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Volatile constituents of *Peganum harmala* (*Zygophyllaceae*)

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Summary.- Fresh and dry *Peganum harmala* from Morocco were investigated for volatile components. Thirty-one volatile constituents were identified from aerial organs (leaves and stems) and roots. The dry parts were qualitatively richer in volatiles than the fresh ones. The leaves contained more volatile molecules than stems and roots. The main constituents were propylic acid and 2,3-dihydrobenzofurane identified in both fresh and dry materials, 3-octanone present in the aerial parts, and isovanillin detected only in dry *P. harmala* organs.

Résumé.- Les parties aériennes et souterraines, sèches et fraîches, de *Peganum harmala* ont été étudiées pour leur composition en substances volatiles. Trente et un constituants volatils ont été identifiés chez cette espèce originaire du Maroc. Les organes secs sont qualitativement plus riches en substances volatiles que les organes frais. Les feuilles contiennent plus de composés que les tiges et les racines. Les constituants volatils les plus représentés sont l'acide propylique et le 2,3-dihydrobenzofurane identifiés dans tous les organes, l'3-octanone présente dans les parties aériennes et l'isovanilline detectée uniquement dans les organes secs de *P. harmala*.

Key-words : *Zygophyllaceae* - *Peganum harmala* - Volatile - 2,3-Dihydrobenzofurane - 3-octanone - Isovanillin.

I. INTRODUCTION

The *Zygophyllaceae* are a family of about 24 genera and 240 species, mostly of xerophytic or halophytic habitats (Ronse Decraene *et al.*, 1996). *Peganum* is a genus of five to six species distributed in the Middle East, along the African coast of the Mediterranean sea

and in Spain. *Peganum harmala* commonly known as "harmal" was claimed to be an important medicinal plant (Adaay, 1994) as in traditional moroccan medicine (Bellakhdar, 1997). The seeds of *P. harmala* were used as a spice and as an intoxicant, and psychotropic effects were attributed to them (Farnsworth, 1968). *P. harmala* alkaloids were reported to possess abortifacient potentiality (Nath *et al.*, 1993), antiproliferative activity (Ayoub *et al.*, 1994) and many other biological activities, i.e. analgesic, diuretic, anthelmintic, antimicrobial effects.

On the other hand, the quality of seed oil from *P. harmala* was determined as edible (Siddiqui and Afza, 1978). The seed oil mainly contained linoleic, oleic and palmitic acids (Al-Shamma and Abdul-Ghany, 1978; Kusmenoglu *et al.*, 1995). Few studies relative to flavonoids and volatile constituents were reported for the aerial parts of *P. harmala* (Zhenli *et al.*, 1994; Sharaf, 1996; Sharaf *et al.*, 1997). As far as we know it is the first time that fresh and dry spicy *P. harmala* were investigated for volatile constituents from both aerial parts (leaves, stems, fruits and seeds) and roots.

II. MATERIAL AND METHOD

A. Plant

Peganum harmala L. was collected in the region of Agadir (Morocco) in the spring of 1997. A voucher specimen was preserved in the Herbarium at the Faculty of Science (Department of Biology, University Ibnou Zohr, Agadir, Morocco).

B. Extraction

The different parts of the plant (seeds, fruits, stems, leaves and roots) were cubed and placed in conical flasks with diethyl ether. After maceration for few days, the filtered organic extracts were concentrated to a small volume under nitrogen and used directly for Gas Chromatography/Mass Spectrometry (GC/MS) analysis.

C. GC/MS analysis

Analysis of the organic extracts from the different parts of *P. harmala* was performed on a Hewlett-Packard GC/MS system. The chromatograph was fitted with a 25 m x 0.20 mm polydimethylsiloxane OPTIMA-1 (fused film thickness: 0.25 µm) silica capillary column. The carrier gas was helium with a flow rate of approx. 0.6 ml/min; the injector and detector temperatures were 200°C and 220°C, respectively. The column was temperature programmed as follow: 50°C - 200°C (3°C/min). The mass spectra were recorded on a mass selective quadrupole-type detector of the HP 5970A class, using a potential of 70 eV for ionisation by electron impact. Volatile compounds were identified by their mass spectra and retention indices (Stenhagen *et al.*, 1976; The Mass Spectrometry Data Centre, 1986; MacLafferty and Stauffer, 1989; Pacakova and Pelt, 1992). The volatile constituents of *P. harmala* extracts were listed in Table 1 in order of their elution.

III. RESULTS AND DISCUSSION

Thirty-one volatile constituents were identified from fresh and dry *P. harmala* (fifteen and twenty five volatile components, respectively). No volatile compounds were detected in fruits and seeds. The fresh and dry leaves were richer than the fresh and dry stems, and the roots (Table 1).

Fresh and dry leaves contained twelve and nineteen identified volatile compounds, respectively. The fresh leaves extract was composed primarily of N-acetylaniline (12.5%), aniline (7.3%) and isoquinoline (6.4%); the dry organs contained mainly 2,3-dihydrobenzofurane (12.5%) and propylic acid (11.1%).

Fresh and dry stems contained six and thirteen identified volatile constituents, respectively. The major volatile components of fresh organs were 2,3-dihydrobenzofurane

Table 1.- Volatile composition (percentage) of fresh and dry parts of *P. harmala*.
Tableau 1.- Composés volatils (en pourcentage) des organes frais et secs de *P. harmala*.

Compounds	Retention indices (min)	Fresh leaves	Fresh stems	Dry leaves	Dry stems	Dry roots
Not identified	3.70			2.5[a]		
Propylic acid	4.00	2.8		11.1	11.5	46.3
Butanol	4.30			3.5		
Pent-3-en-2-one	4.53	4.9		3.2		
Not identified	5.45	2.0				
Butyric acid	6.40			5.0		7.5
(E)-3-hexenol	6.65	2.2				
Methyl-4-methyl valerate	6.80	2.3	2.3		0.9	
(E)-2-heptenal	7.88			1.3		
Tiglic acid	9.55					13.6
3-Octanone	11.10	2.3	1.7	5.3	19.2	
5-Methyltetrahydrofurfural	11.14					6.7
(E,E)-2,4-hexadienal	11.40	0.9		4.3		
Caproic acid	12.30			0.6	2.6	8.9
Not identified	13.30	3.2			3.3	
Not identified	14.45	4.8	1.9			
Aniline	18.90	7.3				
Not identified	21.90	1.8	15.2			
N-Formylaniline	22.30			4.5	9.1	
Isoquinoline	23.60	6.4	4.6	1.4	3.9	
Not identified	23.70	3.9		2.8		
2,3-Dihydrobenzofurane	24.80		51.5	12.5	0.9	
N-Acetylaniline	25.30	12.5		3.8		
(E,Z)-2,4-decadienal	27.28			2.8		
Indole	27.70	1.4				
Thymol	28.11				2.0	
(E,E)-2,4-decadienal	28.30			5.6		
Piperitenone	28.40		15.2			
5-Ethyldihydrofuran-2-one	31.45			0.5	4.2	
Isovanillin	31.70			1.8	2.3	13.4
Not identified	35.05			2.6	3.3	
3,4-Dihydroxybenzene acetic acid	36.80				4.9	
β-ionone	37.00				8.1	
Dihydroactinidiolide	37.71			0.9		
6-Methyl-2-propylpyrimidone	38.40			3.5	5.1	
Pentadecane	39.45	1.0		0.5		
Not identified	39.80	4.8		0.8		
Not identified	40.45	8.2				
1,2-Dihydropyrin-6-one	40.80		2.6			
Not identified	41.14			17.3		
Not identified	44.80		4.9		0.8	3.5
Not identified	47.38			1.9	14.2	
Not identified	49.90				3.7	
Myristic acid	51.72	4.8				
Not identified	56.30	16.6				
Not identified	56.50	5.8				

[a] relative percentage of the volatile compounds based on the GC/MS chromatographic area

(51.5%) and piperitenone (15.2%) while those of the dry stems were 3-octanone (19.2%), propylic acid (11.5%) and N-formylaniline (9.1%). 3-octanone and isoquinoline were identified in all aerial parts (fresh and dry).

Six compounds were identified in the roots, i.e. propylic acid (46.3%) and tiglic acid (13.6%).

The dry organs contained qualitatively more volatile compounds than the fresh ones. Isovanillin and caproic acid were present only in the dry parts (leaves, stems and roots), due to the drying process.

The volatile compounds content of *P. harmala* from Morocco was relatively different from that of *P. harmala* (leaves and stems) from China (Zhenli *et al.*, 1994). However, amine compounds, i.e. aniline were detected in *P. harmala* from both origins, while N-phenylformamide and N-acetylaniline were identified from the chineese and the moroccan plant, respectively.

IV. CONCLUSION

More and more industries are turning to a search for novel sources for natural components. This paper demonstrates the broad spectrum of volatile compounds from fresh and dry *P. harmala* from Morocco. This plant is an attractive natural ressource for research programmes and also for aroma applications in food industry.

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