. Phytother. Res., 11: 113-117.

Meurer-Grimes, B., D.L. Mcbeth, B. Hallian and S. Delp, 1996. Antimicrobial activity in medicinal plants of the Scrophulariaceae and Acanthaceae. Int. J. Pharmacognosy, 34: 243-248.

Moyler, D.A., 1994. Spices-Recent Advances. In: Spices, Herbs and Edible Fungi, Charalambous, G. (Ed.). Elsevier Science, London, UK., pp: 1-70.

Omidbaigi, R., F. Sefidkon and F. Kazemi, 2004. Influence of drying methods on the essential oil content and composition of Roman chamomile. Flavour Frag. J., 19: 196-198.

Ortiz, S., 2007. A new species of *Felicia* L. (Asteraceae, Asterae) from South Africa. Botanical J. Linnean Soc., 154: 545-548.

Rabe, T. and J. Van Staden, 1997. Antibacterial activity of South African plants used for medicinal purposes. J. Ethnopharmacol., 56: 81-87.

Reynolds, J.E.F., 1996. Martindale-the Extra Pharmacopoeia. 31st Edn. Pharmaceutical Society of Great Britain, ISBN: 0 85369 342 0, London .

Robles-Zepeda, R.E., J. Molina-Torres, E. Lozoya-Gloria and M.G. Lopez, 2006. Volatile organic compounds of leaves and flowers of *Montanoa tomentosa*. Flavour Frag. J., 21: 225-227.

Sefidkon, F., K. Abbasi and G. Bakhshi Khaniki, 2006. Influence of drying and extraction methods on yield and chemical composition of he essential oil of Sartureja hotensis. J. Food Chem., 99: 19-23.

Sokmen, A., G. Vardar-Ünlü, M. Polissiou, D. Daferera, M. Sokmen and E. Donmez, 2003. Antimicrobial activity of essential oils and methanol extracts of *Achillea sintenisii* Hub Mor. (Asteraceae). Phytother. Res., 17: 1005-1010.

Tambunan, A.H., Yudistira, Kisdiyani and Hernani, 2001. Freeze drying characteristics of medicinal herbs. Drying Tech., 19: 325-331.

Veskutonis, P.R., 1997. Effect of drying on the volatile constituents of thym (*Thymus vulgare* L.) and sage (*Salivia officinalis* L.). Food Chem., 59: 219-227.