J. Fac. Pharm. Ankara / Ankara Ecz. Fak. Derg., 46(3): 853-858, 2022
Doi: 10.33483/jfpau.1098785

ORIGINAL ARTICLE / ÖZGÜN MAKALE

THE COMPARISON OF VOLATILE COMPONENTS OF *AJUGA ORIENTALIS* L. COLLECTED FROM FOUR DIFFERENT LOCATIONS IN TURKEY

TÜRKİYE'DE DÖRT FARKLI LOKASYONDAN TOPLANAN AJUGA ORIENTALIS L.'İN UÇUCU BİLEŞENLERİNİN KARŞILAŞTIRILMASI

Ayla KAYA[1*], Betül DEMİRCİ[2]

[1]Anadolu University, Faculty of Pharmacy, Department of Pharmaceutical Botany, 26470 Eskisehir, Turkey

[2]Anadolu University, Faculty of Pharmacy, Department of Pharmacognosy, 26470 Eskisehir, Turkey

ABSTRACT

Objective: *This study aimed to determine and compare the volatile compositions of A. orientalis collected from Antalya, Balıkesir, Erzurum, and Samsun in Turkey.*

Material and Method: *Microdistilled volatile samples of A. orientalis were determined by GC-FID and GC-MS systems simultaneously.*

Result and Discussion: *o-Cresol is also present in the volatiles of three provinces (except Erzurum province) as a common main compound. The main compounds of the volatiles were methyl hexadecanoate (15.8%), linalool (11.4%) and hexahydrofarnesyl acetone (9.0%) for Erzurum province; o-cresol (43.7%), methyl oleate (10.1%) and methyl linoleate (9.1%) for Samsun province; o-cresol (75.2%) for Antalya province; hexadecanoic acid (20.3%), o-cresol (10.8%) and dihydroactinidiolide (10.8%) for Balıkesir province. The samples are rich in fatty acid+esters in all localities, except Erzurum province.*

Keywords: *Ajuga orientalis, GC-FID, GC-MS, Lamiaceae, volatile component*

ÖZ

Amaç: *Bu çalışmada, Türkiye'de Antalya, Balıkesir, Erzurum ve Samsun'dan toplanan A. orientalis'in uçucu bileşenlerinin belirlenmesi ve karşılaştırılması amaçlamıştır.*

Gereç ve Yöntem: *A. orientalis'in mikrodistilasyonla elde edilen uçucu bileşenleri GC-FID ve GC-MS sistemleri ile eş-zamanlı olarak belirlenmiştir.*

* **Corresponding Author / Sorumlu Yazar:** Ayla Kaya
e-mail / e-posta: aykaya@anadolu.edu.tr, **Phone / Tel.:** +902223350580

Submitted / Gönderilme: 05.04.2022 **Accepted / Kabul:** 03.08.2022

Sonuç ve Tartışma: *o-Krezol üç ilin (Erzurum ili hariç) uçucu yağlarında ortak ana bileşik olarak bulunmaktadır. Uçucu maddelerin ana bileşikleri Erzurum ili için metil hekzadekanoat (%15.8), linalol (%11.4) ve hekzahidrofarnesil aseton (%9.0); Samsun ili için o-krezol (%43.7), metil oleat (%10.1) ve metil linoleat (%9,1); Antalya ili için o-kresol (%75.2); Balıkesir ili için hekzadekanoik asit (%20.3), o-krezol (%10.8) ve dihidroaktinidiolid (%10.8). Erzurum ili hariç tüm lokaliteler yağ asidi+ester yönünden zengindir.*

Anahtar Kelimeler: *Ajuga orientalis, GK-AİD, GK-KS, Lamiaceae, uçucu bileşen*

INTRODUCTION

The genus *Ajuga* L. (Lamiaceae), comprising about 300 species, is mainly distributed in Asia, Africa, Australia, Europe and North America. In the Flora of Turkey, the genus *Ajuga* is represented by 23 taxa, seven of which are endemic [1]. The genus of *Ajuga* contains many important bioactive compounds are used in traditional medicine against some illnesses such as gout, rheumatism and gastrointestinal diseases. Also, they have antibacterial, antitumor [2], neuroprotective effects [3] and antioxidant [4] activities among others biological effects.

A. orientalis is a perennial herbaceous plant with 6-30 cm long stems. The cauline leaves are 1-2-paired, obovate-oblong shaped. Verticillasters are crowded with violet-blue and cream-colored flowers [5]. The plant is usually grows in every region of Turkey and it is called "dağmayasılı" in the areas where it grows wildly [1].

Previous studies reported that *A. orientalis* was characterized with germacrene D (24.7%), β-cubebene (18.3%) and β-caryophyllene (16.9%) by Sajjadi and Ghannadi [6]; phytol (36.7%), n-hexadecanoic acid (14.2%) and dodecanoic acid (12.2 %) by Kücükbay et al. [7]. Volatile compounds of *A. orientalis* from natural habitat and cultivars in the first and second vegetation periods isolated by SPME analyzed by GC-MS by Dönmez [8]. 2-Hexen-1-al and 1-octen-3-ol were determined as the main components in the natural habitat and cultivars of the samples. In addition, the amount of limonene in *A. orientalis* volatile compounds was found to be another main compound [8].

In this survey, we report chemical compounds of *A. orientalis* growing in four different regions (Erzurum, Samsun, Antalya and Balıkesir) of Turkey.

MATERIAL AND METHOD

Plant Material

A. orientalis (Fig. 1) was collected from Erzurum (ESSE 14461), Samsun (ESSE 10209), Antalya (ESSE 9369) and Balıkesir (ESSE 14462) provinces of Turkey (Fig. 2). A voucher specimen is kept at the herbarium of the Faculty of Pharmacy at Anadolu University, Turkey.

Figure 1. *A. orientalis*

Figure 2. Collection areas

Isolation and Analysis of the Volatiles

The volatiles were obtained by microdistillation of the dried, ground plant materials (~500 mg) using an Eppendorf MicroDistiller®. The volatiles were analyzed by GC-FID and GC-MS systems, simultaneously. All processes were performed with reference to Demirci et. al. [9].

Identification of the Components

Identification of the volatile components was carried out with reference to Demirci et. al. [9].

RESULT AND DISCUSSION

Comparisons of the volatile components for the four populations are given in Table 1. Thirteen, fifteen, eleven and eight components were identified from the volatiles of Erzurum, Samsun, Antalya and Balıkesir localities, respectively, accounting for 72.6%, 95.2%, 97.1% and 64.9% of the oil. The major constituents of the volatiles were methyl hexadecanoate (15.8%), linalool (11.4%), hexahydrofarnesyl acetone (9.0%) and methyl linoleate (7.5%) for Erzurum province; *o*-cresol (43.7%), hexadecanoic acid (11.6%), methyl oleate (10.1%) and methyl linoleate (9.1%) for Samsun province; *o*-cresol (75.2%) for Antalya province; hexadecanoic acid (20.3%), *o*-cresol (10.8%) and dihydroactinidiolide (10.8%) for Balıkesir province. *O*-cresol is also present in three provinces as a common main compound. The volatiles are rich in fatty acid+esters and others (except Balıkesir province) while they are poor in oxygenated monoterpenes (except Erzurum province) in all localities according to Table 1. Oxygenated sesquiterpenes and sesquiterpene hydrocarbones are identified from only two localities, respectively, Erzurum and Samsun.

Table 1. The composition of the volatiles of *Ajuga orientalis*

RRI	Compound	E %	S %	A %	B %	IM
1202	3-Hexanol	-	-	-	0.8	MS
1452	1-Octen-3-ol	tr	-	0.6	5.1	MS
1479	(*E*,*Z*)-2,4-Heptadienal	-	-	-	-	MS
1496	2-Ethyl hexanol	6.1	-	-	4.2	MS
1553	Linalool	**11.4**	-	-	-	MS
1562	Octanol	-	0.3	tr	-	MS
1600	Hexadecane	4.2	-	-	-	RRI, MS
1683	*trans*-Verbenol	-	0.6	-	-	MS
1703	Salicylaldehyde	-	1.0	0.6	-	RRI, MS
1706	α-Terpineol	5.8	-	-	-	RRI, MS
1719	Borneol	-	0.5	0.3	-	RRI, MS
1725	Verbenone	-	1.6	-	-	MS
1856	*m*-Cymen-8-ol	-	0.7	-	-	MS
1864	*p*-Cymen-8-ol	-	0.9	-	-	RRI, MS
2004	*o*-Cresol	-	**43.7**	**75.2**	**10.8**	RRI, MS
2131	Hexahydrofarnesyl acetone	**9.0**	2.2	1.5	6.2	MS
2226	Methyl hexadecanoate	**15.8**	6.7	4.0	-	RRI, MS
2239	Carvacrol	-	2.8	1.9	**7.5**	RRI, MS
2255	α-Cadinol	5.8	-	-	-	MS
2329	Methyl heptadecanoate	-	3.4	-	-	RRI, MS
2380	Dihydroactinidiolide	-	-	-	**10.0**	MS
2456	Methyl oleate	4.9	**10.1**	4.2	-	RRI, MS
2509	Methyl linoleate	**7.5**	**9.1**	4.6	-	RRI, MS
2583	Methyl linolenate	1.5	-	-	-	RRI, MS
2613	Ethyl linolenate	0.5	-	-	-	RRI, MS
2931	Hexadecanoic acid	0.1	**11.6**	4.2	**20.3**	RRI, MS
	Oxygenated Monoterpenes	17.2	5.5	2.2	7.5	
	Sesquiterpene Hydrocarbones	-	1.6	-	-	
	Oxygenated Sesquiterpenes	5.8	-	-	-	
	Fatty acid+esters	19.3	47.2	77.9	54.9	
	Others	30.3	40.9	17	2.5	
	Total	**72.6**	**95.2**	**97.1**	**64.9**	

RRI: Relative retention indices calculated against *n*-alkanes; %: calculated from FID data
Locality: E: Erzurum, S: Samsun, A: Antalya, B: Balıkesir
IM: Identification method based on the relative retention indices (RRI) of authentic compounds on the HP Innowax column; MS, identified on the basis of computer matching of the mass spectra with those of the Wiley and MassFinder libraries and comparison with literature data

In an earlier study, the essential oil composition of *A. orientalis* growing Iran was studied by Sajjadi and Ghannadi [6] and the main constituents were found as germacrene D (24.7%), β-cubabene (18.3%) and β-caryophyllene (16.9%). Iran oil was rich in hydrocarbon sesquiterpenes. Contrary to the earlier report that fatty acid+esters and others were present as main compounds in Turkish oil. In another study, thirty components were identified and phytol (36.7%), *n*-hexadecanoic acid (14.2%) and dodecanoic acid (12.2%) were reported as the main components in the essential oil of the aerial parts of

A. orientalis from Erzurum by Kücükbay et al. [7]. However, the essential oil composition of our samples was found to be quite different from those already reported. Later, Dönmez [8] analyzed the leaves and flowers of *A. orientalis*, which were taken from both their natural habitat and cultivars. 2-hexen-1-al (30.89% in the natural area and 23.12% cultivated plants) was found as the dominant component in the first vegetation period of *A. orientalis* however, there was a nearly 80% decrease during the second vegetation period. In the first and second vegetation periods of the samples, 1-octen-3-ol (26.30-28.16% in natural habitat and 26.79-28.34% in cultivars) was determined as the highest amount of another component. In addition, the amount of limonene (12.26% in natural habitat and 11.69% in cultivars) in *A. orientalis* essential oil increased in the second vegetation period compared to the first.

In the literature, some papers have reported on the variation in the essential oil composition induced by environmental, physiological, and edaphic factors which can cause changes in biosynthesis accumulation or metabolism of given compounds of the essential oil [10].

AUTHOR CONTRIBUTIONS

Concept: *A.K.*; Design: *A.K.*; Control: *A.K.*; Sources: *A.K., B.D.*; Materials: *A.K., B.D.*; Data Collection and/or processing: *A.K.*; Analysis and/or interpretation: *B.D.*; Literature review: *A.K., B.D.*; Manuscript writing: *A.K.*; Critical review: *A.K., B.D.*; Other: -

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS COMMITTEE APPROVAL

The authors declare that the ethics committee approval is not required for this study

REFERENCES

1. Güner, A., Aslan, S., Ekim, T., Vural, M., Babaç, M. (2012). Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını: Türkiye

2. Ben Jannet, H., Chaari, A., Bakhrouf, A., Mighri, Z. (2006). Structure antibacterial activity relationship of secondary metabolites from *Ajuga pseudoiva* Rob. leaves. *Natural Product Research. 203*, 299-304. [CrossRef]

3. Guo, P., Li, Y., Xu, J., Liu, C., Ma, Y., Guo, Y. (2011). Bioactive neo-clerodane diterpenoids from the whole plants of *Ajuga ciliata* Bunge. *Journal of Natural Products. 747*, 1575-1583. [CrossRef]

4. Makni, M., Haddar, A., Kriaa, W., Zeghal, N. (2011). Antioxidant, free radical scavenging, and antimicrobial activities of *Ajuga iva* leaf extract. *International Journal of Food Properties. 164,* 756-765. [CrossRef]

5. Davis, P.H. (1982). *Ajuga* L. In: P.H. Davis (Ed.) Flora of Turkey and the East Aegean Islands. Vol. 7. UK: Edinburgh University Press.

6. Sajjadi, S.E., Ghannadi, A. (2004). Volatile oil composition of the aerial parts of *Ajuga orientalis* L. from Iran. *Zeitschrift für Naturforschung. 59c*, 166-168. [CrossRef]

7. Küçükbay, F.Z., Kuyumcu, E., Yıldız, B. (2013). Essential oil composition from the aerial parts of *Ajuga orientalis* L. growing in Turkey. *Asian Journal of Chemistry. 25,* 9126-9128. [CrossRef]

8. Dönmez, Ş. (2019). Volatile oil composition of *Ajuga* species of natural and cultivated origin in the lake district of Turkey. *Applied Ecology And Environmental Research, 17*(2), 3859-3866. [CrossRef]

9. Demirci, B., Küçükboyaci, N., Adıgüzel, N., Başer, K.H.C., Demirci, F. (2010). Characterization of *Szovitsia callicarpa* volatile constituents obtained by micro- and hydrodistillation. *Natural Product Communications 5*, 297-300. [CrossRef]

10. Senatore, F., De Fusco, R., De Feo, V. (1997). Essential oils from *Salvia* spp. (Lamiaceae). I. chemical composition of the essential oils from *Salvia glutinosa* L. growing wild in southern Italy. *Journal of Essential Oil Research 9*, 151-157. [CrossRef]