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ORIGINAL ARTICLE

Analysis of the chemical composition of essential oil from Algerian *Inula viscosa* (L.) Aiton

Imad Eddine Haoui [a,*], Ratiba Derriche [a], Leila Madani [a], Zahia Oukali [b]

[a] *Laboratoire de valorisation des énergies fossiles, Département Génie Chimique, Ecole Nationale Polytechnique, 10 Avenue, Hassen Badi BP182 El-Harrach, 16200 Alger, Algeria*
[b] *Laboratoire valorisation et conservation des ressources biologiques, Département Biologie, Université de Boumerdès, Algeria*

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Abstract The chemical composition of the essential oil of *Inula viscosa* (L.) leaves, obtained by both hydrodistillation and steam distillation, was investigated by GC–MS. The major components for hydrodistillation were: 12-carboxyeudesma-3,11 (13) diene (28.88%); linolenic acid (7.80%); palmitic acid (5.38%); butyl hydroxy toluene (4.11%) and fokienol (3.37%), while for steam distillation were: 12-carboxyeudesma-3,11 (13) diene (56.81%); 2,3-didehydrocostic acid (3.25%); butyl hydroxy toluene (2.63%) and pentacosane (2.31%).

1. Introduction

Plants have always been part of the daily life of man, since it is used for food, medicine and sometimes in religious rites. Numerous plant extracts were already known and used by Egyptians, Romans and Greeks, for their scent and medicinal properties. The Mediterranean climate of Algeria encourages the development of savage plants, unfortunately among the species that has Algerian flora, until now, only few have been studied. The valorization of these natural resources is based on the extraction of their essential oils which are used in pharmaceutical, cosmetic and food industries.

Inula viscosa that belongs to Asteraceae family is a strong smelling plant. Woody at the base, *I. viscosa* presents at the top of the stem numerous yellow flowered heads. It is widely used in traditional medicine in Algeria, especially in farming areas for the treatment of various diseases such as bronchitis, diabetes and injuries.

Several studies on the chemical composition of the essential oil of *I. viscosa* have been previously reported, Turkish (Perez-Alonso and Velasco-Negueruela, 1996), Spanish (Camacho et al., 2000), Italian (Chiarlo, 1968 and De laurentis et al., 2002) and French (Blanc et al., 2006) species. However, almost all of these published essential oil compositions were different from each other. Therefore, the aim of this study is to determine the chemical composition of the essential oil of *I. viscosa* (L.) growing in Algeria by GC/MS analyses, and to make the comparison with the literature.

* Corresponding author. Tel.: +213 662752621.
E-mail address: imadenp@yahoo.fr (I.E. Haoui).
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Table 1 Essential oil composition of *Inula viscosa* (L.) leaves obtained by both hydrodistillation (HD) and steam distillation (SD).

N°	tr (min)	RI	Component	Relative content (%)	
				HD	SD
1	18.676	1161	Menthol	0.22	–
2	26.697	1510	Butyl hydroxy toluene	4.11	2.63
3	27.355	1544	1,6,10-Dodecatrien-3-ol,3,7,11-trimethyl	0.63	–
4	27.936	1574	Caryophyllene oxide	0.17	–
5	28.336	1594	Fokienol	3.37	1.89
6	28.600	1607	$C_{15}H_{22}O$	1.79	–
7	28.765	1615	$C_{15}H_{24}$	0.14	–
8	28.824	1618	$C_{15}H_{22}O$	1.14	–
9	28.941	1624	Cubenol	–	0.29
10	29.305	1642	$C_{15}H_{24}$	0.77	–
11	29.599	1656	$C_{15}H_{22}$	0.32	–
12	29.828	1667	$C_{15}H_{24}O$	0.52	–
13	30.046	1678	$C_{15}H_{22}O$	0.89	–
14	30.298	1690	Isobutyrate de 3-méthoxycuminyl	0.71	–
15	30.386	1694	$C_{15}H_{24}O$	0.33	–
16	30.610	1708	3,7,11-Trimethyl dodeca-1,6,10 triène,3,9-diol	0.85	–
17	31.268	1759	$C_{15}H_{22}O$	0.85	–
18	32.466	1840	Phytone	0.31	–
19	32.713	1855	$C_{15}H_{22}O_2$	4.65	8.11
20	32.905	1861	Pentadecanoic acid	1.85	–
21	33.742	1922	12-Carboxyeudesma-3,11 (13) diene	28.88	56.81
22	33.847	1930	2,3-Didehydrocostic acid	–	3.25
23	34.770	1998	*n*-Hexadecanoic acid	5.38	1.91
24	37.155	2126	Phytol	2.96	0.28
25	37.452	2145	9,12-Octadecadienoic acid	2.03	–
26	37.555	2154	Linolenic acid	7.80	0.74
27	37.849	2174	Octadecanoic acid	–	0.75
28	39.799	2296	Tricosane	1.50	0.80
29	41.180	2395	Tetracosane	0.80	0.78
30	42.554	2482	Eicosanol	2.46	–
31	42.767	2497	Pentacosane	5.43	2.31
32	44.700	2601	Hexacosane	0.89	1.02
33	47.156	2705	Heptacosane	4.82	2.09
			Sesquiterpenes hydrocarbons	1.23	–
			Oxygenated sesquiterpenes	46.7	72.98
			Fatty acids	17.06	3.4
			Alkanes	13.44	7
			Alcohols	6.9	0.28
			Others	1.24	–
			Total	86.57	83.66

Compound 19 *m*/*z* (relative intensity in %): 234 (30), 219 (55), 201 (10), 189 (8), 173 (19), 164 (20), 145 (24), 138 (100), 131 (23), 123 (46), 117 (33), 105 (44), 97 (83), 91 (72), 81 (53), 67 (25), 55 (43), 41 (34), '–': not detected.

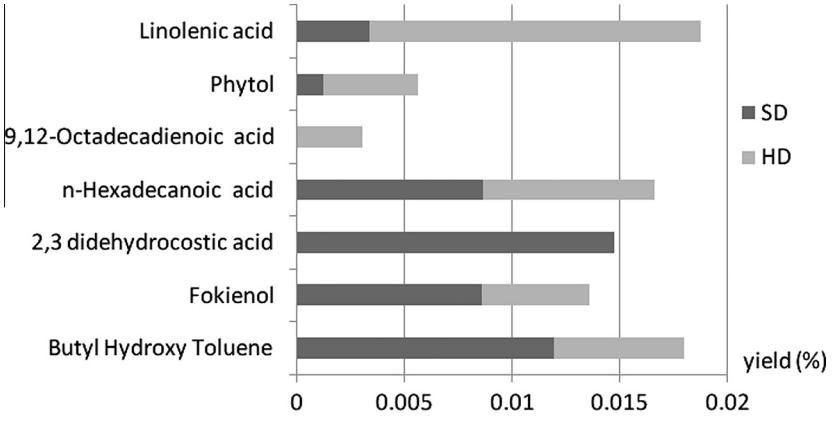

Figure 1 Yields of major compounds given by HD and SD.

2. Materials and methods

2.1. Plant material

Leaves were collected in March 2010 from Sidi Rezine village (South of Algiers). The oil was obtained by extraction of dried plant material (13%) by two extraction methods, hydrodistillation and steam distillation, using a Clevenger type apparatus for 4 h. The *I. viscosa* oils were stored at 4 °C until analysis. The compound yield is calculated by the following formula:

$$\text{yield of compound } (\%) = \frac{\text{extraction yield } (\%) \times \text{compound content } (\%)}{100}$$

2.2. GC–MS analysis conditions

Gas chromatography–mass spectroscopy (GC–MS) analyses of oil samples were carried out on a Hewlett–Packard 6890N gas chromatograph coupled to a HP 5973 mass selective detector (MSD). A HP5 column (30 m × 0.32 mm film thickness 0.25 μm) was used. The analysis was performed using the following temperature program: oven isotherm at 35 °C for 5 min then from 35 to 250 °C at 6 °C/min. Helium was used as the carrier gas at 1 ml/min flow rate. The injector and detector temperatures were held, respectively, at 250 °C. Mass spectra were recorded with ionisation energy of 70 eV and interface temperature of 280 °C.

2.3. Identification of components

The identification of the oil constituents was based on a comparison of their retention indices relative to (C_{10}–C_{24}) *n*-alkanes with those of literature. Further identification was made by matching their recorded mass spectra with those stored in the NIST mass spectral library of the GC–MS data system or with the published mass spectra (Adams, 2007).

3. Results and discussion

The yields of *I. viscosa* essential oils obtained by hydrodistillation and steam distillation were 0.148% (w/w) and 0.453% (w/w), respectively. Thirty-three compounds of the total oil were identified, representing 86.57% and 83.66% for the two used extraction methods, respectively. Its main compounds were 12-carboxyeudesma-3,11 (13) diene (28.88%); linolenic acid (7.80%); pentacosane (5.43%); *n*-hexadecanoic acid (5.38%); heptacosane (4.82%); butyl hydroxy toluene (4.11%) and fokienol (3.37%) for hydrodistillated oil. While for the steam distillated essential oil the mains percentages were 12-carboxyeudesma-3,11 (13) diene (56.81%); 2,3-didehydrocostic acid (3.25%); butyl hydroxy toluene (2.63%); pentacosane (2.31%); heptacosane (2.09%); *n*-hexadecanoic acid (1.91%) and fokienol (1.89%).

To our knowledge, this is the first report on the composition of the essential oil from Algerian *I. viscosa*. The chemical composition for the two oils (Table 1) is characterized by high amounts of oxygenated sesquiterpenes (46.7–72.98%), the steam distillation gives a higher yield (0.257%) of 12-carboxyeudesma-3,11 (13) diene compared to hydrodistillation (0.043%); almost 6 times more.

The essential oil of *I. viscosa* (L.) contains compounds of interesting biological properties. Some authors stated that 12-carboxyeudesma-3,11 (13) diene has an antifungal (Shtacher and Kashman, 1970; Cafarchia et al., 2002) and antimicrobial activity (Blanc et al., 2006). *n*-Hexadecanoic acid was found to have an antioxidant and antimicrobial activity (Bodoprost and Rosemeyer, 2007) and a larvicidal effect on *Rhizopertha dominica* (Falodun et al., 2009). Ogunlesi et al. (2009) communicated the anti-inflammatory activity of phytol. Therefore, according to Hernandez et al. (2005) the sesquiterpene acid "2,3-didehydrocostic acid" has an anti-inflammatory activity. This could well explain the importance of the *I. viscosa* (L.) in the traditional Algerian pharmacopeia.

The Fig. 1 presents the yield of major compounds given by hydrodistillation (HD) and steam distillation (SD). It is noticed that SD gives higher quantities of butyl hydroxy toluene and fokienol, compared to the HD, conversely for the compounds: linolenic acid, phytol. However, the 2,3-didehydrocostic acid exists only in the oil obtained by SD, contrary for the 9,12-octadecadienoic acid which exists only in the HD, for *n*-hexadecanoic acid the two extraction methods give the same quantities. The extraction method influenced the composition of the essential oil; therefore, the choice of method depends on the field of the essential oil use.

This investigation is different to those found in some oils from Turkey (Perez-Alonso and Velasco-Negueruela, 1996) (25.2% borneol, 22.5% isobornyl acetate and 19.5% bornyl acetate), Spain (Camacho et al., 2000) (38.8% fokienol and 7.71% nerolidol) and France (Blanc et al., 2006) (21.1% fokienol, 8.6% nerolidol and 6.2% eudesm-6-en-4α-ol), but in accordance with the oil of Italy (De laurentis et al., 2002) (62.37% 12-Carboxyeudesma-3,11 (13) diene). Probably this difference is caused by the ecological factors and genetic variations.

4. Conclusion

The results presented in this study are the first given informations on the chemical composition of essential oil from the Algerian *I. viscosa* leaves. It showed that oxygenated sesquiterpenes are the major fraction for the two extraction methods (46.7–72.98%), and the *I. viscosa* essential oil can be a good source of sesquiterpenes acids compounds.

The considerable reported biological activities of *I. viscosa* essential oils make them good candidates to develop natural-derived therapeutics. It might be also, an alternative additive for foods and pharmaceuticals preparations. For future works, we will try to isolate 12-carboxyeudesma-3,11 (13) diene and to study some biological activities in order to find its applications.

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