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Research Article

Essential oil composition of *Bellardia trixago* (L.) All. (Orobanchaceae) from Türkiye

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Abstract: *Bellardia trixago* (L.) All. (syn. *Bartsia trixago* L.) is a hemiparasitic plant that is mainly native to the Mediterranean area. Formerly, the genus was considered to be a part of the Scrophulariaceae family, but it is currently classified as belonging to the family Orobanchaceae. *Bellardia* species are used in traditional medicine by the local people to cure backache, menstrual problems and as an antipyretic and against the human immunodeficiency virus. Various populations of *B. trixago* exhibit qualitative and quantitative variations in the chemical composition of the plant. This research described the chemical composition of *B. trixago* from Dazkırı, Afyon/Türkiye. The essential oil of *B. trixago* was obtained by hydro-distillation method and the oil content was analyzed by GC-MS. Cembrene (51.7%) was identified as the major component and the other most abundant components were phellandral (15.4%) and α-terpineol (14.5%). To the best of knowledge, no research has ever been performed on *B. trixago*'s essential oil from Türkiye.

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1. INTRODUCTION

Bellardia trixago (L.) All. (syn. *Bartsia trixago* L.) is a taxon of the Orobanchaceae family (Chase, 2003) and the only member of the monotypic *Bellardia* genus in Türkiye. *B. trixago* is a species native to the Mediterranean Basin and North Africa, but it can also be distributed in other parts of the world with similar climates (Tutin *et al,* 1972; Hedge 1978). Formerly, the genus was considered to be a part of the Scrophulariaceae family, but it is currently classified as belonging to the family of the hemiparasitic Orobanchaceae (Thieret 1967; Olmstead 2002). *B. trixago*, a facultative hemiparasitic plant, is reported to produce a variety of bioactive metabolites and infect ruderal plants that have no detrimental effects on agriculture (Press *et al,* 1993; Uribe-Convers & Tank 2016). Although *B. trixago* is a photosynthetic plant, it is considered a parasitic plant because of its ability to obtain carbohydrates from other plants

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(Carafa *et al,* 1980). The aroma of the plant is described as similar to the smell of honey (Esteban *et al,* 1996). Different types of natural compounds, including glycosides, flavonoids, and terpenes were determined by their chemical composition (De Pascual Teresa *et al,* 1978, 1982; Ersöz *et al,* 1988; Tomas-Barberan *et al,* 1990). There are also some studies on the use of different extracts of *B. trixago* as an insecticide (Pascual-Villalobos & Robledo 1998; Formisano *et al,* 2008). Additionally, Barrero and co-workers showed that various populations of *B. trixago* exhibit qualitative and quantitative variations in the chemical composition of the plant (Barrero *et al,* 1988; 2011). *Bellardia* species are also used in traditional medicine by the local people to cure backache, menstrual problems and as an antifebrile in Peru (Velasco-Negueruela *et al,* 1995), and against HIV/AIDS in Uganda (Lamorde *et al,* 2010). Although the bioactive content of *B. trixago* has been determined by different studies, no study has been found in the literature on the chemical composition of the essential oil of *B. trixago* in Türkiye (Bianco *et al,* 1976; Barrero *et al,* 1988; Ersöz *et al,* 1988; Tomas-Barberan *et al,* 1990). In this study, the chemical contents of the essential oil of *B. trixago* were shown for the first time in Türkiye.

2. MATERIAL and METHODS

2.1. Plant Materials and Essential Oil Collection

B. trixago was collected from its natural population (Dazkırı, Afyon-Türkiye) during its flowering season in 2018. The collected specimen was identified by Prof. Gurkan SEMIZ and voucher specimens (GSE 2013) were deposited in the Biology Department of Pamukkale University. The aerial plant samples, which were air-dried for a week in a shady and cool place, were cut into small pieces. The procedure of essential oil collection using the Clevenger apparatus was followed by Semiz *et al,* 2022.

2.2. GC-MS Analysis

The relative chemical profile of the *B. trixago* essential oil was determined on GC-MS (Hewlett-Packard GC-7820A, MSD-5975). The HP-5MS capillary column, 30 m long, was selected (ID 0.25 mm, film thickness 0.25 mm, Hewlett Packard) and the chromatographic conditions to obtain terpenes were followed by Semiz *et al,* (2018). Briefly, the temperature was set from 50°C to 250°C at 5°C min^{-1}, using helium as the carrier gas (flow rate 1.2 ml/min); SCAN technique (mass numbers from m/z 30 to 350 were recorded; signal ions in monitoring; 93, 133, 136, 161, and 204 m/z) was used; the samples of 1 µl were injected automatically and in the splitless mode. The compounds were identified by comparing their mass spectra and retention indices with those in NIST and Wiley electronic libraries.

3. RESULTS

In this study, the chemical composition of the essential oil from *B. trixago* was characterized by GC-MS. The essential oil constituents of *B. trixago* were dominated by diterpenes. Sixteen compounds representing 97.0% of the oil were detected in *B. trixago*. Essential oil yield was found as 0.27%. The relative amounts of chemical compounds in the essential oils are presented in Table 1. The main constituent of *B. trixago* was determined as cembrene (51.7%). The other major compounds were determined as phellandral (15.4%) and α-terpineol (14.5%).

Table 1. Essential oil composition (%) of *B. trixago.*

No	RRI[a]	RRI[b]	Compounds[c]	%
1	980	980	1-Octen-3-ol	1.0
2	1029	1029	D-Limonene	0.1
3	1032	1031	1,8-Cineole	0.2
4	1060	1059	γ-Terpinene	0.1
5	1099	1099	Linalool	0.9
6	1144	1143	Camphor	0.2
7	1159	1158	Isoborneol	0.6
8	1165	1164	δ-Terpineol	0.1
9	1168	1166	Borneol	0.5
10	1183	1183	*p*-Cymen-8-ol	2.9
11	1190	1189	α-Terpineol	**14.5**
12	1219	1219	Fenchyl acetate	5.4
13	1255	1255	Linalool acetate	1.0
14	1274	1274	Phellandral	**15.4**
15	1956	1947	Cembrene	**51.7**
16	2086	2087	Cembratrienol	2.4
TOTAL				**94.5**

[a] RRI: Relative retention indices measured to against *n*-alkanes on HP-5MS column, [b] Retention indices from literature (Adams 2007; Babushok *et al*, 2011; Chizzola *et al,* 2021), [c]Compounds listed in order of their elution. The values in bold indicate the highest amounts.

4. DISCUSSION and CONCLUSION

Aromatic and medicinal plant species and their essential oils were described as sources of secondary metabolites and have been frequently used for centuries in traditional medicine (Deans & Svoboda, 1990). In addition to serving as a natural source for acquiring and isolating compounds with pharmacological uses, plants can also be used to make herbal medicines for use in conventional or alternative medicine. At this point, *B. trixago* is an ethnomedicinal plant, which is used by local people in many parts of the world for different purposes. However, the information available in the literature on the essential oil of *B. trixago* is quite limited. In a study conducted by Formisano and her co-workers (2008) in Italy, the most abundant compounds from the essential oil of *B. trixago* were (*E,E*)-farnesyl acetone (42.1%), trixagol (8.0%), and 4-vinyl guaiacol (5.4%). In another study conducted to determine the volatile components of some aromatic plants by automatic thermal desorption technique, it was determined that trixagoyl acetate (56.1%), trixagol (25.4%) and trixagoene (4.22%) were the three most abundant compounds among the volatile organic compounds of *B. trixago* (Esteban *et al,* 1996). In the same study, according to the simultaneous distillation-extraction technique, the most abundant compounds of *B. trixago* were determined as trixagol (25.4%), trixagoene (4.22%) and 3,4-dihydro-γ-ionone (14.12%). The large variations between the findings and the earlier publications may be the consequence of genetic, environmental and collection-time variations. In conclusion, our findings show that environmental and climatic factors have an impact on the chemical profile of the essential oils of *B. trixago*.

It may be advantageous to use essential oils in medicinal, cosmetic, and industrial fields after considering their pharmacological qualities and their constituent parts. It is safe to employ essential oils and the components they contain in studies to find novel antibacterial treatments that may be effective against pathogenic microorganisms. We hope that these findings will stimulate more research into the chemistry of *Bellardia* species and that terpene-based chemical content profiling of the species may be helpful in taxonomic studies.

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research and publishing ethics. The scientific and legal responsibility for manuscripts published in IJSM belongs to the authors.

Authorship Contribution Statement

Gurkan Semiz: Investigation, Resources, Visualization, Software, Formal Analysis, and Writing-original draft. **Batikan Gunal**: Methodology and Validation.

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