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Volatile constituents as complementary tools to characterize seven sardinian *Genista* species

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ABSTRACT

The aroma fingerprints of seven endemic Sardinian populations of *Genista* species (*Genista bocchierii*, *Genista arbusensis*, *Genista cadasonensis*, *Genista corsica*, *Genista morisii*, *Genista pichisermolliana*, *Genista sulcitana*) were defined for the first time in order to investigate the relationship between their chemotaxonomic classification and discriminating volatiles. It is the first time that the inter-species compositional variations of non-terpenoidic constituents and target volatiles such as linalool, limonene, 2,6-nonadienal, 2-pentylfuran, (*E*)-2-(2-pentenyl)-furan, *ß*-caryophyllene and caryophyllene oxide were related by Principal Components Analysis to the actual chemotaxonomic classification of the selected Sardinian *Genista* species. Although they are not considered marketable aromatic plants, these original results have shown the potential role of volatiles not only as new further important chemotaxonomic markers of *Genista* species, but also as potential ecological factors in the chemodiversity of some endemic Mediterranean *Genista* or, more in general, in vegetation changes and reforestation processes.

1. Introduction

The genus *Genista* L. (Fabaceae = Leguminosae) comprises about 100 species of spiny and non-spiny shrubs distributed mainly in the Mediterranean region (Gibbs, 1968). The taxonomy of the genus *Genista* is rather complex and the classification of the Italian species is mainly based on their morphological and chorological characteristics. Several Sardinian *Genista* species have already been studied (Brullo and De Marco, 1996; Valsecchi, 1986, 1993) and more recently *Genista ephedroides* (Fabaceae) has been investigated on its karyological, molecular, and phenetic aspects (Bacchetta et al., 2011, 2012).

Many phytochemical studies of the genus *Genista* have focused especially on the content of quinolizidine alkaloids (Bousquet et al., 2005; Martins et al., 2005; Pistelli et al., 2001), flavonoids (Giachi et al., 2002; Rauteret al., 2009; Serrilli et al., 2010), and saponins (Boutaghane et al., 2013).

In contrast, very few data have been reported about the volatile constituents of *Genista* species. A study on *Genista aucheri* Boiss, a Turkish endemic species (Sener et al., 1986) identified several monoterpenes and the sesquiterpene caryophyllene

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was the main constituent. More recently, some *Genista* spp. endemic to Algeria have been investigated on the essential oil composition and antimicrobial activity (Lograda et al., 2009, 2010, 2011). In addition, the essential oil composition of *Genista tinctoria* L. and G. *sessifolia* DC. (Southern Italy) and their biological activities have been investigated (Rigano et al., 2009). Furthermore, some studies on Mediterranean plant biodiversity and endemism have been paying special attention to taxa with narrow geographical distributions as well as to small populations such as *Genistae* spp. (Bacchetta et al., 2012; De Castro et al., 2012; Santos-Gally et al., 2012). Considering the role of *Genista* genus in the Mediterranean ecosystems and vegetation changes, it is important to point out that the *Genista* genus has been already included in monitoring studies on the volatile organic compounds (VOCs) and shrubland expansion in different habitats (Kaal et al., 2011; Owen et al., 2001). In this contest, *Genista* spp. shrubs have been considered useful to manage semi-arid environments in the mitigation processes of Mediterranean desertification (Bianchi et al., 2005; Gabriels et al., 2008; Geeson and Brandt, 2003).

Therefore, in the present work, the hydrodistilled essential oils (EOs) from seven Sardinian *Genista* endemisms collected during their flowering period were studied for the first time. In respect to the Gibbs arrangement (Valsecchi, 1984, 1986, 1993), the selected species belong to different subgenera and sections:

- subgenus *Genista* Gibbs (section *Erinacoides* Spach: *G. sulcitana* Valsecchi, *G. pichisermolliana* Valsecchi and *G. arbusensis* Valsecchi; section *Scorpioides* Spach: *G. corsica* Loisel DC., *G. cadasonensis* Valsecchi and *G. morisii* Colla);
- subgenus *Spartocarpus* Spach (section *Ephedrospartum* Spach: *G. bocchierii* Bacch.).

Furthermore, the EOs fingerprints of these selected species were compared by Principal Components Analysis (PCA) in order to characterize the chemo-and biodiversity of these peculiar Mediterranean island endemisms of *Genista* genus.

2. Materials and methods

2.1. Plant material

The *Genista* species samples (A-G) were collected in specific Sardinian areas and voucher specimens were deposited at the Department of Environmental and Life Science Section Botany and Botanical Garden of the University of Cagliari. Table 1 reports botanical identification names, voucher numbers, flower morphological description, collection places, and ecological features of the analysed *Genista* populations.

Table 1
Distribution, ecology and sampling of the selected *Genista* species.

	Species	Subgenus	Section	Distribution and pedoclimatic conditions	Flower morphological description	Voucher number	Collection place
B	*G. cadasonensis* Valsecchi	Genista	Scorpioides	CS, coasts, thermophilous, heliophilous, arid, stony, sunny calcicolous substrates	shrubs with alternate branching, with axillary spines; leaves are simple or tree-foliolate; flowers isolated or in cymes, with calyx glabrous; standard equalling the keel and the wings; legume is oblong, glabrous containing one or eight seeds.	GD290403CS	Codula di Sisine (NU)
E	*G. morisii* Colla	Genista	Scorpioides	SWS, thermophilous, heliophilous, various substrates		GM080403SA	Sardara (CA)
C	*G. corsica* (Loisel) DC.	Genista	Scorpioides	Sardinia, Corsica, thermophilous, heliophilous, costal and mountain substrates		GC230402CA	Calamosca (CA)
D	*G. bocchierii*. Bacch.	Spartocarpus	Ephedrospartum	SWS, thermophilous, granite costal substrate	unarmed and ephedriform shrubs, whit one-three foliolate leaves, racemose and many-flowered inflorescences; calix is sericeus, conical-campanulate; standard is ovate-cordate, rounded to obtuse at apex, sericeus on the back; legume is ovate-beaked pubescents	GB240504PU	S. Margherita di Pula (CA)
A	*G. arbusensis* Valsecchi	Genista	Erinacoides	SWS, thermophilous, heliophilous, hilly, dolostones and costal fossil dune substrates	trees or shrubs with alternate branching, spines, leaves are simple or tree-foliolate; flowers in cymes or racemes with calyx sericeus; standard broadly ovate, equalling the keel both standard; legume is narrowly oblong, sericeus containing one or more seeds	GA120503NE	Nebida (CA)
F	*G. pichisermolliana* Valsecchi	Genista	Erinacoides	CES, heliophilous, sunny, open, degraded and granite substrates		GP130603LA	Laconi (NU)
G	*G. sulcitana* Valsecchi	Genista	Erinacoides	SWS, thermophilous, heliophilous, degraded, stony, silicicolous substrates		GS090503MV	Guspini (CA)

CS = Central Sardinia, CES = Central Eastern Sardinia; SWS = South-Western Sardinia.