PHARMACIA

Pharmacia 72: 1–3
DOI 10.3897/pharmacia.72.e146435

Short Communication

Essential oil composition of *Satureja kitaibelii* Wierzb. ex Heuff. from the central Danubian plain, Bulgaria

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Received 10 January 2025 ♦ **Accepted** 21 January 2025 ♦ **Published** 27 February 2025

Citation: Gavrilov GV, Nikolova MT, Gavrilova AB, Pashev AS (2025) Essential oil composition of *Satureja kitaibelii* Wierzb. ex Heuff. from the central Danubian plain, Bulgaria. Pharmacia 72: 1–3. https://doi.org/10.3897/pharmacia.72.e146435

Short summary

This study investigates the essential oil composition of *Satureja kitaibelii* Wierzb. ex Heuff., a Balkan endemic species with notable medicinal properties, from the central Danubian Plain, an unexplored region in Bulgaria. Essential oil were extracted using a Clevenger apparatus and analyzed via GC/MS, revealing *p*-cymene, limonene, carvacrol, and borneol as dominant compounds. Differences between localities (Kaylaka and Kartozhabene) were identified, alongside similarities with populations from other parts of Bulgaria and Serbia. These findings contribute to understanding phytochemical variability and hold implications for standardizing *S. kitaibelii* essential oil for pharmaceutical and industrial applications.

Keywords

essential oil, GC/MS, *Satureja kitaibelii*, Danubian plain

Introduction

The species *Satureja kitaibelii* Wierzb. ex Heuff. is a Balkan endemic species, which is one of the five most common wild species of the genus in the Balkans and the second most common in Bulgaria (Đorđević et al. 2014; Euro+Med plantbase 2024).

The above-ground parts of the plants are used in traditional cuisine and medicine in the whole range of species distribution. As a folk remedy, it is mainly used for diarrhea, nausea, indigestion, respiratory and infectious diseases, cramps, muscle pain, infertility, and menstrual disorders (Acimovic et al. 2021). In the recent years many valuable properties of the species such as antioxidant, anti-inflammatory, hypoglycemic, antitumor and antimicrobial activity were reported (Gopcevic et al. 2019; Acimovic et al. 2021; Dimitrijevic et al. 2023). Considering the increasing resistance of microorganisms to antibiotics, the discovery of new bioactive molecules with high antimicrobial potential is very important (Uddin et al. 2021).

The literature references show that the essential oil composition of the species varies a lot (Slavkovska et al. 2001; Dodoš et al. 2019; Zheljazkov et al. 2022). Therefore, the research on the essential oil profiles of this species from different localities is important.

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The aim of the presented study is to determine the essential oil composition of *Satureja kitaibelii* Wierzb. ex Heuff. from the previously unexplored region of the central Danubian plain.

Materials and methods

Aerial parts of *S. kitaibelii* plants in full bloom were harvested in late September 2021 from two localities near Pleven: the protected area "Kaylaka" and Kartozhabene village. The bedrock in both areas is limestone, and the altitude is around 200 m a.s.l. The plants in Kaylaka develop mainly in rock crevices, while the plants from Kartozhabene were collected from the base of a scree, where they compete with gramineous species. The sample material was air-dried at room temperature.

The essential oil was extracted on a Clevenger apparatus by water distillation from 50 g of dry plant material in a flask with 500 ml of water for 3 h. Oil sample analysis was performed on a Thermo GC equipped with a Focus DSQ II mass detector coupled with an HP-5MS capillary column (30 m × 0.25 mm i.d., 0.25 μm film thicknesses). Chromatographic conditions were according to Traykova et al. (2019). The components were identified by comparing their mass spectra and retention indices (RI), referring to known compounds from the literature (Adams 2007), and also by comparison with those of the National Institute of Standards and Technology (NIST). Relative percentage amounts of the compounds were calculated from total ion current (TIC).

Results and discussion

The dominant compounds of the essential oil of *S. kitaibelii*, which are common for both localities, are *p*-cymene, limonene, carvacrol, and borneol (Table 1). In the samples from Kartozhabene, the leading components are limonene, geraniol, and carvacrol, while in the samples from Kaylaka, they are *p*-cymene, carvacrol, and limonene. The differences in essential oil profiles between these two geographically close localities may be attributed to microclimatic variations, soil pH, and differences in vegetation. The essential oil profile of Kartozhabene is similar to those from samples gathered near Beledie Han, Bulgaria (Konakchiev and Tsankova 2002). On the other hand, the essential oil profile of Kaylaka with carvacrol in second place is especially close to those from one Serbian locality of *S. kitaibelii* near the town of Boljevac in the vicinity of Rtanj Mountain (Chalchat et al. 1999). Other authors also report high content of *p*-cymene and limonene from the same Rtanj Mountain (Kundaković et al. 2011; Dodoš et al. 2019; Aćimović et al. 2021). The leading essential oil compounds of *S. kitaibelii* possess high pharmaceutical relevance. Carvacrol has a promising anti-microbial effect on multidrug-resistant bacteria and even in sub-lethal doses affects their phenotypic properties and genes' expression (Abed et al. 2021; da Silva et al. 2023). Geraniol and *p*-cymene have pronounced antitumor, anti-inflammatory, and antidiabetic activities and an antinociceptive effect (Lei et al. 2018; Balahbib et al. 2021).

Table 1. Chemical composition (%) of the essential oil of *S. kitaibelii* from two localities near the town of Pleven (Central Danubian plain).

Compounds	RI	Kartozhabene	Kaylaka
Cumol	921	0.50	1.03
α-Pinene	937	5.94	4.03
Camphene	952	4.74	2.09
1-Octen-3-ol	980	1.33	0.83
β-Myrcene	991	2.3	0.97
α-Phellandrene	1005	0.25	0.91
α-Terpinene	1017	0.58	0.95
***p*-Cymene**	1025	**8.75**	**22.58**
Limonene	1030	**13.67**	**9.76**
trans-β-Ocimene	1049	5.42	2.16
γ-Terpinene	1161	4.57	5.05
Borneol	1166	9.23	7.50
Terpinen-4-ol	1177	0.85	2.25
cis-Geraniol	1228	0.63	0.56
Carvacrol methyl ether	1244	4.64	5.28
Geraniol	1255	**11.89**	3.44
Carvacrol	1299	**9.65**	**13.95**
Caryophyllene	1419	1.62	2.06
Germacrene D	1481	1.23	1.68
β-Bisabolene	1509	0.29	0.65
Spathulenol	1576	0.87	0.32
Caryophyllene oxide	1581	1.11	0.74

RI = Retention indices.

Conclusion

The Danubian Plain represents an unexplored region regarding the phytochemical composition of the essential oil of *Satureja kitaibelii*, and this study provides the first data from this area. Despite the geographical proximity of the two studied localities (Kaylaka and Kartozhabene) and the consistent collection conditions, notable differences were observed in their essential oil profiles, highlighting the species' phytochemical variability. These findings also reveal similarities with remote populations of *S. kitaibelii* in Bulgaria and Serbia, suggesting regional patterns in essential oil composition. Further research is required to explore the environmental factors influencing essential oil variability, such as soil composition, microclimate, and ecological conditions. Such data will be essential for the standardization of *S. kitaibelii* essential oil and its potential application in pharmaceutical and industrial fields.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statements

The authors declared that no clinical trials were used in the present study.

The authors declared that no experiments on humans or human tissues were performed for the present study.
The authors declared that no informed consent was obtained from the humans, donors or donors' representatives participating in the study.
The authors declared that no experiments on animals were performed for the present study.
The authors declared that no commercially available immortalised human and animal cell lines were used in the present study.

Funding

This study was financially supported by Medical University—Pleven, research grant № 18/2024 under the project "Biological and phytochemical characteristics of Satureja kitaibelii Wierzb. ex Heuff. (Lamiaceae) near Pleven, Bulgaria."

Author contributions

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Data availability

All of the data that support the findings of this study are available in the main text.

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