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Research Article

Essential oil composition and antimicrobial activity of *Glaucosciadium cordifolium* (Boiss.) Burtt. & Davis

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ABSTRACT

Glaucosciadium cordifolium (Boiss.) Burtt. & Davis, which is a monotypic species naturally grown in Turkey belonging to the Apiaceae (Umbelliferae) family. In this study, the essential oil obtained from *G. cordifolium* was analyzed and evaluated for its antimicrobial effects. In chemical studies, the analyzes of essential oil compounds obtained from the aerial parts of plants by hydrodistillation were carried out with GC-FID and GC-MS. In total, 23 compounds were identified making up 98.7% of the total volatile constituents. Sabinene (42.1%), α-pinene (17.1%), and α-phellandrene (10.1%) were found as the main constituents in the oil.

In antimicrobial studies, the anticandidal and antibacterial effects of essential oils were tested against 14 pathogenic microorganisms according to the standard protocols of the Clinical Laboratory Standards Institute (CLSI). It has been determined that essential oils have a very weak inhibitory effect when compared with standard antibacterial agents. MIC values of 1800, 3600 µg/Ml, and higher were determined. In addition, it was determined that it showed inhibitory effects, especially against *C. krusei* at a concentration of 250 µg/mL, with MIC values ranging from 250 to 2000 µg/mL.

Keywords: Antimicrobial activity, Apiaceae, essential oil, GC-MS, *Glaucosciadium cordifolium*

1. INTRODUCTION

The Flora of Turkey states that there is just one taxon of the genus *Glaucosciadium* Burtt & Davis in Turkey and two taxa worldwide [1]. *G. cordifolium*, known as "çağşır otu, sakar otu" is used as an aphrodisiac in traditional medicine by crushing its roots and chewing with honey [2]. It has also been reported that the roots and leaves are crushed and used for stomach ailments [3]. Regarding the ethnobotanical use of the plant, there are no known reports of toxicity and/or side effects. In Turkey, it spreads in Central Anatolia, the Mediterranean region, and Cyprus. Creeping, perennial, glaucous, erect, 34-180 cm long and 3-10 mm diameter, glabrous plant. Stem branched and pronounced stripes, with an acrid smell when bruised [4]. Başer et al. (2000) stated that there was 0.7% essential oil in the aerial parts of the samples taken from the Konya and that the main components that make up the essential oil were limonene (39.7%), α- pinene (12.3%) and β-pinene (10.3%) [5]. In the study conducted by Karadoğan et al. (2015), the essential oil components of the aerial parts of *G. cordifolium* grown in different locations (Isparta and Burdur) were defined. In essential oils, 1-limonene, α-pinene, and cis-ocimene were determined as the main components [6]. In another study, the main components of the essential oil prepared from the aerial parts of the plant collected from Karaman-Ermenek were found to be α-pinene (27.7%), β-pinene (15.7%), (Z)-β-ocimene (14%), sabinene (7%) has been reported [7]. In previous studies, it has been reported that there are significant differences between the components that make up the essential oil of *G.cordifolium* and the proportional distributions of the components, depending on the locations where they were collected [5-7].

Our study deals with the analysis of essential oil isolated from the aerial parts of *G. cordifolium* growing in Kütahya, Turkey. Additionally, using microdilution techniques, the antibacterial properties of the aforementioned volatile oil were examined.

2. MATERIALS AND METHODS

2.1. Plant Material

G. cordifolium was collected at the flowering stage in July, in Uşak-Gediz road 3rd km by the roadside (Figure 1). A voucher specimen is also deposited at the Herbarium of Faculty of Pharmacy of the Anadolu University, Eskişehir, Turkey (ESSE No: 15001).

2.2. Isolation of Essential Oil

A Clevenger apparatus was used to hydrodistilled the air-dried aerial components after they had been roughly crushed. Before analysis, the obtained oil was kept at a low temperature in a dark vial.

2.3. GC-MS Analysis

The GC-MS analysis was carried out with an Agilent 5975 GC-MSD system. Innowax FSC column (60 m x 0.25 mm, 0.25 m film thickness) was used with helium as carrier gas (0.8 ml/min). GC oven temperature was kept at 60ºC for 10 min and programmed to 220ºC at a rate of 4 ºC/min, and kept constant at 220 ºC for 10 min and then programmed to 240°C at a rate of 1°C/min. The split ratio was adjusted at 40:1. The injector temperature was set at 250ºC. Mass spectra were recorded at 70 eV. Mass range was from m/z 35 to 450.

2.4. GC Analysis

The GC analysis was carried out using an Agilent 6890N GC system. FID detector temperature was 300ºC. To obtain the same elution order with GC-MS, simultaneous auto-injection was done on a duplicate of the same column applying the same operational conditions. Relative percentage amounts of the separated compounds were calculated from FID chromatograms. The analysis results are given in Table 1.

2.5. Identification of the essential oil components

Identification of the essential oil components were carried out by comparison of their relative retention times with those of authentic samples or by comparison of their relative retention indices (RRI) to the series of nalkanes. Computer matching against commercial [8,9] and in-house "Başer Library of Essential Oil Constituents" built up by genuine compounds and components of known oils, as well as MS literature data [10,11] was used for the identification.

2.6. Antimicrobial Activity

The minimum inhibitory (MIC) concentrations of the essential oil was determined using standard protocols [12,13]. Anticandidal effects of essential oil obtained from *G. cordifolium* on 7 *Candida* species (*C. albicans, C. utilis, C. glabrata, C. krusei, C. parapsilosis, C. tropicalis,* and *C. zeylanoides*) were identified. Moreover, the antibacterial activity of *G. cordifolium* essential oil against 7 bacteria (*Serratia marcescens*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Staphylococcus aureus, Escherichia coli*, *Listeria monocytogenes*, *Staphylococcus epidermidis*) was evaluated. Positive controls for anticandidal testing included ampicillin and chloramphenicol, whereas, for antibacterial tests, ketoconazole and amphotericin were employed**.**

3. RESULTS AND DISCUSSION

3.1. Chemical composition of the essential oil

GC and GC/MS analyses were carried out simultaneously in the essential oil obtained after distillation. As a result of the analysis of the essential oil obtained from the aerial parts of *G. cordifolium* with a yield of 0.4% (v/w), 23 volatile components were determined, corresponding to 98.7% (Table 1). It was determined that the main components of the essential oil obtained were sabinene (42.1%), α-pinene (17.1%), and α- phellandrene (10.1%). Sabinene is a monoterpene isolated from the essential oil of many plants including medicinal herbs [14-16]. Increasing data suggest that sabinene may be used as a treatment for a number of illnesses [17-20]. Sabinene possesses biological characteristics like anti-inflammatory and anti-fungal capabilities [21,22]. It has been shown that sabinene may have antioxidant [23-25] and anti-radical properties in respect to DPPH radicals [26]. Furthermore, sabinene decreases the increased level of reactive oxygen species (ROS) in myotubes under starvation [27].

Figure 1. *G. cordifolium*

On the other hand, it is also known that essential oils of popular plants can reveal toxic properties that many people are unaware of. Studies reporting that Savin oil (50% sabinyl acetate) obtained from *Juniperus sabina* L. is embryo-fetotoxic, abortifacient, and hepatotoxic recommend that caution should be taken when using the plant. [28].

Table 1. The chemical components of *G. cordifolium* essential oil

RRI	Compounds	%
1032	α-Pinene	17.1
1035	α-Thujene	0.4
1118	β-Pinene	0.6
1132	Sabinene	42.1
1174	Myrene	4.1
1176	α- Phellandrene	10.1
1188	α-Terpinene	1.1
1203	Limonene	2.4
1218	β-phellandrene	4.3
1255	γ-Terpinene	2.3
1280	p-Cymene	4.3
1290	Terpinolene	0.9
1474	trans-Sabinene hydrate	0.9
1483	Octyl acetate	1.9
1556	cis-Sabinene hydrate	0.7
1571	trans-p-Menth-2-en-1-ol	0.4
1611	Terpinene-4-ol	4.8
1638	cis-p-Menth-2-en-1-ol	0.2
1690	Krypton	0.3
1706	α-Terpineol	0.2
1823	p-Mentha 1(7),5-dien-2-ol	0.3
2209	T-Muurolol	0.2
2239	Carvacrol	0.2
	Monoterpenes	89.7
	Oxygenated terpenes	8
	Oxygenated sesquiterpenes	0.2
	Others	1.9
	Total	98.71

RRI: Relative retention indices calculated against n-alkanes; %: calculated from the FID chromatograms; tr: Trace (<0.1 %). Identification method (IM): tR, identification based on the retention times of genuine compounds on the HP Innowax column; MS, identified on the basis of computer matching of the mass spectra with those of the in-house Baser Library of Essential Oil Constituents, Adams, MassFinder and Wiley libraries and comparison with literature data.

In the study conducted by Maral (2022), the major components of the essential oil obtained from the aerial parts of *G. cordifolium* collected from Ermenek district of Karaman were found to be 1-phellandrene (9.23-34.08%), α-pinene (10.23-31.95%), dl-limonene. (10.39-22.21%) and cis-ocimene (6.84-12.45%) have been reported [29]. In another study (2019), a total of 62 volatile compounds were detected in *G. cordifolium* essential oil collected from Karaman-Ermenek. The three main ingredients in the essential oil of the aerial part are β-pinene (15.7%), (Z)-β-ocimene (14%), and sabinene (7%) while the three principal constituents in the essential oil of fruits are sabinene (10.1%), β-pinene (10.1%) and α-phellandrene (5.3%). Furthermore, in the essential oil obtained from the root, hexadecane (12.2%), tetradecane (11.9%), and octadecane (7.4%) were reported, respectively [7]. The main elements of the essential oil extracted from the aerial parts and those reported in other studies have similarities, according to the findings. The possible differences between the volatile components are thought to be due to the location and ecological differences of the plants.

3.2. Antimicrobial activity

The antibacterial effect of the essential oil obtained from *G. cordifolium* on seven different bacteria strains were investigated. It has been determined that essential oils have a very weak inhibitory effect when compared with standard antibacterial agents. MIC (minimum inhibitory concentration) values of 1800, 3600 µg/mL, and higher were determined (Table 2).

In anticandidal effect studies, *G. cordifolium* essential oil is effective at lower concentrations, especially against *C. krusei* (125 µg/mL), *C. parapsilosis*, *C. tropicalis* and *C. zeylanoides*, with MIC values ranging from 250 to 2000 µg/mL. was determined (Table 3).

In a study in which the antimicrobial effect of the essential oil of *G. cordifolium* was tested against some pathogenic bacteria, it was reported that *Listeria monocytogenes* (0.156 mg/mL) was more sensitive to essential oils. Sabinene, one of the main components of essential oil obtained from *G. cordifolium*, has been reported to inhibit the growth

Table 2. Antibacterial effects of *G. cordifolium* essential oil (MIC, µg/mL)

Microorganisms	EO	Ampicillin	Chloramphenicol
Serratia marcescens NRRL B-2544	>3600	32	16
Pseudomonas aeruginosa ATCC 10145	>3600	32	8
Salmonella typhimurium ATCC 14028	>3600	0.5	8
Staphylococcus aureus ATCC 43300	>3600	1	16
Escherichia coli ATCC 8739	>3600	1	2
Listeria monocytogenes ATCC 19111	1800	1	8
Staphylococcus epidermidis ATCC 14990	1800	1	1

EO: Essential oil

Table 3. Anticandidal effects of *G. cordifolium* essential oil (MIC, µg/mL)

Microorganisms	EO	Ampicillin	Chloramphenicol
Candida albicans ATCC 10231	2000	0.5	0.5
C. utilis NRRL Y-900	2000	0.5	0.125
C. zeylanoides NRRL Y-1774	500	1	0.5
C. glabrata ATCC 66032	500	0.5	0.5
C. tropicalis ATCC 750	500	1	0.5
C. parapsilosis ATCC 22019	500	0.5	2
C. krusei ATCC 6258	250	0.25	2

EO: Essential oil

of various fungi *in vitro*, including several *Candida*, *Trichophyton,* and *Aspergillus* species (MIC = 0.16-5 µl/ml) [22]. Among the tested bacteria in this present study, *L. monocytogenes* and *S. epidermidis* were the more sensitive to the essential oils, while the others appeared to be more resistant. Additionally, it has been established that the essential oil possesses anti-*Candida* effects, particularly against *C. krusei*. The chemical composition of the plant is assumed to be significantly influenced by climatic and geographic factors. The results imply that shifting plant locations may affect biological activity by changing the phytochemistry of plants.

In conclusion, to the best of our knowledge, this is the first report of volatiles and *in vitro* antimicrobial activities of *G. cordifolium* collected from this locality.

4. CONCLUSION

In previous studies, it has been reported that plants in the Apiaceae family are mostly used for digestive system diseases, hemorrhoids, diabetes, aphrodisiac and sedative [3]. *G. cordifolium* is one of the species used for these purposes. Our research revealed that the essential oil isolated from the aerial parts of *G. cordifolium* had a significant amount of monoterpene hydrocarbons. The major class of secondary metabolites in plants, monoterpenes are present in a wide range of plants, including those in the Apiaceae family. The compounds have antioxidative, antibacterial, sedative, and anti-inflammatory properties, which is the reason they are frequently used in pharmaceuticals and medicine. Nevertheless, long-lasting studies have revealed their toxic properties. Although the majority of monoterpene compounds are safe for use in food and medicine for humans, some of them have the potential to be harmful in certain doses or under specific conditions (such as pregnancy). Numerous monoterpenes can exhibit a variety of hazardous features, including genotoxic, allergic, neurotoxic, and embryotoxic effects.

Additionally, the antibacterial activity of the essential oil was moderate. The findings of this study also suggested that this plant's essential oil might be employed as an antimicrobial component to ensure the safety of foodborne pathogens.

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Ethical approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Author contribution

Concept: NS, AK; Design: NS, AK; Supervision: AK; Materials: NS; Data Collection and/or Processing: NS, AK; Analysis and/or Interpretation: NS, Gİ, BD; Literature Search: NS; Writing: NS, AK, Gİ, BD; Critical Reviews: AK.

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Conflict of interest

The authors declared that there is no conflict of interest.

REFERENCES

1. Davis PH. Flora of Turkey and the East Aegean Islands. Vol. 4. Edinburgh, UK: Edinburgh University Press; 1982. p. 514.
2. Ozhatay N, Kocak S. Plants used for medicinal purposes in Karaman Province (Southern Turkey). Istanbul J Pharm. 2011;41:75-89.
3. Bulut G, Tuzlacı E, Doğan A, Şenkardeş İ. An ethnopharmacological review on the Turkish Apiaceae species. J Fac Pharm Istanbul. 2014;44(2):163-179. Available at: https://dergipark.org.tr/tr/pub/iujfp/issue/585/5875
4. Saltan N, Kaya A, Dinc M, Doğu S. Morpho-anatomical and palynological studies on *Glaucosciadium cordifolium* (Apiaceae) from Turkey. Istanbul J Pharm. 2021;51(3):403-410. https://doi.org/10.26650/IstanbulJPharm.2021.909570

5. Baser KHC, Özek T, Demirci B, Duman H. Composition of the essential oil of *Glaucosciadium cordifolium* (Boiss.) Burtt et Davis from Turkey. Flavour Fragr J. 2000;15(1):45-46. https://doi.org/10.1002/(SICI)1099-1026(200001/02)15:1<45::AID-FFJ867>3.0.CO;2-L

6. Karadoğan T, Şanlı A, Tosun B, Özçelik H. Essential Oil Content and Composition of *Glaucosciadium cordifolium* (Boiss.) Burtt & Davis from Türkiye/Lakes Region. BIBAD. 2015;8(1):35-39.

7. Karadağ AE, Demirci B, Çeçen Ö, Tosun F. Chemical characterization of *Glaucosciadium cordifolium* (Boiss.) B. L. Burtt & P. H. Davis essential oils and their antimicrobial, and antioxidant activities. Istanbul J Pharm. (2019);49 (2): 77-80. https://doi.org/10.26650/IstanbulJPharm.2019.19013

8. McLafferty FW, Stauffer DB. The Wiley/NBS Registry of Mass Spectral Data. New York: Wiley and Sons; 1989.

9. Koenig WA, Joulain D, Hochmuth DH. Terpenoids and related constituents of essential oils. MassFinder 3. Convenient and Rapid Analysis of GC-MS. 2004.

10. Joulain D, Koenig WA. The Atlas of Spectra Data of Sesquiterpene Hydrocarbons. Hamburg: EB-Verlag; 1998.

11. ESO 2000. The complete database of essential oils. The Netherlands: Boelens Aroma Chemical Information Service (BACIS); 1999.

12. CLSI (NCCLS) M27-A2, 2002. Reference method for broth dilution antifungal susceptibility testing of yeasts; approved standard, second edition.

13. CLSI (NCCLS) M7-A7, 2006. Methods for dilution antimicrobial susceptibility tests for bacteria that grow aerobically; approved standard, seventh edition.

14. Maya KM, Zachariah TJ, Krishnamoorthy B. Chemical composition of essential oil of nutmeg (*Myristica fragrans* Hout) accessions. J Species Aromat Crops. 2004;13:135-139.

15. Rouatbi M, Duquenoy A, Giampaoli P. Extraction of the essential oil of thyme and black pepper by superheated steam. J Food Eng. 2007;78:708-714. https://doi.org/10.1016/j.jfoodeng.2005.11.010

16. Sieniawska E, Swiatek L, Rajtar B, Kozioł E, Polz-Dacewicz M, Skalicka-Wozniak K. Carrot seed essential oil-Source of carotol and cytotoxicity study. Ind Crops Prod. 2016;92:109-115. https://doi.org/10.1016/j.indcrop.2016.08.001

17. Sieniawska E, Sawicki R, Swatko-Ossor M, et al. The effect of combining natural terpenes and antituberculous agents against reference and clinical *Mycobacterium tuberculosis* strains. Molecules. 2018;23:176. https://doi.org/10.3390/molecules23010176

18. Sruthi D, John ZT, Leela NK, Jayarajan K. Correlation between chemical profiles of black pepper (*Piper nigrum* L.) var. Panniyur-1 collected from different locations. J Med Plants Res. 2013;7:2349-2357. https://doi.org/10.5897/JMPR2013.4493

19. Viña A, Murillo E. Essential oil composition from twelve varieties of basil (*Ocimum* spp) grown in Colombia. J Braz Chem Soc. 2003;14:744-749. https://doi.org/10.1590/S0103-50532003000500008

20. Zhao T, Solheim H, Langström B, Borg-Karlson AK. Storm-induced tree resistance and chemical differences in Norway spruce (*Picea abies*). Ann For Sci. 2011;68:657-665. https://doi.org/10.1007/s13595-011-0049-3

21. Yamasaki Y, Kunoh H, Yamamoto H, Akimitsu K. Biological roles of monoterpene volatiles derived from rough lemon (*Citrus jambhiri* Lush) in citrus defense. J Gen Plant Pathol. 2007;73:168-179. https://doi.org/10.1007/s10327-007-0013-0

22. Valente J, Zuzarte M, Gonçalves MJ, et al. Antifungal, antioxidant and anti-inflammatory activities of *Oenanthe crocata* L. essential oil. Food Chem Toxicol. 2003;62:349-354. https://doi.org/10.1016/j.fct.2013.08.083

23. Quirog, PR, Asensio CM, Nepote V. Antioxidant effects of the monoterpenes carvacrol, thymol and sabinene hydrate on chemical and sensory stability of roasted sunflower seeds. J Sci Food Agric. 2015;95:471-479. https://doi.org/10.1002/jsfa.6744

24. Zheljazkov VD, Astatkie T, Jeliazkova EA, Heidel B, Ciampa L. Essential oil content, composition and bioactivity of *Juniper* species in Wyoming, United States. Nat Prod Commun. 2017;12:201-204.

25. Zheljazkov VD, Astatkie T, Jeliazkova EA, Schlegel V. Distillation time alters essential oil yield, composition, and antioxidant activity of male *Juniperus scopulorum* trees. J Oleo Sci. 2012;61:537-546. https://doi.org/10.5650/jos.61.537

26. Bua-in S, Paisooksantivatana Y. Essential oil and antioxidant activity of *Cassumunar ginger* (Zingiberaceae: *Zingiber montanum* (Koenig) Link ex Dietr.) collected from various parts of Thailand. Kasetsart J. 2009;43:467-475.

27. Ryu Y, Lee D, Jung SH, et al. Sabinene Prevents Skeletal Muscle Atrophy by Inhibiting the MAPK-MuRF-1 Pathway in Rats. Int J Mol Sci. 2019;20(19):4955. https://doi.org/10.3390/ijms20194955

28. Pages N, Fournier G, Chamorro G, Salazar M, Paris M, Boudene C. Teratological evaluation of *Juniperus sabina* essential oil in mice. Planta Med. 1989;55(2):144-146. https://doi.org/10.1055/s-2006-961908

29. Maral H. Composition of essential oil and antioxidant properties of *Glaucosciadium cordifolium* (Boiss.) B.L. Burtt and PH. Davis plant organs growing wild in Turkey. Bangladesh J Bot. 2022;51(3):573-579. https://doi.org/10.3329/bjb.v51i3.62004