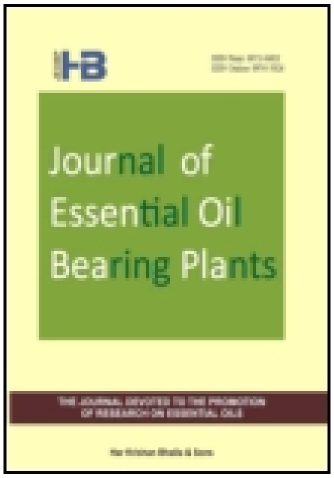

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Variations in the Quality and Yield of the Essential Oil from Artemisia afra Using Different Drying Methods

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Variations in the Quality and Yield of the Essential Oil from *Artemisia afra* Using Different Drying Methods

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Abstract: The impact of drying methods, namely, air, sun and oven-drying on the quality and quantity of the essential oil of *Artemisia afra* was studied. The oil yields from the plant differed according to the drying methods; viz: 0.18%, 0.88%, 1.54% and 1.88% for fresh, oven-dried, air-dried and sun-dried oils respectively. The essential oil from the plant contained mostly monoterpenoids (96.3% - 84.0%) and, to a small extent, sesquiterpenoids (2.6% - 0.1%). Compounds such as α- and β-Thujone (52.1 - 39.8%), camphor (14.4 - 8.2%), 1, 8-cineole (21.8-13.1%) and borneol (7.8 - 2.7%) which are the major components responsible for the characteristic flavour of the herb, were present in significant amounts in the oils from the entire dried herb preparations. The fresh oil contained artemisia ketone (6.9%), which was absent in the dried oils. Apart from the large quantitative difference in the yield of the hydrodistillates, there was no significant loss of volatile components, except in the sun-dried oil which were mainly sesquiterpenoids. Generally, the drying methods had no significant effect on the monoterpenoids composition of the essential oils from *A. afra*, however sun drying which has the lowest no of components (14) has the highest percentage oil yield and composition.

Keywords: *Artemisia afra*, essential oil, α-thujone, β-thujone, camphor, 1,8-cineole, drying methods.

Introduction: *Artemisia afra* Jacq. ex Willd., a member of the Asteraceae, is commonly called wild wormwood or *unhlonyane* in South Africa, where it is one of the most widely used medicinal plants[1]. The roots, stems and leaves are used in many different ways for the treatment of several ailments[2,3]. Many workers have reported the antimicrobial activities of *Artemisia afra* as validation for its use in traditional remedies[4-6]. It also has the ability to prevent food spoilage due to its antimicrobial properties[7,8].

The essential oil of the herb has considerable radical scavenging potential[4,9]. The oil could serve as natural fragrances in aqueous cream as well as assuring protection against

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microbial contamination[10]. The compounds α and β-thujone, 1,8-cineole, camphor and α-pinene were reported as the major constituents of the essential oil[1,4,7].

The need for herbs to be dried prior to essential oil extraction is crucial for the isolation of valuable oils from plants, hence, the drying method employed is an important factor for essential oil quality and yield[11]. The present work is part of a series of studies which is aimed at finding suitable drying methods to maximize essential oil yield and obtain desirable oil quality from common aromatic plants in the Eastern Cape Province of South Africa.

Experimental

Plant material and extraction of essential oil: The aerial parts of *Artemisia afra* were collected randomly from plants growing in the wild at the Eastern Cape of South Africa in July, 2005. The plant was authenticated at the Botany Department, University of Fort Hare and a voucher specimen (ASE2/05) was deposited in the herbarium of the University. Three portions (100g each) of the plant material were dried to constant weights by air drying in the dark, sun drying and oven drying at 40°C respectively.

The fresh and dried aerial parts were separately subjected to hydrodistillation for 3 hrs using a Clevenger unit according to the British Pharmacopoeia[12].

GC-MS Analysis and identification of the compounds: 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 temp 70°C, equilibration time 3.00 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; HP-5 column: capillary, 30 m x 0.25 mm i.d., film thickness 0.25 µm, initial flow 0.7ml/min, average velocity 32 cm/sec; MS: EI method at 70eV.

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[13].

Results and discussion: The methods of drying were found to have noteworthy effects on the oil content of *Artemisia afra* as should be expected. Sun-dried plant had the highest oil content (1.83%), while oven-dried and air-dried plants gave oil yields of 0.88% and 1.54% respectively. The total oil composition in the fresh, air-dried, sun-dried and oven-dried oils were 98.9%, 86.3%, 99.7% and 93.2%. The most important components were all well represented in the oils. The essential oil from the fresh plant had α- and β-thujone (45.0%), camphor (14.2%), 1,8-cineole (13.9%), borneol (7.8%) and artemisia ketone (6.9%) as major compounds. Similarly, the main components of the oil from the air-dried plant were α- and β- thujone (47.6%), camphor (8.2%), 1,8-cineole. (17.1%) and borneol (2.7%), while those from the sun-dried plant were α- and β-thujone (52.1%), 1,8-cineole (21.8%), camphor (12.4%), and borneol (6.1%). The oil from the oven-dried plant contained α- and β-thujone (39.8%), camphor (14.4%), 1,8-cineole (13.1%), artemisia ketone (12.9%) and camphene (3.9%) as the most prominent compounds.

The dominance of monoterpenoids was experiential in all the hydrodistillates (99.6%-

84.3%). The minor monoterpenoids identified were α-terpinene found in the fresh and air-dried oils, γ-terpinene and chrysanthenone which appeared in the air and sun dried oils, *trans* piperitol was identified in the fresh and oven-dried oils and chrysanthenyl acetate was present in the three dried oils. The sesquipterpenoid content of the essential oil was generally low. This group of compounds was significantly affected by sun-drying, as only one of them germacrene D (0.1%) was detected in the sun-dried oil. Other compounds like α-copaene, β-caryophyllene, bicyclogermacrene, δ-cadinene, spathulenol and T-muurolol were present in the fresh, air-dried and oven-dried oils.

The essential oil of *A. afra* from South Africa[7] and other parts of the world[1,4] have been reported earlier to contain the compounds α and β-thujone, 1,8-cineole, camphor and α-pinene in support of the components of our essential oils. In this analysis, the drying methods had no considerable effect on the monoterpenoids composition of the essential oil from *A. afra*, in view of the fact that the prominent monoterpenoids responsible for the aroma and biological activities of the plant were present from all the oils. However, the drying methods affected the relative quantities of the components. Unexpectedly, sun drying which has the lowest number of components (14) brings about the highest percentage in oil yield and composition of the most prominent constituents in *A. afra*,.

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Table 1. Chemical composition of the essential oil of *Artemisia afra* using varied drying methods

Compound	KI[b]	Drying method (Concentration %)[a]			
		Fresh	Air dried	Sun dried	Oven dried
Camphene	908	3.8	1.8	2.1	3.9
α-Terpinene	985	0.1	0.3	-	-
1,8-Cineole	1007	13.9	17.1	21.8	13.1
γ-Terpinene	1038	-	0.2	0.5	-
Artemisia ketone	1084	6.9	-	-	12.9
α- and β-Thujone	1125	45.0	47.6	52.1	39.8
Chrysanthenone	1167	-	3.1	1.8	-
Camphor	1156	14.2	8.2	12.4	14.4
Borneol	1126	7.8	2.7	6.1	3.4
Terpinen-4-ol	1187	1.6	1.4	1.3	1.5
α-Terpineol	1198	0.3	0.3	0.4	0.2
Myrtenol	1205	0.4	0.4	0.3	0.3
trans-Piperitol	1215	0.2	-	-	0.1
trans (+)-Carveol	1227	0.1	0.1	0.3	0.1
Pulegone	1252	0.4	-	-	-
Carvone	1260	t	t	-	0.1
Chrysanthenyl acetate	1279	-	0.3	0.1	0.3
(-)-Bornyl acetate	1308	1.6	0.4	0.4	1.0
Bicycloelemene	1367	0.1	-	-	t
Eugenol	1392	-	0.1	-	t
α-Copaene	1414	0.1	0.1	-	0.1
β-Caryophyllene	1468	0.1	0.2	-	0.1
α-Humulene	1534	-	-	-	0.1

table 1. (continued)

Compound	KI[b]	Drying method (Concentration %)[a]			
		Fresh	Air dried	Sun dried	Oven dried
Germacrene D	1547	0.6	0.4	0.1	0.4
Bicyclogermacrene	1566	0.5	0.3	-	0.4
E, E-α-Farnesene	1579	0.1	-	-	-
δ-Cardinene	1598	0.1	0.1	-	0.1
Spathulenol	1669	0.2	0.2	-	0.2
Caryophyllene oxide	1677	-	0.2	-	0.2
Viridiflorol	1687	0.3	-	-	0.1
T-Muurolol	1754	0.5	0.5	-	0.4
γ-Gurjunene	1780	-	0.3	-	-
% yield		0.18%	1.54%	1.88%	0.88%

[a]Relative concentration (mean of triplicate determinations);
[b]Elution order (HP-5 column) and Kovat retention index calculated from retention time.;
t = trace = less than 0.05%