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A chemotaxonomic evaluation of some *Scabiosa* L. species in Iran

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ABSTRACT

In this study, the chemotaxonomic status and fatty acid compositions of eleven species of *Scabiosa* L., naturally growing in Iran, were determined using gas chromatography. The main compounds were found to be palmitic acid (16:0; 4.63–23%), behenic acid (22:0; 2.40–35.52%), lignoceric acid (24:0; 1.91–34.02%) and linoleic acid (18:3n6; 0.73–13.95%). Principal Component and Principal Coordinate analyses revealed the segregation of the studied *Scabiosa* species in two groups. This was consistent with the traditional classification presented by Rechinger. However, there is a lot of debate about the taxonomy of the *Scabiosa* species. Based on pitted epicalyx, Greuter and Raus have removed members of the *Scabiosa* sect. *Asterocephalus* to the genus *Lomelosia*. Our results showed that the fatty acid profiles of the species belonging to the sect. *Scabiosa* were distinct and confirmed the opinion supported by Greuter and Raus, that these species should be moved to the *Lomelosia* genus.

1. Introduction

Scabiosa L., a genus of the Dipsacaceae family, consists of approximately 80 annual or perennial species distributed throughout the world (Verlaque, 1983). According to APG III, it is included within the larger family of Caprifoliaceae (Reveal and Chase, 2011). Some *Scabiosa* species are widely used in traditional medicine, as well as cosmetic and food industry (Hartwell, 1982; Perdetzoglou, 1994; Bonet and Valles, 2007).

There is some complexity in the taxonomic position of the *Scabiosa* species (Carlson et al., 2012). Hybridization is common and, as a result, the number of reported species (and subspecies) varies widely (Bobrov, 1957; Jasiewicz, 1976). The most-important changes of taxonomy within *Scabiosa* species were established by Greuter and Raus (1985). Based on morphological characters, they moved some taxa within *Scabiosa* s. l. to *Lomelosia* Raf. However, Rechinger and Lack (1991) and Jamzad (1993) did not accept the changes but maintained a traditional and broad concept of the *Scabiosa* genus. It is interesting to note whether there is any correlation between the classical taxonomy and chemical taxonomy.

Chemotaxonomic studies constitute an important method for evaluating the relationship among species (Nakiboglu, 2002; Christopoulou et al., 2008; Perdetzoglou et al., 1996). The chemical compounds which

are traditionally employed as chemosystematics markers were reported from *S. hymettia* Boiss. & Spruner, *S. tenuis* Spruner ex Boiss. and *S. argentea* L. Fatty acid (FA) profiles are increasingly being used as chemotaxonomic tools for the identification and classification of different plant species.

This study is aimed at identifying the potential of fatty acids as chemotaxonomic markers within *Scabiosa* species. To our knowledge, this is the first report on the chemotaxonomy and chemical diversity of *Scabiosa* species in Iran.

2. Materials and methods

2.1. Chemicals

Standard chemicals were purchased from Merck (Darmstadt, Germany). All organic solvents used for fatty acid extraction were of analytical grade.

2.2. Plant sample

The plant used in this study were collected from their natural habitats in Iran and identified according to *Flora Iranica* (Rechinger, 1989)

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Table 1The *Scabiosa* L. investigated taxa, place of collection and vouchers.

Vochers No.	Locality	Species	Sect.	Subgen.	Genus
HSBU4004	Siahbisheh	<i>S. columbaria</i> L.	<i>Scabiosa</i>	<i>Scabiosa</i>	<i>Scabiosa</i> L.
ASMUH95007	Masuleh	<i>S. amoena</i> Jacq.			
ASMUH95008	Bojnord	<i>S. koelzii</i> Rech. f.			
HSBU4000	Piranshahr	<i>S. persica</i> Boiss.	<i>Asterocephalus</i>	<i>Asterocephalus</i>	
HSBU4001	Tehran	<i>S. calocephala</i> Boiss.			
ASMUH95011	Khozestan	<i>S. leucactis</i> Pat.			
ASMUH95006	Ardebil	<i>S. caucasica</i> M. B.			
ASMUH95009	Mashhad	<i>S. rotata</i> Bieb.			
ASMUH95010	Kashmar	<i>S. porphyroneura</i> B.			
HSBU4003	Tehran	<i>S. olivieri</i> Coult.	<i>Olivierianae</i>		

and Flor of Iran (Jamzad, 1993). The voucher specimens were deposited in Azarbaijan Shahid Madani University Herbarium (ASMUH) and the Herbarium of Shahid Beheshti University (HSBU). The list of voucher specimens and the details of localities are presented in Table 1.

2.3. Extraction process

The dried plant material (0.5 g) was extracted with 5 mL diethyl ether at room temperature for 30 s using a vortex. After the solvent separation, the residue was extracted three times more in the same way. The solvent was evaporated to dryness, until a constant weight was obtained under a stream of nitrogen at room temperature (Hashempour et al., 2018).

2.4. Methylation methods for FAME synthesis

In this procedure, 10 mg of the extract was placed in test tubes to which 0.5 mL of n-hexane and 2.0 mL potassium hydroxide (10 M) solution were added. The reaction was performed at 60 °C for 15 min. After cooling to room temperature, 2.0 mL of NaCl (20% w/v) solution and 0.5 mL n-hexane was added and mixed for 5 min. Subsequently, the tubes were centrifuged for 10 min and the n-hexane layer was collected for GC analysis (Christie, 1993).

Table 2Percentage fatty acid composition of some *Scabiosa* species from Iran.

11	10	9	8	7	6	5	4	3	2	1	Compounds
1.15	0.70	1.33	1.17	1.67	1.93	1.32	0.72	2.54	0.81	5.95	Lauric acid (C12:0)
3.41	0.50	3.38	0.25	4.43	2.5	4.09	0.82	2.93	1.35	5.65	Myristic acid (C14:0)
0.99	2.04	1.04	1.08	0.88	0.29	2.41	1.01	1.21	0.75	1.05	Myristoleic acid (C14:1)
–	1.51	0.97	0.64	0.68	0.19	0.59	1.40	1.05	0.64	–	Ginkgolic acid (C15:1)
23.00	10.62	23.43	4.63	20.19	16.79	20.14	5.78	12.04	9.45	21.15	Palmitic acid (C16:0)
0.63	1.50	0.68	0.95	0.49	0.18	1.01	1.49	0.99	1.13	–	9-Hexadecenoic acid (C16:1)
6.03	2.99	7.01	2.45	6.44	5.92	5.46	1.02	4.01	3.92	5.78	Stearic acid (C18:0)
2.30	2.72	0.81	1.52	7.19	3.97	4.72	0.92	10.46	1.74	3.06	Oleic acid (C18:1n9c)
–	1.93	–	0.90	–	–	1.58	0.84	0.58	0.71	–	Linoleic acid (C18:2n6c)
3.72	7.09	7.93	3.53	0.89	3.91	3.66	23.90	3.44	8.90	4.19	Arachidic acid (C20:0)
12.49	4.73	13.95	0.73	2.57	17.88	10.01	4.20	4.33	6.32	5.46	γ-Linolenic acid (C18:3n6)
–	1.95	–	1.31	–	–	1.61	1.56	1.15	1.05	7.59	Eicosenoic acid (C20:1n9)
12.58	15.18	8.78	14.93	14.09	12.67	6.52	35.52	13.79	26.82	2.40	Behenic acid (C22:0)
0.85	1.63	0.81	1.82	1.07	0.7	1.07	1.05	1.00	1.01	–	Erucic acid (C22:1n9)
–	–	–	0.52	–	–	0.56	0.36	–	0.46	–	DHA (C22:6n3)
–	4.94	–	1.78	–	0.28	0.74	0.25	0.27	–	–	Docosadienoic acid (C22:2)
6.47	8.70	4.23	34.02	19.77	14.25	4.49	11.41	14.23	18.52	1.91	Tricosanoic acid (C23:0)
5.62	2.47	6.78	2.47	4.19	2.97	3.50	0.94	3.12	1.92	6.50	Lignoceric acid (C24:0)
–	–	–	10.69	4.76	1.90	–	0.54	1.66	1.41	–	Nervonic acid (C24:1n9)
61.98	48.97	62.87	63.45	71.67	60.94	49.18	80.11	56.11	71.69	53.99	Σ Saturated FA
17.26	22.95	18.26	21.94	17.64	25.39	24.30	13.62	22.94	15.22	19.57	Σ Unsaturated FA
79.24	71.92	81.13	85.39	89.31	86.33	73.48	93.73	79.04	86.91	73.56	Total FA

The species – 1: *S. micrantha*, 2: *S. caucasica*, 3: *S. calocephala*, 4: *S. leucactis*, 5: *S. rotata*, 6: *S. koelzii*, 7: *S. columbaria*, 8: *S. amoena*, 9: *S. persica*, 10: *S. olivieri*, 11: *S. porphyroneura*.

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