Chemistry of Natural Compounds, Vol. 45, No. 6, 2009

VOLATILE CONSTITUENTS ANALYSIS OF *Nepeta cataria* FROM CENTRAL IRAN

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UDC 547.913

The genus *Nepeta* (Lamiaceae) comprises 250 species of perennial herbs that are distributed in Europe, Asia, North Africa, and the mountains of tropical Africa. These plants are commonly known as catmint [1]. The common Persian name of this genus is pune-sa, and about 67 species are recorded in Iran [2]. Many *Nepeta* species have some biological activity and are used in folk medicine because of their antispasmodic, diuretic, antiseptic, antitussive, antiasthmatic, and febrifuge activities [3–8]. *Nepeta cataria* L. (Lamiaceae) is one of the endemic species of this genus in Iran. *N. cataria*, commonly known as catnip, is native to Asia Minor and Southeast Europe and grows to a height of 90 cm. It is used as a fortifier, a disinfectant, and a cure against cold [1, 9]. Literature surveys reveal that most oils of *Nepeta* species such as *N. cataria* contain nepetalactones as the main component. Antibacterial, fungicidal, and antiviral activities have been attributed to nepetalactones [3, 6, 10]. According to our finding, there is no report on the chemical composition of the essential oil of *N. cataria* growing in central Iran, so the aim of the present research was to determine the chemical composition of *N. cataria* essential oil. The constituents of the volatile oil were analyzed by gas chromatography (GC) and gas chromatography–mass spectroscopy (GC–MS). The components of the oil of air-dried herbal parts of *N. cataria* are listed Table 1, including percentages and retention indices of the components. Constituents are listed in order of their elution from an HP-5MS column. As is shown, nine compounds were identified in the oil of *N. cataria*, making up 98.0% of the total oil. Among the constituents of the volatile oil, 4aα,7α,7aα-nepetalactone (87.1%), 4aα,7α,7aβ-nepetalactone (3.1%), β-caryophyllene (2.5%), and β-pinene (1.7%) were the major ones; the other constituents were present in relatively small amounts, representing only (3.6%) of the total oil. Nepetalactone isomers, which are the major constituens in our oil, were present in the essential oil of several *Nepeta* spp [11–20]. It was found that nepetalactones were responsible for the feline attractant properties of *Nepeta* species. 4aα,7α,7aα-Nepetalactone, which was the main component of our oil, has been detected as the major one in four *Nepeta* species growing in Turkey [21] and also in *N. cataria* growing in Germany [22], while caryophyllene oxide, which was abundant in *N. cataria* from Lebanon [23] and Lithuania [24] (6.4%, 7.3% respectively), was not found in our work. β-Caryophyllene, which was the third major component of our oil, has been reported in the oil of some *Nepeta* species such as *N. cataria* [23], *N. daenensis* [25], and *N. fissa* from Iran [26], and in *N. curviflora* growing in Lebanon [23]. On the other hand, 1,8-cineole, which was the most abundant component in many *Nepeta* species [4, 27–30], was not present in our work. Also, linalool and germacrene D have been identified in sizable amounts in other *Nepeta* species [4, 29, 31, 32], but traces of these compounds were found as oil constituents in this study. This is not unexpected since plants often manufacture different amounts of phytochemicals when grown in different geographical locations.

The aerial parts (leaves and flowers/inflorescences) of *Nepeta cataria* L. growing wildly in the Kashan area (Isfahan Province, Central Iran) at an altitude of ca. 1550 m were collected in July 2007 and were dried in the shade (at room temperature). Voucher specimens of the plant were deposited in the Herbarium of Kashan Botanical Garden, Research Institute of Forests and Rangelands, Kashan, Iran.

The air-dried aerial parts of the plant (130 g) subjected to volatile fractionation were isolated by hydrodistillation using an all-glass Clevenger-type apparatus for 3.5 h according to the method recommended in the European Pharmacopoeia [33]. After decanting and drying of the pale yellow oil (0.89%) over anhydrous sodium sulfate, it was stored in vials at low temperature (4°C) before analysis.

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0009-3130/09/4506-0913

TABLE 1. Percentage Composition of the Oil of the Aerial Parts of *Nepeta cataria L.* from Central Iran (Kashan area), %

Compound[a]	%[b]	RI[c]	Compound[a]	%[b]	RI[c]
β-Pinene	1.7	965	4aα, 7α,7aβ-Nepetalactone[d]	3.1	1379
Ascaridole	0.5	1248	4aα, 7β,7aα-Nepetalactone	1.3	1384
4aα,7α,7aα-Nepetalactone	87.1	1356	β-Caryophyllene	2.5	1406
α-Copaene	0.7	1363	(*Z*)-β-Farnesene	0.7	1445
β-Bourbonene	0.4	1373	Total	98.0	

[a]As identified by GC-TOF/MS software; names according to Wiley 275.L and Wiley 7n.l mass spectra library, and by comparing their retention indices; [b]percentage of each component is calculated as (peak area of analyte/peak area of total ion chromatogram) × 100 (in the case of multiple identification), the areas of the peaks that belong to one analyte were combined to find the total area for this particular analyte; [c]Kovats retention indices measured relative to n-alkanes (C_6–C_{24}) on the HP 5MS capillary column; [d]Tentatively identified according to mass spectra data; RI = 1379, MS data 70 eV, *m/z* (rel. int.): 166 (58), 138 (20), 123 (84), 109 (58), 95 (82), 81 (100), 69 (82), 55 (58), 53 (50), MW (166).

The oil was analyzed by GC and GC-MS. GC analysis of the oil was conducted using a Hewlett-Packard-6890 gas chromatograph equipped with an FID detector and an HP-5MS fused silica column (30 m × 0.25 mm, film thickness 0.25 μm). The column temperature was kept at 50°C for 2 min and programmed to 130°C at a rate of 3°C/min, and kept constant at 130°C for 2 min, programmed to 270°C at a rate of 5°C/min, kept constant at 270°C for 3 min; injector and detector (FID) temperature 280°C; carrier gas helium with flow rate 1 mL/min, volume injected 0.1 μL of the oil in pentane (0. 001%); split ratio 1:10. GC/MS analysis was performed on an Agilent HP-6890 gas chromatograph equipped with a mass Agilent HP-5973 and an HP-5MS 5% phenyl methyl siloxane capillary column (30 m × 0.25 mm, film thickness, 0.25 μm) and operating under the same conditions as described above. The MS operating parameters were as follows: ionization potential 70 eV; ionization current 2 A; ion source temperature 230°C; resolution 1000; scan time 1 sec, mass range 40–465 amu.

The essential oil was analyzed by GC and GC/MS systems using a nonpolar column. Identification of the components in the oil was based on retention indices (RI) relative to *n*-alkanes and computer matching with the Wiley 275. L and Wiley 7n.l libraries, as well as by comparison of the fragmentation pattern of the mass spectra with data published in the literature [34–36]. The percentage composition of the samples was computed from the GC-FID peak areas without the use of correction factors.

ACKNOWLEDGMENT

Financial support from the Research Affairs Office of the University of Kashan, Kashan, I. R. Iran is gratefully acknowledged.

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