Taylor & Francis
Taylor & Francis Group

Natural Product Research
Formerly Natural Product Letters

ISSN: 1478-6419 (Print) 1478-6427 (Online) Journal homepage: http://www.tandfonline.com/loi/gnpl20

Composition of the essential oils of three Uzbek Scutellaria species (Lamiaceae) and their antioxidant activities

Nilufar Zokirjonovna Mamadalieva, Farukh Sharopov, Prabodh Satyal, Shahnoz Sadykovna Azimova & Michael Wink

To cite this article: Nilufar Zokirjonovna Mamadalieva, Farukh Sharopov, Prabodh Satyal, Shahnoz Sadykovna Azimova & Michael Wink (2016): Composition of the essential oils of three Uzbek Scutellaria species (Lamiaceae) and their antioxidant activities, Natural Product Research, DOI: 10.1080/14786419.2016.1222383

To link to this article: http://dx.doi.org/10.1080/14786419.2016.1222383

NATURAL PRODUCT RESEARCH, 2016
http://dx.doi.org/10.1080/14786419.2016.1222383

Taylor & Francis
Taylor & Francis Group

SHORT COMMUNICATION

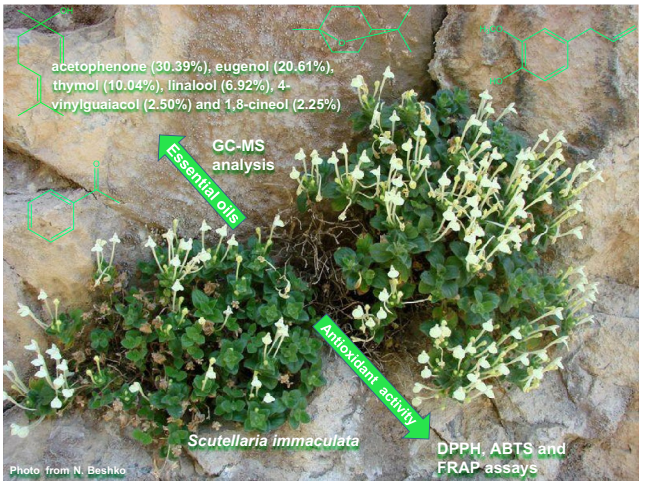
Composition of the essential oils of three Uzbek *Scutellaria* species (Lamiaceae) and their antioxidant activities

Nilufar Zokirjonovna Mamadalieva[a], Farukh Sharopov[b], Prabodh Satyal[c], Shahnoz Sadykovna Azimova[a] and Michael Wink[b]

[a]Laboratory of the Chemistry of Glycosides, Institute of the Chemistry of Plant Substances, Tashkent, Uzbekistan; [b]Department of Biology, Heidelberg University, Institute of Pharmacy and Molecular Biotechnology, Heidelberg, Germany; [c]Department of Chemistry, University of Alabama in Huntsville, Huntsville, AL, USA

ABSTRACT

The chemical composition of the essential oils obtained from aerial parts of *Scutellaria immaculata* Nevski ex Juz., *Scutellaria ramosissima* M. Pop. and *Scutellaria schachristanica* Juz. (Lamiaceae) growing wild in Uzbekistan was analysed by GC and GC–MS. The main constituents of the essential oils from *S. immaculata* were acetophenone (30.39%), eugenol (20.61%), thymol (10.04%) and linalool (6.92%), whereas constituents of the essential oils from*S. schachristanica* were acetophenone (34.74%), linalool (26.98%) and eugenol (20.67%). The *S. ramosissima* oil is dominated by germacrene D (23.96%), *β*-caryophyllene (11.09%), linalool (9.63%) and hexadecanoic acid (8.34%). The essential oils of *Scutellaria* species exhibited weaker antioxidant effects in DPPH, ABTS and FRAP assays. In FRAP assay, only eugenol exhibited a substantial reducing power IC_{50} = 2476.92 ± 15.8 (mM Fe(II)/g).



ARTICLE HISTORY
Received 29 February 2016
Accepted 12 July 2016

KEYWORDS
Flora of Uzbekistan; *Scutellaria*; GC–MS; essential oils; antioxidant activity

CONTACT Nilufar Zokirjonovna Mamadalieva nmamadalieva@yahoo.com

Supplemental data for this article can be accessed here at http://dx.doi.org/10.1080/14786419.2016.1222383.

1. Introduction

The genus *Scutellaria* (Lamiaceae) includes approximately 350 species. Many of them have been used in traditional medicine. This genus has a widespread distribution in temperate regions and tropical mountains, including Europe, North America and East Asia. In Asian countries, some *Scutellaria* species are widely used in traditional medicine, especially in China, Korea and Japan due to their anti-inflammatory, sedative, antithrombotic, antioxidant and antiviral effects (Shang et al. 2010).

In Uzbekistan, the genus *Scutellaria* is represented by 32 species and these plants are used in traditional medicine to treat epilepsy, inflammation, allergies, chorea, nervous tension states and high blood pressure (Mamadalieva et al. 2011). *Scutellaria immaculata* Nevski ex Juz. and *Scutellaria ramosissima* M. Pop. are perennial shrubs growing in Northern Tien Shan and Pamir-Alai mountains. *Scutellaria schachristanica* Juz., mainly occurring in the Pamir-Alai mountains, is a perennial subshrub species endemic to Central Asia. Flavonoids on this plant species have been extensively studied (Yuldashev & Karimov 2005; Mamadalieva et al. 2011; Eshbakova et al. 2013).

There are several reports on the composition of the essential oils of *Scutellaria* species (Cicek et al. 2011; Formisano et al. 2011). But until now, there are no published reports concerning the phytochemistry and biological activities of the essential oils of Uzbek *Scutellaria* species. As a continuation of our studies on *Scutellaria*, we describe here the volatile compounds in the essential oils of *S. immaculata, S. ramosissima* and *S. schachristanica*. Although there are widespread reports about the antioxidant effects of flavonoids from some *Scutellaria* species, the essential oils have not been studied in this context. Our study shows that the essential oil of *S. immaculata* shows substantial antioxidant activities.

2. Results and discussion

2.1. Chemical composition of essential oils

In *S. immaculata*, the major compounds of the essential oils were acetophenone (30.39%), eugenol (20.61%), thymol (10.04%), linalool (6.92%), 4-vinylguaiacol (2.50%) and 1,8-cineol (2.25%) (Table S1). The major components of *S. schachristanica* were acetophenone (34.74%), linalool (26.98%), eugenol (20.67%), *β*-terpineol (3.57%), 2-methoxy-*p*-cresol (1.89%) and 4-vinylguaiacol (1.64%), whereas the essential oil of *S. ramosissima* is dominated by the germacrene D (23.96%), *β*-caryophyllene (11.09%), linalool (9.63%), hexadecanoic acid (8.34%), caryophyllene oxide (5.90%), eugenol (5.29%), acetophenone (4.67%), thymol (3.01%) and 4-vinylguaiacol (2.42%). Overall, 38, 29 and 30 constituents were identified in the aerial parts of *S. immaculata*, *S. ramosissima* and *S. schachristanica* essential oils representing 98.92, 99.03 and 99.95% of the total, respectively (Table S1).

Like many other studies of volatile compounds of *Scutellaria* species (Dereboylu et al. 2012; Miyazawa et al. 2013; Nikbin et al. 2014), the chemical composition in the three Uzbekistan *Scutellaria* species varied with regard to predominance of sesquiterpenes and monoterpenes. The essential oils of these species were dominated by acetophenone (4.67–34.74%), linalool (6.92–26.98%), thymol (0.30–10.04%) and eugenol (5.29–20.67%). These results agree with those of previously published for essential oils content other *Scutellaria* species (Skaltsa et al. 2000; Ghannadi & Mehregan 2003; Cicek et al. 2011; Formisano et al. 2011; Wohlmuth et al. 2011). Two *Scutellaria* taxa, *Scutellaria sieberi* and *Scutellaria rupestris*

ssp. *adenotricha,* also contained high amount of linalool with a value of 22.7 and 38.8%, respectively (Skaltsa et al. 2005). Also, the results have shown that *β*-caryophyllene (22.58%) and germacrene D (42.01%) were detected as major components in *Scutellaria sibthorpii*. Eugenol (23.05%) was the main component in *Scutellaria cypria* var. *cypria*, while linalool was determined as a major component (10.92%) for *S. cypria* var. *elatior* (Dereboylu et al. 2012). Monoterpene hydrocarbons were not present in the *S. immaculata* oil; also, this oil was rather low in sesquiterpene hydrocarbons and oxygenated sesquiterpenoids. Among other compounds, considerable amount of thymol was found as a major component of the *S. immaculata* (10.04%) and *S. ramosissima* (3.01%) essential oil; thymol had been reported in the oil of *Scutellaria barbata* (Yu et al. 2004). Our study showed clear qualitative and quantitative differences. In our samples, acetophenone and eugenol were much greater than in other works. These results showed that variability in yield and chemical composition of the essential oils in *Scutellaria* species may be linked to the local environmental factors such as availability water and other unique climatic factors.

In the DPPH, ABTS and FRAP assays, the radical scavenging abilities of the essential oils and their three main components (eugenol, thymol and linalool) and also of the positive control (ascorbic acid) were measured spectrophotometrically (Table S2). The *Scutellaria* essential oil exhibited weaker antioxidant effects than ascorbic acid in DPPH, ABTS assays, but due to the presence of eugenol, thymol and carvacrol, they showed moderate antioxidant properties. In FRAP assay, only eugenol exhibited a substantial reducing power $IC_{50} = 2476.92 \pm 15.8$ (mM Fe(II)/g).

Trying to correlate obtained antioxidant effect with the chemical compositions of the tested essential oils, it is worthy to cite the work of Ruberto and Baratta (2000), who studied the antioxidant effect of essential oils and showed that monoterpenes had a significant protective effect. Also, some researchers showed that essential oils rich in phenolic monoterpenes eugenol, thymol and carvacrol have antioxidant potentials (Amiri 2012). The methanol/water extracts of *Scutellaria* are known as potent free radical scavengers (Shao et al. 1999; Schinella et al. 2002; Sokol-Letowska et al. 2007). The active principles of *Scutellaria* include the flavonoids baicalin, baicalein, wogonoside and wogonin, which are known to scavenge free radicals and limit ROS attack in food items and in organisms (Choi et al. 2002). Senol et al. (2010) reported that extracts of 33 *Scutellaria* species of Turkish origin showed weak inhibition of acetylcholine esterase and butyrylcholine esterase, while the tested extracts had a very high DPPH radical scavenging effect and moderate antioxidant activity in ferrous ion-chelating and FRAP tests. Our recent studies established that extracts *S. immaculata* and *S. ramosissima* contain various phenolic compounds such as scutellarin, baicalin and wogonin, which are known for their antioxidant activities (Mamadalieva et al. 2011). However, as compared to the results for water extracts of *S. immaculata* and *S. ramosissima,* the essential oils of *Scutellaria* species only show moderate antioxidant activity (Figures S1–S2). We assume that the antioxidant activity of the tested essential oils could be linked to their phenolic components. Due to the absence of phenols in many essential oils, most of them exhibit no or low antioxidant activities (Sharopov et al. 2015).

3. Conclusion

This study reports the chemical profiles of the essential oils from three Uzbek *Scutellaria* species containing acetophenone, linalool, thymol and eugenol as major compounds.

Essential oils *S. immaculata*, *S. ramosissima* and *S. schachristanica* showed moderate antioxidant activity due to the presence of thymol and eugenol. These properties could partly explain the utilisation of these plants in traditional medicine.

Supplementary material

Supplementary material relating to this article is available online, alongside Figures S1–S2, Tables S1–S2.

Acknowledgements

N. Z. Mamadalieva and F. Sharopov gratefully acknowledge the support of DAAD research grants.

Disclosure statement

No potential conflict of interest was reported by the authors

References

Amiri H. 2012. Essential oils composition and antioxidant properties of three *Thymus* species. Evidence-Based Complementary Altern Med. Article ID 728065. 2012: 8. http://dx.doi.org/ 10.1155/2012/728065.

Choi J, Conrad CC, Malakowsky CA, Talent JM, Yuan CS, Gracy RW. 2002. Flavones from *Scutellaria baicalensis* Georgi attenuate apoptosis and protein oxidation in neuronal cell lines. Biochim Biophys Acta - Gen Subj. 1571:201–210.

Cicek M, Demirci B, Yilmaz G, Baser KHC. 2011. Essential oil composition of three species of *Scutellaria* from Turkey. Nat Prod Res. 25:1720–1726.

Dereboylu AE, Sarikahya NB, Sengonca N, Kirmizigul S, Yasa I, Gucel S, Guvensen A. 2012. Glandular trichomes morphology, chemical composition and antimicrobial activity of the essential oil of three endemic *Scutellaria* taxa (Lamiaceae). Asian J Chem. 24:4911–4916.

Eshbakova KA, Toshmatov ZO, Yili A, Aisa HA, Abdullaev ND. 2013. Flavonoid galacturonides and glucuronide from the aerial part of *Scutellaria schachristanica*. Chem Nat Compd. 49:103–105.

Formisano C, Rigano D, Senatore F, Piozzi F, Arnold NA. 2011. Analysis of essential oils from *Scutellaria orientalis* ssp. *alpina* and *S. utriculata* by GC and GC–MS. Nat Prod Commun. 6:1347–1350.

Ghannadi A, Mehregan I. 2003. Essential oil of one of the Iranian skullcaps. Z Naturforsch C. 58:316–318.

Mamadalieva NZ, Herrmann F, El-Readi MZ, Tahrani A, Hamoud R, Egamberdieva D, Azimova SS, Wink M. 2011. Flavonoids in *Scutellaria immaculata* and *S. ramosissima* and their biological activities. J Pharm Pharmacol. 63:1346–1357.

Miyazawa M, Nomura M, Marumoto S, Mori K. 2013. Characteristic odor components of essential oil from *Scutellaria laeteviolacea*. J Oleo Sci. 62:51–56.

Nikbin M, Kazemipour N, Maghsoodlou MT, Valizadeh J, Sepehrimanesh M, Davarimanesh A. 2014. Mineral elements and essential oil contents of *Scutellaria luteo-caerulea* Bornm. & Snit. Avicenna J Phytomed. 4:182–190.

Ruberto G, Baratta MT. 2000. Antioxidant activity of selected essential oils components in two lipid model systems. Food Chem. 69:167–174.

Schinella GR, Tournier HA, Prieto JM, Mordujovich de Buschiazzo P, Ríos JL. 2002. Antioxidant activity of anti-inflammatory plant extracts. Life Sci. 70:1023–1033.

Senol FS, Orhan I, Yilmaz G, Çiçek M, Şener B. 2010. Acetylcholinesterase, butyrylcholinesterase, and tyrosinase inhibition studies and antioxidant activities of 33 *Scutellaria* L. taxa from Turkey. Food Chem Toxicol. 48:781–788.

Shang X, He X, He X, Li M, Zhang R, Fan P, Zhang Q, Jia Z. 2010. The genus *Scutellaria* an ethnopharmacological and phytochemical review. J Ethnopharmacol. 128:279–313.

Shao ZH, Li CQ, Vanden Hoek TL, Becker LB, Schumacker PT, Wu JA, Attele AS, Yuan CS. 1999. Extract from *Scutellaria baicalensis* georgi attenuates oxidant stress in cardiomyocytes. J Mol Cell Cardiol. 31:1885–1895.

Sharopov FS, Wink M, Setzer WN. 2015. Radical scavenging and antioxidant activities of essential oil components-an experimental and computational investigation. Nat Prod Commun. 10:153–156.

Skaltsa HD, Lazari DM, Kyriazopoulos P, Golegou S, Triantaphyllidis S, Sokovic M, Kypriotakis Z. 2005. Composition and antimicrobial activity of the essential oils of *Scutellaria sieberi* Benth. and *Scutellaria rupestris* Boiss. et Heldr. ssp. *adenotricha* (Boiss. et Heldr.) Greuter et Burdet from Greece. J Essent Oil Res. 17:232–235.

Skaltsa HD, Lazari DM, Mavromati AS, Tiligada EA, Constantinidis TA. 2000. Composition and antimicrobial activity of the essential oil of *Scutellaria albida* ssp. *albida* from Greece. Planta Med. 66:672–674.

Sokol-Letowska A, Oszmianski J, Wojdylo A. 2007. Antioxidant activity of phenolic compounds of hawthorn, pine, and skullcap. Food Chem. 103:853–859.

Wohlmuth H, Shepherd KM, Leach DM. 2011. Skullcap (*Scutellaria lateriflora* L.) – essential oil composition from North American and Australian provenances. 42nd International Symposium on Essential Oils. Turkey. Available from: www.scu.edu.au

Yu J, Lei J, Yu H, Cai X, Zou G. 2004. Chemical composition and antimicrobial activity of the essential oil of *Scutellaria barbata*. Phytochemistry. 65:881–884.

Yuldashev M, Karimov A. 2005. Flavonoids of *Scutellaria immaculate* roots. Chem Nat Compd. 41:32–34.