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Essential oil of some seasonal flowering plants grown in Saudi Arabia

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P. Boissieri;
A. Linearifolia;
F. Vulgare;
T. Hamosa;
L. Halophilus;
R. Muricata;
C. Ciliaris

Abstract The constituents of the essential oils of *Rumex vesicarius*, *Erucaria hispanica*, *Schimpera arabica*, *Savignya parviflora*, *Horwoodia dicksoniae*, *Sisymbrium irio*, *Plantago amplexicaulis*, *Plantago boissieri*, *Arnebia linearifolia*, *Foeniculum vulgare*, *Trigonella hamosa*, *Lotus halophilus*, *Reseda muricata*, *Cenchrus ciliaris* is reported. These oils were analyzed by GC/MS and most of them are being studied for the first time.

1. Introduction

The rainy season in the central region of Saudi Arabia which comes between January and April brings with it a variety of flowering plants. Some of those plants are edible by local people while others are used in folk medicine (Chaudhary et al., 1419; Takechi and Tangka, 1994; Tanira et al., 1996; Singh et al., 1998; Ruberto et al., 2000; Shukla et al., 1989; Kim and Ahn, 2001; Boulios, 1983; Shinwar and Khan, 2000).

In continuation of our interest in the chemical constituents of plants grown in Saudi Arabia (Al-Khathlan et al., 1991; Al-Hazimi and Al-Khthlan, 1993; Al-Khathlan and Al-Hazimi, 1996; Al-Mazroa, 2003). We report here a detailed GC/MS study of the essential oils of fourteen plants belonging to eight different families. These are *Rumex vesicarius* (Polygonaceae), *Erucaria hispanica*, *Schimpera arabica*, *Savignya parviflora*, *Horwoodia dicksoniae*, *Sisymbrium irio* (Cruciferae), *Plantago amplexicaulis*, *Plantago boissieri*, (Plantaginaceae), *Arnebia linearifolia* (Boraginaceae), *Foeniculum vulgare* (Umbeliferae,

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Apiaceae), *Trigonella hamosa*, *Lotus halophilus* (Leguminosae), *Reseda muricata* (Resedaceae), *Cenchrus ciliaris* (Gramineae). Most of these plants are being studied here for the first time except for *R. vesicarius* (Al-Hazimi and Al-Khthlan, 1993) *S. irio* (Khan et al., 1991). *P. ampexicaulis* (Ronsted et al., 2001). *R. muricata* (El-sayed et al., 2001) and *F. vulgare* (Ravid et al., 1983; Arsalan et al., 1989; Singh et al., 1990; Venskutonis and Dapkevicius, 1996; Baser and Ozek, 1997; Muckenstrum et al., 1997; Ruberto et al., 2000; Jimenez et al., 2000; Ono et al., 1996; Mimica-Dukic et al., 2003; Kawther, 2007; Gulfaraz et al., 2008; Chowdury et al., 2009; Miguel et al., 2010).

2. Experimental

2.1. Plant material

The plant samples were collected from the central region of Saudi Arabia over the period of January to March 2001 and was identified at the Herbarium of the Department of Botany, King Saud University, Riyadh, Saudi Arabia. Aerial parts of fresh plants (50 gm each) were ground and subjected to hydrodistillation for 4 h using essential oil distillation apparatus.

2.2. Essential oils analysis

The essential oils were analyzed on Shimadzu GC/MS-QP 5050 system. The column used was DB-1 glass column (30 m × 0.25 nm). The carrier gas was helium with a flaw rate of 41.8 ml/min, the injector temperature was 250 °C with column temperature ranging from 50–290 °C. The MS was operated with 0.1 L split 100:1 using El Mode. Each compound was identified by comparison with the literature reports and by computer matching with standard spectra in NIST and Wiley libraries (Stenhagen et al., 1975; Formacek, 1982).

3. Results and discussion

3.1. Rumex vesicarius

Essential oils of six plant samples collected from different places of central Saudi Arabia were obtained by steam distillation. The samples were given the following codes according to the place of collections: Sudier (200 km north of Riyadh) (RV-1), Dawadmi (300 km west of Riyadh) (RV-2), Kharj (100 km south of Riyadh) (RV-3), Riyadh Airport (50 km north of Riyadh) (RV-4), Aljenadriah (80 km east of Riyadh) (RV-5), and Riyadh city (RV-6). Yields of essential oils obtained from these samples on fresh weight basis are given in Table 1.

Table 1 Yield of essential oils obtained from the samples of *R. vesicarius*.

Sample	%
RV-1	0.02
RV-2	0.10
RV-3	0.09
RV-4	0.06
RV-5	0.03
RV-6	0.06

Steam distillation of these samples gave light brownish color oil with no smell which turned to a waxy like material after being left for few minutes at room temperature. Gas chromatography–mass spectrometry (GC–MS) analysis of the oil samples resulted in the identification of fifteen constituents of the oils in total. The relative concentrations of the volatile components identified are presented in Table 2. The major constituents of Sudier (RV-1) oil were nonacosane (27.7%), pentatriacontane (16.7%), palmitic acid (12.9%), 3,8-dimethylundecane (6.4%), and 2-ethyl-2-methyl-l-decanol (5.8%). The major constituents of Dawadmi (RV-2) oil were 9,12-octadecadienoic acid (41.4%), palmitic acid (39.4%) and phytol (7.7%). The major constituents of Kharj (RV-3) oil were palmitic acid (30.7%) and phytol (17.4%). The major constituents of Riyadh Airport (RV-4) oil were 9,12,15-octadecatrienoic acid (46.7%) and palmitic acid (26.0%). The major constituents of Aljenadriah (RV-5) were palmitic acid (37.2%) and 9,12,15-octadecatrienoic acid (29.5%) while the major constituents of Riyadh city (RV-6) oil were 9,12-octadecadienoic acid (29.1%) and palmitic acid (20.3%).

From Table 2 it is evident that essential oils composition of *R. vesicarius* collected from six places of central Saudi Arabia were drastically varies quantitatively as well as qualitatively. Palmitic acid was the only compound which was present as major constituents (ranging from 12.9–39.4%) in all oil samples of *R. vesicarius*, thus presence of palmitic acid could be considered as a characteristic parameter for *R. vesicarius* essential oils.

3.2. Erucaria hispanica

Steam distillation of *E. hispanica* aerial parts gave oil in 0.04% yield (v/w) on fresh weight basis. Gas chromatography–mass spectrometry (GC–MS) analysis of the oil resulted in the identification of total 13 constituents representing 85.1% of the oil. The relative concentrations of the volatile components identified are presented in Table 3. The main constituents of the oil were palmitic acid (36.7%), cyclohexanol dodecyl (11.2%), 1,14,17-Eicosatrienoic acid methyl ester (9.1%), Linolenic acid (7.5%) and phytol (5.6%).

3.3. Schimpera arabica

Fresh aerial parts of *S. arabica* was steam distilled to gave oil in 0.18% yield (v/w) on fresh weight basis. The oil was analyzed by Gas chromatography–massspectrometry (GC–MS) which resulted in the identification of 13 constituents representing 97.4% of the oil. The relative concentrations of the identified compounds are presented in Table 4. The major constituents of the oil were palmitic acid (42.6%), linolenic acid (16.7%), tetradecanoic acid (14.3%) and undecanoic acid (5.6%).

3.4. Savignya parviflora

Aerial parts of this plant gave yellow color oil in 0.13% yield (v/w) on a fresh weight basis by steam distillation. Gas chromatography–mass spectrometry (GC/MS) analysis of the oil resulted in the identification of 14 components representing 89.8% of the oil. The relative concentrations of the identified constituents are presented in Table 5. The major constituents

Table 2 Percentage composition of essential oils from the aerial parts of *R. vesicarius* grown in different locations of central Saudi Arabia.

Compound	RV-1	RV-2	RV-3	RV-4	RV-5	RV-6
Palmitic acid	12.9	39.4	30.7	26.0	37.2	20.3
Phytol	–	7.7	17.4	–	5.8	2.8
Tetracosane	2.6	–	1.5	1.6	–	–
Eicosane	3.8	–	2.4	–	–	–
Tetratetracontane	4.4	0.3	–	–	–	4.4
Pentatriacontane	16.7	0.3	–	1.4	–	1.4
Nonacosane	27.7	–	–	–	–	
2-Ethyl-2-rnethyl-l-decanol	5.8	0.2	–	–	2.3	1.8
3,8-Dimethylundecane	6.4	–	2.4	–	–	–
9,12-Ottadecadienoic acid	–	41.4	–	–	–	29.1
Tritetracontane	–	0.5	–	0.6	–	2.3
1-Nonene-4,6,8-trimethyl	–	–	–	–	1.4	4.6
3-Dodecanone	3.5	–	–	–	2.6	–
Nonadecane	–	–	2.2	–	1.4	–
9,12,15-Octadecatrienoic acid methyl ester	–	–	–	46.7	29.5	–

Table 3 Percentage composition of essential oils from aerial parts of *E. hispanica*.

Compound	%	MW
Dodecanoic acid	3.9	200
Tetradecanoic acid (Myristic acid)	6.4	228
Cyclohexanol, dodecyl	11.2	268
Linolenic acid	7.5	292
Palmitic acid	36.7	256
Bicyclo-3,1,1-hept-3-en-2-ol	1.3	152
Phytol	5.6	296
1 l,14,17,Eicosatrienoic acid, methyl ester	9.1	320
Palmitaldehydedially acetate	1.8	338
4,1 1-Dodecanedione	1.6	198
3,8-Dimethyl decane	4.5	170
Docosane	2.4	310
Pentatriacontane	3.2	492

Table 4 Percentage composition of essential oils from aerial parts of *S. arabica*.

Compound	%	MW
Pentanoic acid	1.4	102
Undecanoic acid	5.6	186
Tetradecanoic acid	14.3	228
Oxirane, decyl	3.1	184
Palmitic acid	42.6	256
Butanoic acid	1.6	88
Butanoic acid,2-propenyl ester	0.4	128
Linolenic acid	16.7	292
Ether,3-butenyl pntyl	0.9	142
Eicosane	4.9	282
Octane,3-ethyl-2,7-dimethyl	0.7	170
2,9-Dimethyldecane	4.7	170
Hexane,3,3-dimethyl	0.5	144

of the oil were palmitic acid (40.9%), Phytol (8.5%), eicosane (6.4%) and tetratetracontane (5.9%).

Table 5 Percentage of composition of essential oil from aerial parts of *S. parviflora*.

Compound	%	MW
Cyclopentaneundecanoic acid	1.6	254
Dodecanoic acid	3.5	200
Tetradecanoic acid (Myristic acid)	3.2	228
p-Menth-8(10)-en-9-ol	4.5	154
Palmitic acid	40.9	256
Butanoic acid-3-methyl	1.8	102
Phytol	8.5	296
1 0-Undecyn- 1-ol	5.1	168
Oleic acid	2.8	280
2,9-Dimethyldecane	2.2	170
3,3-Dimethylhexane	1.6	114
Eicosane	6.4	228
Dodecane, 2-methyl	1.7	184
Tetratetracontane	5.9	618

Table 6 Percentage composition of essential oils from aerial parts of *H. dicksoniae*.

Compound	%	MW
Oxirane, dodecyl	0.9	212
Undecannoic acid, methyl ester	0.6	200
Palmitic acid	6.2	256
Nonadecanoic acid, methyl ester	0.6	326
1 0-Octadecanoic acid, methyl ester	1.0	296
Phytol	3.1	296
Cyclopentanone-2-(1-methylpropyl)	1.1	140
Nonadecanol	1.6	284
Tricosane	4.9	324
Cyclogeraniolane	0.7	126
Eicosane	1.4	282
Pentacosane	19.4	352
Heptacosane	3.0	380
Nonacosane	1.5	408
Hexatriacontane	55.0	506

3.5. Horwoodia dicksoniae

Aerial parts of *H. dicksoniae* yielded 0.07% oil (v/w) on fresh weight basis by steam distillation. The volatile oil has a yellow color. Fifteen component representing 98.8% of the oil were identified through Gas chromatography–mass spectrometry (GC/MS) analysis. The relative concentrations of the identified constituents are presented in Table 6. The principle components of this oil were heaxtriacontane (55.0%), pentacosane (19.4%), palmitic acid (6.2%) and tricosane (4.9%).

3.6. Sisymbrium irio

Steam distillation of *S. irio* Aerial parts gave yellow color oil in 0.08% yield (v/w) on fresh weight basis. Gas chromatography–mass spectrometry (GC–MS) analysis of the oil resulted in the identification of total 13 constituents representing 67.1% of the oil. The relative concentrations of the volatile components identified are presented in Table 7. The main constituents of the oil were palmitic acid (10.4%), menthol (6.7%), Pentacosane (6.5%) and n-heptadecanol (5.2%).

3.7. Plantago amplexicaulis

Fresh aerial parts of P. *amplexicaulis* yielded 0.07% oil (v/w) on fresh weight basis by steam distillation. The volatile oil turned to a waxy like material after being left for few minutes at room temperature. Eight constituents representing 49.7% of the oil were identified through Gas chromatography–mass spectrometry (GC/MS) analysis. The relative concentrations of the identified constituents are presented in Table 8. The principle components of this oil were palmitic acid (19.8%), 3-mathylundecane (10.5%) and l-ethyl-2-methylcyclohexanol (7.8%).

3.8. Plantago boissieri

Steam distillation of *P. boissieri* aerial parts gave oil in good yield i.e. 0.2% (v/w) on fresh weight basis. Gas chromatography–mass spectrometry (GC–MS) analysis of the oil resulted in the identification of total seven constituents representing 67.89% of the oil. The relative concentrations of the volatile components identified are presented in Table 9. The main constituents of the oil were Bicyclo-2,2,1-heptane,2-(2-propenyl) (17.86%), l-dodecane-3-ol (12.36%), phenol, 3-ethyl (9.8%) phenol, 4-methyl (7.96%), nonacosane (7.64%), 2,3,6-trimethyl hepta-6-en-l-ol (6.41%) and benzoic acid (5.86%).

3.9. Arnebia. linearifolia

Aerial parts of *A. linearifolia* gave oil in 0.01% yield (v/w) on fresh weight basis by steam distillation. The volatile oil turned to a waxy like material after being left for few minutes at room temperature. Twelve constituents representing 90.6% of the oil were identified through Gas chromatography–mass spectrometry (GC/MS) analysis. The relative concentrations of the identified constituents are presented in Table 10. The major

Table 7 Percentage composition of essential oils from aerial parts of *S. irio*.

Compound	%	MW
Palmitic acid	10.4	256
n-Heptadecanol	5.2	256
Menthol	6.7	156
2-Hexyl-l-decanol	4.2	242
cis-Cyclohexan-l,l,2-trimethyl-3,5-bis(l-methylethyl)	3.8	206
Hexatriacontane	3.8	506
Pentacosane	6.5	352
Tricyclo-4,3,O,O,7,9-nonane,2,2,5,5,8,8-hexamethyl	4.8	206
Oxirane, dodecyl	4.2	212
2-Hex,yl-l-decanol	4.9	242
NonadecanoJ	4.7	284
Decahydro-9-ethyl-4,4,8,10-tetramethyl naphthalene	4.5	222
Oxirane,tetradecyl	3.5	240

Table 8 Percentage composition of essential oils from aerial parts of *P. amplexicaulis*.

Compound	%	MW
Myristic acid	1.7	228
1-Ethyl-2-methylcyclohexanol	7.8	142
Palmitic acid	19.8	156
3 -Methyl undecane	10.5	170
2,4-Dimethyl undecane	1.1	184
Pentane,2,3,3-trimethyl	1.3	114
2,4-Dimethyl decane	3.1	170
2,9-Dimethyl decane	4.6	170

Table 9 Percentage composition of essential oils from aerial parts of *P. boissieri*.

Compound	%	MW
Phenol, 4-methyl	8.0	108
Bicyclo-2,2, 1-heptane,2-(2-propenyl)-	17.9	136
Phenol, 3–ethyl	9.8	122
Benzoic acid	5.9	122
2,3,6-Trimethyl hepta-6-en-l-ol	6.4	156
l-Dodecane-3-ol	12.4	184
Nonacosane	7.6	408

Table 10 Percentage composition of essential oils from aerial parts of *A. linearifolia*.

Compound	%	MW
Myristic acid	1.2	228
Pentalene, octahydro-1-(2-octyldecyl)	18.8	362
1,6, 1 0-Dodectrien-3-ol,3,7, 1 1–trimethyl	2.5	222
Palmitic acid	7.3	256
Bicyclo-3,l,l-heptane,2,6,6-trimethyl-3(2-ropenyl)	1.7	178
Phytol	19.0	296
3,3-Dimethyl hexane	1.3	114
Heptadecane	7.9	240
2-methyl, undecane	4.7	170
Docosane	11.8	310
Hexatriacontane	5.2	506
Tetfatefracontane	9.2	618

Table 11 Percentage composition of essential oils from aerial parts of *F. vulgare*.

Compound	%	MW
7-Anisaldehyde	0.9	136
Anethole	76.4	148
Apiol	16.3	222
Palmitic acid	0.8	256
Falcarinol(Z)-(−)-1,9-heptadecadiene-4,6-diyne-3^{L}ol	0.3	244
Phytol	4.0	296
Dodecane	0.3	170
Eicosane	0.3	282
2,9-Dimethyl decane	0.4	170

Table 12 Percentage composition of essential oils from aerial parts of *T. hamosa*.

Compound	%	MW
Decanoic acid	7.3	200
Tetradecanoic acid	15.9	228
Cyclohexanol, dodecyl	0.8	268
Palmitic acid	38.4	256
Ether, heptyl hexyl	1.1	200
Phytol	7.6	296
Linolenic acid, methyl ester	11.3	292
Isopregol	1.5	154
Oleic acid	1.4	282
Pentatricontane	0.9	492
Docasane	1.5	310
Hexatricontane	3.4	506

Table 13 Percentage composition of essential oils from aerial parts of *L. halophilus*.

Compound	%	MW
Phytol	49.8	296
2,9-Dimethyldecane	16.3	170
Heptadecane	33.0	240

Table 14 Percentage composition of essential oils from aerial parts of *R. muricata*.

Compound	%	MW
2,2-Dimethyl-3-(E)-beta(2-methylallyl) Cyclopropane-carboxylic acid	6.5	168
2,4-Dimethyl decane	0.4	170
Palmitic acid	10.0	256
Pbytol	6.8	296
1,3-Methanopentalene,octahydro	2.3	122
Pentanoic acid,3–methyl	0.3	116
Eicosane	4.9	282
Hexane-3,3-dimethyl	2.5	114
Nonadecane	8.9	268
Ether,hexyl pentyl	1.8	172
Hexatricontane	17.2	268
Octane,3-ethyl-2,7-dimethyl	1.4	170

Table 15 Percentage composition of essential oils from aerial parts of *C. ciliaris*.

Compound	%	MW
Valeric acid	3.0	102
n-Caproic acid	1.4	116
3,4-Dimethyl cyclohexanol	4.2	128
Palmitic acid	42.9	256
Phytol	9.9	296
3-Buten-2-ol,2-methyl	2.0	86
cis-3-Hexane	1.3	84
3,3-Dimethyl hexane	0.7	114
l-Butyne,3-methyl-3(l-methylethoxy)	1.4	126
Tridecanol,2-ethyl-2-methyl	6.7	242
4-Penten-1-ol,2,2,4-trimethyl	5.1	128
3,9-Dimethyl undecane	5.8	184
Octane,3-ethyl-2,7-dimethyl	2.0	170

components of this oil were phytol (19.0%), pentalene, octahydro-l-(2-octyldecyl) (18.8%), docosane (11.8%), tetratetracontane (9.2%), heptadecane (7.9%) and palmitic acid (7.3%).

3.10. *Foeniculum vulgare*

Detailed literature survey revealed that several studies on essential oil of *F. vulgare* growing in different parts of world (Ronsted et al., 2001; El-sayed et al., 2001; Ravid et al., 1983; Arsalan et al., 1989; Singh et al., 1990; Venskutonis and Dapkevicius, 1996; Baser and Ozek, 1997; Muckenstrum et al., 1997) have been done. However, no literatures on chemical investigation of *F. vulgare* grown in Saudi Arabia were found. This prompted us carry out this study. Steam distillation of *F. vulgare* aerial parts gave a yellow oil in 0.1 yield (v/w) on fresh weight basis. Gas chromatography–mass spectrometry (GC–MS) analysis of the oil resulted in the identification of total nine constituents representing 99.6% of the oil. The relative concentrations of the volatile components identified are presented in Table 11. The principle constituents of the oil were anethole (76.4%) and apiol (16.3%).

3.11. *Trigonella hamosa*

Fresh aerial parts of *T. hamosa* on steam distillation gave yellow color oil in yield 0.04% (v/w) on fresh weight basis. Twelve constituents representing 91.1% of the oil were identified through Gas chromatography–mass spectrometry (GC/MS) analysis. The relative concentrations of the identified components are presented in Table 12. The major components of this oil were palmitic acid (38.4%), tetradecanoic acid (15.9%), linolenic acid methyl ester (11.3%), phytol (7.6%) and decanoic acid (7.3%).

3.12. *Lotus halophilus*

Steam distillation of *L. halophilus* aerial parts gave yellow color oil in yield 0.07% (v/w) on fresh weight basis, interestingly, only three components contributing 99.3% of the oil were identified. The relative concentrations of these three identified components i.e. phytol (49.8%), Heptadecane (33.0%) and 2,9-Dimethyldecane (6.3%) are presented in Table 13.

3.13. *Reseda muricata*

Steam distillation of *R. muricata* aerial parts gave yellow oil in 0.13% yield (v/w) on fresh weight basis. Gas chromatography–mass spectrometry (GC–MS) analysis of the oil resulted in the identification of total 12 constituents representing 63.2% of the oil. The relative concentrations of the volatile components identified are presented in Table 14. The main constituents of the oil were hexatricontane (17.2%), palmitic acid (10.0%), nonadecane (8.9%), phytol (6.8%) and 2,2-dimethyl-3-(E)-beta-(2-methylallyl)-cyclopropane carboxylic acid (6.5%).

3.14. *Cenchrus ciliaris*

Fresh aerial parts of *C. ciliaris* was steam distilled to gave oil in 0.08% yield (v/w) on fresh weight basis. The oil was analyzed by Gas chromatography–mass spectrometry (GC–MS) which resulted in the identification of 13 constituents representing 86.4% of the oil. The relative concentrations of the identified compounds are presented in Table 15. The major constituents of the oil were palmitic acid (42.9%), phytol (9.9%), tridecanol, 2-ethyl-2-methyl (6.7%) and 3,9-dimethylundecane (5.8%).

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