Natural Product Research

Formerly Natural Product Letters

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/gnpl20

Geographical variation of the chemical composition in essential oils extracted from Sardinian *Salvia verbenaca*

Alberto Mannu , Sara Melito , Giacomo Luigi Petretto , Paola Manconi , Giorgio Mario Pintore & Mario Chessa

NATURAL PRODUCT RESEARCH
https://doi.org/10.1080/14786419.2020.1788021

Taylor & Francis
Taylor & Francis Group

Check for updates

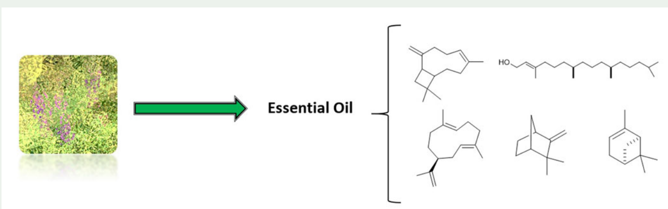
Geographical variation of the chemical composition in essential oils extracted from Sardinian *Salvia verbenaca*

Alberto Mannu[a], Sara Melito[b], Giacomo Luigi Petretto[a], Paola Manconi[a], Giorgio Mario Pintore[a] and Mario Chessa[a]

[a]Department of Chemistry and Pharmacy, University of Sassari, Sassari, Italy; [b]Department of Agriculture Science, University of Sassari, Sassari, Italy

ABSTRACT

Salvia verbenaca is a perennial herbaceous plant well appreciated as medicinal herb which can be found in Mediterranean area, Europe, Africa and Asia. In this study, *S. verbenaca* flowers and leaves were collected in six different geographical areas of Sardinia (Italy). Information about the variation of the chemical composition of plants grown in different locations were obtained from gas chromatography analysis of the extracted essential oils. Gas chromatography analysis detected 33 compounds, which have been grouped in oxygenated monoterpenes, monoterpene hydrocarbons, sesquiterpenes and other compounds. The chemical composition of each group resulted significantly affected by sampling site in terms of geography and altitude. Concerning the geographical distribution of the detected chemicals, sesquiterpenes were found in considerable amount in three localities, monoterpenes hydrocarbons in two and other compounds were predominant only in one site. Regarding the altitude level, monoterpenes, sesquiterpenes and other compounds were predominant, respectively, at medium and medium-high altitude.



ARTICLE HISTORY
Received 6 March 2020
Accepted 11 June 2020

KEYWORDS
GC/MS analysis; Salvia verbenaca; essential oil; volatiles

1. Introduction

The genus *Salvia* comprises about 900 species which spontaneously grow worldwide except in Australia where it has been naturalised (Atlas of living Australia 2019). It is diffused in both the hemispheres, in temperate and tropical regions. The *Salvia* genus can be found in six main biodiversity areas: 40 species are present in the central-

CONTACT Mario Chessa mchessa@uniss.it

Supplemental data for this article can be accessed at https://doi.org/10.1080/14786419.2020.1788021.

meridional USA, 17 in California, 300 within Mexico and near lands, 210 in south America, 250 distributed between the Mediterranean area and Asia, 30 in austral Africa and 90 in east Asia (Natural Resources Conservation Service 2019). Many environmental factors like temperature, light, pH, osmotic and salt stress affect the germination and the growth of *Salvia verbenaca* (Javaid et al. 2018). Also, morphological and genetical characteristics of *Salvia* plants are affected by the specific geographical area (Farhat et al. 2019). Many applications of *Salvia* are known: dry leaves species of *Salvia* (*officinalis, fruticosa, lavandulifolia, sclarea, verbenaca*), as well as corresponding essential oils (EOs) have been extensively employed in cosmetics, pharmaceutics and as food ingredient. In traditional European medicine, *S. verbenaca* extracts have been employed to contrast soft dyspepsia, hyper-sweating, cognitive disorders related to ageing, skin and throat inflammation (Bonesi et al. 2017). Several *Salvia* species have shown antimicrobial, antiviral, cytotoxic, antimutagenic and antifungal activity. Some beneficial effects of *Salvia* are related to its antioxidant properties, due to its ability to act as radical scavenger (Zhao et al. 2011). Polyphenols have been proposed to contrast the aggregation process of fibrils and inhibit the formation of fibrillar assemblies (Porat et al. 2006). Also, polyphenols from *S. officinalis* show neuroprotective activity of high interest for the type II diabetes, amyloidosis, Alzheimer, Parkinson and Huntington diseases. Quali-quantitative composition of the volatile fraction has been associated with soil type, altitude, habitat and microclimatic conditions. *Salvia desoleana* EO profiles, for instance, are influenced by the soil composition and structure (Rapposelli et al. 2015). The variability of the chemical composition depending on the geographical origin is also a matter of interest for dedicate cultivations. Limited information is available on the chemical composition of volatile fraction of *S. verbenaca* and on the effect of environmental factor that can affect the chemical composition of EO (Farhat et al. 2019).

Herein, the variation of the volatile composition, with respect to geography and altitude, (determined by GC/MS) in EOs samples of Sardinian *S. verbenaca* collected from different locations (Italy) is described and discussed.

2. Results and discussion

EOs were obtained from samples of Sardinian *S. verbenaca* with an average yield value of 0.01% w/v, in accordance with the low yields reported for similar samples (Senatore et al. 1997).

Qualitative (GC–MS) and semi-quantitative (GC-FID) gas chromatography analyses of such samples allowed to detect a total of 33 volatiles compounds (Table S1, Supplementary File). Chemicals were grouped into four categories **MO**, **MI**, **SE** and **OT**, according to the compounds detected (Table S2, Supplementary File).

The chemical composition of the EOs resulted related to the specific collecting area as highlighted in Table S2. This statement it is even more evident if only the volatile compounds detected in a relative amount higher than 1% are considered.

Volatile composition of samples derived from the Asinara island (AS) and Alà dei Sardi (ALA) is quite similar and characterised by a high content of sesquiterpenes (Figure S1, Supplementary File). The first (AS) is mainly composed by monoterpenes and sesquiterpene hydrocarbons. Terpinolene (**MI**, 11.9%), (*E*)-β-caryophyllene (**SE**, 23.7%), germacrene D (**SE**, 26.3%), phytol (**OT**, 10.4%) and α-humulene (**SE**, 4.6%) contribute to almost the 75% of the overall volatile composition. The second (ALA) resulted to be composed mainly of (*E*)-β-caryophyllene (**SE**, 32.2%), germacrene D (**SE**, 32.3%), phytol (**OT**, 4.7%) and α-humulene (**SE**, 5.8%). A predominant contribution of sesquiterpene compounds was already observed in Tunisian samples of *S. verbenaca* (Taarit et al., 2010).

Phytol was the only component common to the six localities, present in an amount >1%. It follows the trend SS (78.8%) > BE (22.2%) > BU (12.1%) > AS (10.4%) > SA (8.0%) > ALA (4.7%). SA EO shows high levels of α-pinene (**MI**, 34.1%), followed by β-myrcene (**MI**, 15.2%), (*Z*)-β-ocimene (**MI**, 7.5%) and terpinen-4-ol (**MO**, 7.8%). Moderate amounts of terpineol were also detected in the samples of EO derived from Saudi-Arabian *S. verbenaca* (Al-Howariny 2002). BU samples analysis revealed high content of caryophyllene oxide (**c**, 51.0%), present only in this EO. The consistent presence of monoterpene hydrocarbons observed in samples SA and BE confirms the similar data on volatile fraction reported for EOs from Indian and Grecian Salvia (*verticillata, verbenaca, glutinosa* and *candidissima*) (Pitarokili et al. 2006). Apart from phytol, a mixture of octen-3-ol (**OT**, 1.7%), linalool (**MO**, 6.8%), α-terpineol (**MO**, 3.8%) and neryl propanoate (**MO**, 1.9%) was present in the SS samples. The predominant presence of polar compounds confirms the data reported for other Italian EOs from *S. verbenaca* (Canzoneri et al. 2011, Russo et al. 2015). As reported for other medicinal plants, some environmental parameters, characterising a specific sampling site, deeply influence, in terms of quantity, yield and chemical composition, the volatiles fractions (Melito et al., 2013, 2016). In our case, all four chemical groups are significantly affected by the sampling site and by altitude ($p < .001$) (Figure S2, Supplementary File). In particular, increasing of the category **OT** (other compounds) and **MO** (oxygenated monoterpenes) was observed as a consequence of the increasing of the altitude. A different trend was instead observed for group **MI** (hydrocarbons monoterpenes), which reaches its maximum value at medium altitude (M), and decreases at sea level (SL) and medium-high altitude (MH). Group **SE** (sesquiterpenes), instead, was predominant at SL and MH conditions. More details are reported in the Supplementary Material file.

3. Conclusions

In conclusion, the present study shows the results of a preliminary exploration of EO composition of Sardinian *S. verbenaca*. The EOs extracted from samples collected in different sites resulted characteristic of the geographical area of origin. The EO profile resulted significantly affected not only from the site origin, but also by the altitude for the four principal chemical groups identified.

Disclosure statement

No potential conflict of interest was reported by the authors.

Author's contribution

Study and designed the experiment (Mario Chessa). Performed the experiment and analysed the data (Giacomo L. Petretto, Paola Manconi). Wrote the manuscript (Sara Melito and Alberto Mannu). Revised the manuscript (Giorgio M. Pintore). All authors have read and approved the final manuscript.

References

Al-Howariny TA. 2002. Chemical composition and antimicrobial activity of essential oil of *Salvia verbenaca*. Biotechnology. 1:45–48.

Atlas of living Australia. 2019. [accessed 2020 Jan 8] http://biocache.ala.org.au/occurrences/search?q=qid:1511747200624#tab_mapView.

Bonesi M, Loizzo MR, Acquaviva R, Malfa GA, Aiello F, Tundis R. 2017. Anti-inflammatory and antioxidant agents from *Salvia Genus* (Lamiaceae): an assessment of the current state of knowledge. Antiinflamm Antiallergy Agents Med Chem. 16(2):70–86..

Canzoneri M, Bruno M, Rosselli S, Russo A, Cardile V, Formisano C, Rigano D, Senatore F. 2011. Chemical composition and biological activity of *Salvia verbenaca* essential oil. Nat Prod Commun. 6(7):1934578X1100600–1934578X1100604..

Farhat MB, Sotomayor JA, Jordán MJ. 2019. *Salvia verbenaca* L. essential oil: variation of yield and composition according to collection site and phenophase. Biochem Syst Ecol. 82:35–43..

Javaid MM, Florentine S, Ali HH, Weller S. 2018. Effect of environmental factors on the germination and emergence of *Salvia verbenaca* L. cultivars (*verbenaca* and *vernalis*): an invasive species in semi-arid and arid rangeland regions. Plos One. 13(3):e0194319..

Melito S, Sias A, Petretto GL, Chessa M, Pintore G, Porceddu A. 2013. Genetic and metabolite diversity of Sardinian populations of *Helichrysum italicum*. PloS One. 8 (11):e79043..

Melito S, Petretto GL, Podani J, Foddai M, Maldini M, Chessa M, Pintore G. 2016. Altitude and climate influence *Helichrysum italicum subsp. microphyllum* essential oils composition. Ind Crop Prod. 80:242–250..

Natural Resources Conservation Service. 2019. [accessed 2020 Jan 8] https://plants.usda.gov/core/profile?symbol=SAVE12.

Pitarokili D, Tzakou O, Loukis A. 2006. Essential oil composition of *Salvia verticillata, S. verbenaca, S. glutinosa and S. candidissima* growing wild in Greece. Flavour Fragr J. 21(4):670–673..

Porat Y, Abramowitz A, Gazit E. 2006. Inhibition of amyloid fibril formation by polyphenols: structural similarity and aromatic interactions as a common inhibition mechanism. Chem Biol Drug Des. 67(1):27–37..

Rapposelli E, Melito S, Barmina GG, Foddai M, Azara E, Scarpa GM. 2015. Relationship between soil and essential oil profiles in *Salvia desoleana* populations: preliminary results. Nat Prod Commun. 10(9):1615–1618.

Russo A, Cardile V, Graziano C, Formisano ACE, Rigano D, Canzoneri M, Bruno M, Senatore F. 2015. Comparison of essential oil components and in vitro anticancer activity in wild and cultivated *Salvia verbenaca*. Nat Prod Res. 29(17):1630–1640..

Senatore F, De Feo V, De Fusco R. 1997. Essential oils from *Salvia* spp. (Lamiaceae). I. Chemical composition of the essential oils from *Salvia glutinosa* L. growing wild in southern Italy. J Essent Oil Res. 9(2):151–157..

Taarit MB, Msaada K, Hosni K, Chahed T, Marzouk B. 2010. GC analyses of salvia seeds as valuable essential oil source. J Food Biochem. 34(1):142–151. http://dx.doi.org/10.1155/2014/838162.

Zhao J, Lou J, Mou Y, Li P, Wu J, Zhou L. 2011. Diterpenoid tanshinones and phenolic acids from cultured hairy roots of *Salvia miltiorrhiza* bunge and their antimicrobial activities. Molecules. 16(3):2259–2267..