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Chemical Composition and Antimicrobial Activity of Essential Oil of *Moricandia arvensis* L. (DC.)

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Abstract: The essential oils of the aerial parts of two populations of Moricandia arvensis in the Setif region (Algeria) were analyzed by gas chromatography and mass spectrometry (GC-MS). Thirty compounds were identified from the oils of M. arvensis, representing 80.8% of the total essential oil of southern population and 19 compounds of the population north of Setif, representing 93% of total oil. The analysis showed that the essential oils are rich in fatty acid (34.1-22.1%). The major constituent are palmitic acid (13.2-12.9%) and the phytol (7.9-10.5%). The Setif population is characterized by 3-butenylisothiocyanate and Octadecanoic acid, 2-hydroxy-1,3-p. The effects of these oils on the growth of *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853) and *Staphylococcus aureus* (ATCC 25923) were investigated by the diffusion method. The oils showed no significant antibacterial activity.

Key words: *Moricandia arvensis*, brassicaceae, antimicrobial activities, essential oil

INTRODUCTION

Moricandia arvensis, Brasicaceae family, includes five subspecies distributed in northern Africa; the studies on essential oils of this species are rare. The Brassicaceae is very rich in glucosinolates and sulfur compounds responsible for strong odors (Vaughn and Berhow, 2005); hydrolysis of these glucosonates can provide fatty acids (Rash *et al*., 2001; Jones *et al*., 2006). Rodriguez *et al*. (2006) have identified the 5-methylthiopentane-nitrile as majority component in *Diplotaxis tenuifolia*. The Isothiocyanates and nitrile have been identified in *Lepidium coronopus* by Radulovic *et al*. (2008) and in *Arabidopsis thaliana* by Rohloff and Bones (2005); Majetic *et al*. (2007). The major product of *Lepidium meyenii* is the phenyl acetonitrile (Tellez *et al*., 2002). The major component in oil of *Raphanus sativus* is the phytol (Blazevic and Mastelic, 2009), while that of the fruits of the same species is the 3-butenyl isothiocyanate (Mastelic *et al*. 2008; Taveira *et al*., 2009).

M. arvensis is rich in sulfur compounds, glucosinolates and isothiocyanates (Fahey *et al*., 2001). The indole glucosinolates is reported in *M. arvensis* (Belkhiri and Lockwood, 1990). The study of Braham *et al*. (2005) allowed the isolation of eight phenolic glycosides.

A number of studies have suggested that cruciferous vegetables have anticarcinogenic activity (Graham, 1983; Wattenburg, 1972). Glucosinolates are biologically active secondary metabolites found in the Brassicaceae and related families (Raybould and Moyes, 2001; Fahey *et al*., 2001; Tokuhisa *et al*., 2004; Aaron *et al*., 2005).
Moricandia arvensis is a dietetic species (Local Food-Nutraceuticals Consortium, 2005); it shows an important antioxidant activity and also serves as a source of various products, including polyphenols (Braham *et al*., 2005). The leaves of *M. arvensis* are used in traditional cooking. Decoctions of leaves and stems were employed in the treatment of syphilis (Le Floch, 1983) and scorbut (Cheieb and Boukhris, 1998).

The aims of the present study were to identify and compare the composition of essential oils of *M. arvensis* and determine the antibacterial activity.

MATERIALS AND METHODS

Plant material: The aerial parts of *Moricandia arvensis* were collected from two Setif regions (north and south) (Algeria) in April 2010. A voucher specimen is deposited in the Herbarium of the Biology Department of Ferhat Abbas University (Algeria). Leaves, flowers and branches

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were dried at room temperature for 7 days and used for analyses.

Essential oil analysis: The essential oils were extracted by hydrodistillation of dried plant material using a Clevenger-type apparatus for 3 h. The oils were stored in sealed glass vials at 4-5°C prior to analysis. Yield based on dry weight of the sample was calculated. The essential oil were analysed on a Hewlett-Packard gas chromatograph Model 5890, coupled to a Hewlett-Packard MS model 5871, equipped with a DB5 MS column (30 m X 0.25 mm; 0.25 μm), programming from 50°C (5 min) to 300°C at 5°C mn^{-1}, 5 min hold. Helium as carrier gas (1,0 mL min^{-1}); injection in split mode (1 : 30); injector and detector temperature, 250 and 280°C respectively. The MS working in electron impact mode at 70 eV; electron multiplier, 2500 V; ion source temperature, 180°C; mass spectra data were acquired in the scan mode in *m/z* range 33-450. The compounds assayed by GC in the different essential oils were identified by comparing their retention indices with those of reference compounds in the literature and confirmed by GC-MS by comparison of their mass spectra with those of reference substances (Adams, 2001).

Evaluation of the antibacterial activity: The antibacterial activity of the oil was carried out by the disc diffusion method, according to the National committee of clinical laboratory standards against three of American Type Culture Collection (ATCC) namely: *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853), *Staphylococcus aureus* (ATCC 25923) which were obtained from the Microbiology and Parasitology Laboratory of Ferhat Abbas University Hospital. It was performed using an 20 h culture growth at 37°C and adjusted to approximately 105 CFU mL^{-1}. Five hundred microliters of the bacterial suspension was spread on the surface of Muller-Hinton Agar plates. Sterile filter paper disks (Whatman No. 1.6 mm in diameter) containing 10 μL of each dilution of the oil (half, 1/4 and 1/8 v/v in the absolute ethanol) were placed on the surface of the media. The plates were left 30 min at room temperature to allow the diffusion of the oil and then they were incubated at 37°C for 24 h. At the end of this period, the inhibition zones were measured. All the experiments were performed in triplicate. Positive (Gentamycin, 10 μg $disc^{-1}$) and negative controls (10 μL ethanol) were also included in the test.

RESULTS AND DISCUSSION

The extraction of essential oils of two populations of *Moricandia arvensis* (L.) DC., presents an average yield of 0.065%. This yield is 0.07% for the southern population of Setif and 0.06% for the north population.

The analysis of essential oils by GC and GC/MS enabled the identification of 4 alkanes, one alkene, 7 fatty acids, six alcohols, one aldehyde, three ester and two derivatives of glucosinolates, which 2 sulfur compounds and one isothiocyanate. In total, 30 compounds were identified in the population of southern Setif and 19 in the population of the north (Table 1). Fatty acids are predominant in the essential oil of *M. arvensis,* to 34.1% for the population of southern Setif and 22.1% for the population of the north, followed by the glucosinolates (23.5-12%). The two dominant compounds in the essential oil of *M. arvenssis* are palmitic acid (13.2-12.9%) and phytol (7.9-10.5%). The population of southern Setif differs from the north of Setif by the presence of 3-butenylisothiocyanate (11.9%), the octadecanoic acid (10.3%), the heptacosane and the pentadecanoic acid (2%).

Many essential oils, derived of plant, are known to exhibit antimicrobial activity against a wide range of bacteria and fungi. The *in vitro* antibacterial activity of the *Moricanda arvensis* essential oil in comparison with Gentamicin is shown in Table 2. The bacteria tested were resistant to all concentrations of essential oils studied, except for the half dilution of the essential oil of population of northern Setif which has showed a moderate activity against *Escherichia coli* and *Staphylococcus aureus*, with a diameter of 9 and 15 mm, respectively.

The result yield of *M. arvensis* is similar to that obtained by Rodriguez *et al.* (2006) for *Diplotaxis tenuifolia* (0.079%). This performance can be considered low compared to other species of Brassicaceae, such as *Raphanus sativus* (0.18%) (Blazevic and Mastelic, 2009). The components identified in our study characterizes almost all species of Brasicaceae. The studies conducted on the phytochemical *M. arvensis* shows that this species contains phenolic glycosides, indoles, derivatives of glucosinolates and the fatty acid (Belkhiri and Lockwood, 1990; Bennett *et al*., 2004; Braham *et al*., 2005). Glucosinolates are compounds containing sulphur and nitrogen, they characterize the Brassicaceae family and neighboring families of *Caparales* order (Chen and Andreasson, 2001; Hopkins and Evrard, 2003; Yan and Chen, 2007).

Twenty Two chemical components identified in *M. arvensis* essential oils are identical to those found in other species of the Brassicaceae cited by Rohloff and Bones (2005), Mastelic *et al.* (2008) and Blazevic and Mastelic (2009).

Table 1: Chemical composition of *M. arvensis* essential oil

Compounds	KI	Setif	
		South	North
Essential oil wild		0.07	0.06
Total of the essential oil (%)		80.8	93
Number of compounds		30	19
Alkane			
Tridecane	1300	3.9	6.9
Eicosane	1998	1.1	0.6
Pentacosane	2498	0.8	0.9
Heptacosane	2672	2	-
Total		6.0	8.4
Alkene			
Tridecene <1->	1292	0.9	1.4
Fatty acid			
Nonanoïc acid	1266	0.6	-
Capric acid	1362	0.8	0.7
Lauric acid	1555	4.6	4.8
Myristic acid	1753	3.5	2.8
1,2-Benzenedicarboxylic acid, (phtalate)	1853	1.1	0.9
Palmitic acid	1953	13.2	12.9
Octadecanoic acid, 2-hydroxy-1,3-p	2680	10.3	-
Total		34.1	22.1
Alcohol			
Octadecanol	2082	1.6	1.1
Acetone			
4-hydroxy-4-methyl-pentan-2-one	839	1.9	3.3
4-(2,6,6-trimethylcyclohexa-1,3-dienyl)but-2one	1330	0.4	-
Nerylacetone	1447	0.8	0.6
2-pentadecanone	1778	0.5	-
2-pentadecanone, 6,10,14-trimethyl	1836	4.7	7.6
Farnesylacetone C	1904	1.6	1.4
Total		9.9	12.9
Aldehyde			
Benzene acetaldehyde	1045	0.5	-
Nonanal	1105	0.7	-
Tetradecanal	1610	0.3	2.7
Pentadecanal	1711	0.4	-
Total	1.9	2.7	
Esters			
Cyclopentanoate d'ethenyle	1512	0.4	1.5
Linolenoate de methyl	2134	2.5	0.9
Total		2.9	2.4
Others			
Dimethyltrisulfide	970	2.5	1.5
1,4-dimethyl tetrasulfide	1219	0.9	-
3-butenylisothiocyanate	981	11.9	-
Phytol	2102	7.9	10.5
Heptyl hexyl ether	1263	0.3	-
Total		23.5	12

Table 2: Antibacterial activity of *Moricandia arvensis* oil *in vitro*

	Inhibition zone (mm)						
	1/2		1/4		1/8		
Strains [C] v/v	P_1	P_2	P_1	P_2	P_1	P_2	Gen.
Escherichia coli ATCC 25922	3	9	-	5	-	-	32
Pseudomonas aeruginosa ATCC 27853	2	3	-	4	-	-	20
Staphylococcus aureus ATCC 25923	5	15	-	8	-	-	30

P_1: Setif south, P_2: Setif north, Gen.: Gentamicine (10 μg $disk^{-1}$); Inhibition zone (diameter of the disk, 6 mm, include), values represent average of three determination

Glucosinolates and these derivatives have various applications due to their antibacterial properties (Al-Gendy *et al*., 2010), antifungal (Rodriguez *et al*., 2006), antioxidants (Skandrani *et al*., 2008) and anti-nutrients in food (Hopkins and Evrard, 2003; Jahangir *et al*., 2009) but present results show that the oil of Setif populations has no bacterial activity.

In brief, essential oils analysis carried out on the populations of *M. arvensis* showed both inter-specific variability in their essential oil composition; but the abundance of majorities' compounds were emphasized.

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