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Research Article

Essential oil composition of two endemic *Nepeta* L. (Lamiaceae) taxa from Southwestern Turkey

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Abstract: *Nepeta* L. is one of the important genus in the Lamiaceae family. It includes *ca.* 300 herbaceous species and mostly grows in Eurasia. *Nepeta* is represented in Turkey by 40 taxa and of these 16 are endemic. *Nepeta* species are commonly utilized in traditional medicine by the local people, primarily as spasmolytic, diuretic, and bronchodilator agents. As a consequence of studies on *Nepeta* taxa, terpenoids and flavonoids have been identified as the most common components. In this report, chemical contents of two endemic *Nepeta* taxa (*N. viscida* from Buharkent/Aydın and *N. nuda* L. subsp. *lydiae* from Altınyayla/Burdur) were presented. The main constituents were determined as *α*-terpineol (20.59%), *trans*-*β*-caryophyllene (9.90%) and spathulenol (9.37%) for *N. viscida,* and 1,8-cineole (31.31%), borneol (18.95%) and caryophyllene oxide (14.59%) for *N. nuda* subsp. *lydiae.*

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1. INTRODUCTION

The Lamiaceae (=Labiatae) is a family in the Lamiales order, with 236 genera and over 7000 species (El Khoury *et al.,* 2019). At this point, 226 genera have been allocated to seven subfamilies, with ten genera classified as *incertae sedis* since they could not be assigned to any of the subfamilies (Harley *et al.,* 2004; Jamzad, 2013). In addition, five new subfamilies have been defined recently (Li *et al.,* 2016; Li & Olmstead, 2017). Lamiaceae family is the third-largest family in the Flora of Turkey in terms of the number of taxa (Celep & Dirmenci, 2017), and the endemism rate is approximately 44% in this area (Baser & Kırımer, 2018). Turkey is recognized as a major gene center for the Lamiaceae (Celep & Dirmenci, 2017; Baser & Kırımer, 2018). Lamiaceae members are characterized by their strong aromatic properties such as rich essential oil contents. Humans have probably used these plants since ancient times. Archeological evidence suggests that Lamiaceae members were once cultivated on a local scale (Nuńez & De Castro, 1992; Rattray & Van Wyk, 2021). Today, *Mentha*, *Thymus*, *Origanum*, *Salvia*, and *Nepeta* species are frequently used in traditional and modern medicine almost all over the world (Naghibi *et al.,* 2005).

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The *Nepeta* L. is one of the richest genera among the members of the Lamiaceae family in Turkey in terms of the number of taxa. It is a member of the tribe *Mentheae* (subfamily *Nepetoideae*) and includes about 300 species (Asgarpanah *et al.,* 2014). In Turkey, there are 40 taxa in the *Nepeta* genus, 16 of which are endemic (Gökbulut & Yılmaz, 2020). *Nepeta* species are commonly utilized in traditional medicine by the local people, primarily as spasmolytic, diuretic and bronchodilator agents (Sharma *et al.,* 2021). As a consequence of studies on *Nepeta* species, terpenoids and flavonoids have been identified as the most common components (Sharma *et al.,* 2021). Several *Nepeta* species have long been recognized to offer feline attractant characteristics. The feline attractant action of the genus is thought to be caused by nepetalactone and its isomers (Baser *et al.,* 2000). The first phytochemical research on *Nepeta* species dates back to 1955 (McElvain & Eisenbraun, 1955). Since then, various chemical compounds have been reported within the genus. Until 2010, *ca.* 200 compounds have been recognized from *Nepeta* species (Formisano *et al.,* 2011). Some societies have learned to use *Nepeta* species primarily for flavor as well as medical purposes such as venereal diseases, aphrodisiac, headaches, backaches, rheumatic pain, sunburn, diuretic, wound healing agents (Koyuncu *e et al.,* 2010; Mükemre *et al.,* 2015; Gomes *et al.,* 2020).

The literature searches indicated that the chemical profiles of the essential oil of some other *Nepeta* species have previously been studied (Baser *et al.,* 1993-1995-1998-2000-2001; Baser & Özek, 1994; Kökdil *et al.,* 1996-1997-1998; Tümen *et al.,* 1999; Senatore & Özcan, 2003; Tepe *et al.,* 2007; Emre *et al.,* 2011; İşcan *et al.,* 2011; Kilic *et al.,* 2011-2013; Gormez *et al.,* 2013; Bozok *et al.,* 2017; Bozok, 2018; Sarıkurkcu *et al.,* 2018; Akdeniz *et al.,* 2020; Karakus *et al.,* 2021; Zengin *et al.,* 2021), but there is no report for the essential oil contents of *N. viscida* Boiss. and *N. nuda* L. subsp. *lydiae* P.H. Davis in the localities used in our study. In this report, the chemical contents of the essential oil of two endemic *Nepeta* taxa were presented.

2. MATERIAL and METHODS

2.1. Plant Materials and Sample Preparation

Nepeta viscida and *N. nuda* subsp. *lydiae* were sampled at their flowering period from their natural habitats (Buharkent, Aydın-Turkey and Altınyayla, Burdur-Turkey, respectively). The collected species were identified by Prof. Dr. Gürkan SEMİZ and voucher specimens (GSE2020 for *Nepeta viscida* and GSE2004 for *N. nuda* L. subsp. *lydiae*) were deposited in the Chemical Ecology Laboratory Herbarium of the Pamukkale University, Biology Department in Denizli, Turkey. The air-dried aerial parts of each species (100 mg) were cut into small pieces and powdered. The essential oils were collected using a Clevenger-type apparatus with hydro-distillation for 4 hours. The essential oils were stored in amber bottles at 4°C until analysis.

2.2. GC-MS Analysis

The chemical profiles of the essential oils were analyzed on Gas Chromatography-Mass Spectrometer (Hewlett Packard GC-7820A, MSD-5975). A 30 m-long HP-5MS capillary column was used (ID 0.25 mm, film thickness 0.25 mm, Hewlett Packard). The chromatographic conditions to obtain for mono- and sesquiterpenes were followed by Semiz *et al* (2018). The percentages were calculated from the GC peak areas using the normalization procedure.

3. RESULTS

In this study, the essential oils of *N. viscida* and *N. nuda* L. subsp. *lydiae* were characterized by GC-MS. Chromatographic analysis of the essential oils showed that the chemical compositions of *N. viscida* and *N. nuda* subsp. *lydiae* were more or less similar to each other but differed between the amounts of the compounds. The essential oil contents of our *Nepeta* species were dominated by mainly monoterpene and sesquiterpenes hydrocarbons. Essential oil yield was found as 0.12% for *N. viscida* and 0.08% for *N. nuda* subsp. *lydiae* based on the dry weights.

Table 1. Essential oil composition (%) of *N. nuda* subsp. *lydiae* and *N. Viscida.*

No	RRI*	Compounds	*N. nuda* subsp. *lydiae*	*N. viscida*
1	922	tricyclene	0.20	-
2	937	*α*-pinene	0.41	0.19
3	969	sabinene	-	0.36
4	974	*β*-pinene	0.10	1.91
5	983	myrcene	0.20	0.32
6	1009	3-carene	1.72	-
7	1020	*p*-cymene	0.71	-
8	1028	1,8-cineol	**30.90**	4.60
9	1032	limonene	-	0.36
10	1035	*β*-ocimene	1.22	-
11	1052	*γ*-terpinene	0.71	-
12	1090	linalool	10.78	2.88
13	1134	*trans*-pinocarveol	-	0.19
14	1142	camphor	2.23	-
15	1160	borneol	**18.70**	-
16	1164	*δ*-terpineol	2.13	-
17	1176	terpinen-4-ol	0.81	0.95
18	1186	*α*-terpineol	-	**20.59**
19	1204	verbenone	0.20	-
20	1230	pulegone	1.01	-
21	1252	geraniol	1.82	-
22	1336	bicycloelemene	-	0.81
23	1357	*α*-cubebene	-	0.15
24	1376	*α*-copaene	-	0.90
25	1382	*β*-cubebene	-	0.24
26	1383	*β*-bourbonene	1.22	-
27	1392	*β*-elemene	0.71	0.93
28	1406	*α*-gurjunene	-	3.03
29	1411	*trans*-*β*-caryophyllene	-	**9.90**
30	1438	aromadendrene	-	0.74
31	1448	*trans*-*β*-farnesene	4.36	2.46
32	1453	*α*-humulene	0.81	4.32
33	1474	germacrene-D	1.52	1.92
34	1490	zingiberene	-	3.64
35	1499	*β*-bisabolene	-	2.08
36	1505	*γ*-cadinene	-	0.62
37	1512	*δ*-cadinene	0.41	4.88
38	1548	germacrene-B	-	6.38
39	1564	palustrol	-	2.92
40	1570	spathulenol	-	**9.37**
41	1578	caryophyllene oxide	**14.40**	2.36
42	1590	viridiflorol	-	0.56
43	1602	ledol	-	3.19
44	1641	*α*-cadinol	-	2.28
45	1710	farnesol	1.42	-

[a] Compounds listed in order their elution,
[b] RRI: Relative retention indices measured to against *n*-alkanes on HP-5MS column,
[c] The values in bold indicate the highest amounts.

Thirty-two compounds representing 96.0% of total oil were detected in *N. viscida*, and twenty-five compounds representing 98.7% of the total oil were detected in *N. nuda* subsp. *lydiae*. The percentage compositions of the essential oils were listed in Table 1. The main constituents were determined as *α*-terpineol (11.78%), *trans*-*β*-caryophyllene (5.66%) and spathulenol (5.36%) for *N. viscida*, and 1,8-cineole (31.31%), borneol (18.95%) and caryophyllene oxide (14.59%) for *N. nuda* subsp. *lydiae.*

4. DISCUSSION and CONCLUSION

The composition of main components in *Nepeta* species' essential oils has been categorized into two groups. Group I contains some isomers of nepetalactone, whereas Group II contains compounds other than nepetalactone isomers as main components, such as 1,8-cineole, *β*-caryophyllene, caryophyllene oxide (Sharma & Cannoo, 2013). At this point, our *Nepeta* species should be classified in Group II because of the most abundant components (1,8-cineole for *N. nuda* subsp. *lydiae* and *α*-terpineol for *N. viscida*). However, in a previous study by Kabalay *et al* (2018), they showed that neptalactone isomers were the most abundant compound for *N. nuda* subsp. *lydiae*. The plant samples in their study were collected from a different locality compared to our study. There are almost no studies in the literature, except for Kabalay *et al* (2018), which revealed the chemical composition of the essential oil of *N. nuda* subsp. *lydiae*. Therefore, our study is the most detailed chemical content study for *N. nuda* subsp. *lydiae* in the current literature.

Baser *et al* (1995) showed that the most abundant component of the essential oil of *N. viscida* from Manisa region was found as *α*-terpineol. In another study, Carikci (2021) evaluated the essential oils contents of *N. viscida* from two different localities from Balikesir and İzmir, and spathulenol and 1,8-cineole were the most abundant components, respectively. The results of our study are partially similar to the results of these studies. The differences in composition could be explained by the chemotype, soil factors, climatic conditions or geographic location. It was clearly explained that the production of secondary compounds can be affected by climate drivers (Tingey *et al.,* 1980; Banthorpe & Njar, 1984; Kainulainen *et al.,* 1992; Loziené *et al.,* 2008; Blanch *et al.,* 2009; Ormeño & Fernandez, 2012; Yu *et al.,* 2021). *Nepeta* species have been associated with several medicinal benefits since ancient times. Scientists have only recently become aware of its new potential therapeutic properties (Baytop, 1999). Significant scientific advances in the chemical compositions and bioactivities of *Nepeta* species from Turkey have been declared (Baser *et al.,* 1993-1995-1998-2000-2001; Baser & Özek, 1994; Kökdil *et al.,* 1996-1997-1998; Tümen *et al.,* 1999; Senatore & Özcan, 2003; Tepe *et al.,* 2007; Emre *et al.,* 2011; İşcan *et al.,* 2011; Kilic *et al.,* 2011-2013; Gormez *et al.,* 2013; Bozok *et al.,* 2017; Bozok, 2018; Sarıkurkcu *et al.,* 2018; Akdeniz *et al.,* 2020; Karakus *et al.,* 2021; Zengin *et al.,* 2021). As a conclusion, we believe that our results will encourage more investigation into the chemistry of *Nepeta* species and chemical content profiling of the species using terpenes may be useful in taxonomical 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, Supervision, and Validation. **Metin Armagan.** Investigation, Supervision, Writing – original draft.

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