Chemistry of Natural Compounds, Vol. 45, No. 4, 2009

COMPOSITION AND ANTIOXIDANT ACTIVITY OF *Nepeta foliosa* ESSENTIAL OIL FROM SARDINIA (ITALY)

Laura Giamperi,[1] Anahi Bucchini,[1] Pierpaolo Cara,[1] Daniele Fraternale,[1] Donata Ricci,[1]* Salvatore Genovese,[2] Massimo Curini,[2] and Francesco Epifano[3]

UDC 547.913

The genus *Nepeta* (Lamiales, Lamiaceae), comprises about 250 species distributed in the central and southern parts of Europe, Asia, and the Middle East [1].

It is represented in Italy by 8 species, including 4 endemics [2].

Several *Nepeta* species are used in folk medicine as fungistatic [3], bacteriostatic, and disinfectant [4–6], as well as against eczema-type skin disorders [7]. *Nepeta* species are used also as antifebrile and diuretic and as a remedy for stomachache and dropsy [8], and they contain monoterpenes, sesquiterpenes, cyclopentanoid iridoid derivatives, and nepetalactone [9].

The feline attractant properties of several *Nepeta* species have been known for a long time; in fact the activity of nepetalactone and also of its isomers on the olfactory sense of domestic cats (*Felix domestica*) was proven in 1969 [10].

The antioxidant activity was evaluated "*in vitro*" only in *Nepeta flavida* essential oil from Turkey [11] and *Nepeta cataria* from Lithuania [12] by DPPH and beta-carotene bleaching tests.

In this study we characterized for the first time the chemical constituents of the essential oil of *Nepeta foliosa*, an endemic species of Sardinia Island (Italy), and investigated its antioxidant activity by two "*in vitro*" systems.

In Table 1 are summarized 16 compounds representing 96.4% of the essential oil (yield 0.1% v/w). GC and GC/MS analyses revealed nepetalactone (31.17%) and linalool (15.24%) as the main components, amounting to 46.41% of the total oil. 1,8-Cineole (eucalyptol) (12.54%), β-pinene (8.93%), and geranyl acetate (5.52%) were the other constituents of the essential oil studied.

The antioxidant activity of *Nepeta foliosa* oil was determined using two *in vitro* assays: (1) the scavenging effect on DPPH and (2) the inhibition of lipid peroxide radical formation. The data concerning the antioxidant activity of the oil, expressed as $IC_{50,}$ are reported in Table 2 and compared with the activity of three known antioxidants (ascorbic acid, BHT, and Trolox).

The data collected in Table 2 show that, in the reduction of the stable radical DPPH, the lowest activity was obtained with the essential oil (IC_{50} = 20.10 mg/mL).

In the inhibition of lipid peroxidation, the IC_{50} values obtained showed that the essential oil antioxidant activity was similar to BHT (IC_{50} = 2.13 μg/mL and 3.86 μg/mL, respectively), while the values obtained for ascorbic acid and Trolox were 18.63 μg/mL and 11.88 μg/mL, respectively.

Literature data show three main chemotypes for the essential oils of *Nepeta* genus [11]. The first one is the nepetalactone chemotype, the second group is the caryophyllene oxide chemotype, and the last group is the 1,8-cineole and/or linalool chemotype. *Nepeta foliosa* of Sardinia can be ascribed to the first chemotype reported (nepetalactone), although the oil shows a mildly menthol-like odor, which may be attributed to its content of 1,8-cineole (12.54%). To our knowledge, the oil of *Nepeta foliosa* from Sardinia should represent an intermediate chemotype between the first one reported (nepetalactone) and the third one (1,8-cineole and/or linalool). For this reason, we can consider this endemic plant the first example of a *Nepeta* species rich in both nepetalactone and linalool.

1) Istituto di Botanica e Orto Botanico "P. Scaramella," Facolta di Farmacia, Universita degli Studi di Urbino "Carlo Bo," Urbino (PU), Italy, fax: +390722303777, e-mail: d.ricci@uniurb.it; 2) Dipartimento di Chimica e Tecnologia del Farmaco, Sezione di Chimica Organica, Universita degli Studi di Perugia, Perugia, Italy; 3) Dipartimento di Scienze del Farmaco, Universita "G. D′Annunzio" di Chieti-Pescara, Via dei Vestini 31, 66013 Chieti Scalo (CH), Italy. Published in Khimiya Prirodnykh Soedinenii, No. 4, pp. 469–470, July–August, 2009. Original article submitted November 22, 2007.

 0009-3130/09/4504-0554

TABLE 1. Essential Oil Composition of Aerial Parts of *Nepeta foliosa* from Sardinia (Italy)

Compound[ab]	$RI_{(1)}$	$RI_{(2)}$	%	Compound[ab]	$RI_{(1)}$	$RI_{(2)}$	%
β-Pinene	978	1120	8.93	*cis-allo*-Ocimene	1120	1392	2.25
β-Myrcene	986	1166	3.69	*trans-allo*-Ocimene	1132	1373	2.84
cis-β-Ocimene	1025	1223	3.70	*p*-Menth-1(7)-en-9-ol	1134	1904	0.39
1,8-Cineole	1027	1238	12.54	Borneol	1164	1698	1.71
trans-β-Ocimene	1042	1257	2.63	Nepetalactone	1344	1607	31.17
cis-Linalool oxide	1068	1423	1.06	Geranyl acetate	1363	1648	5.52
trans-Linalool oxide	1082	1451	3.86	*α*-Cariophyllene	1425	1619	1.63
Linalool	1092	1506	15.24	Germacrene D	1468	1712	2.84

$RI_{(1)}$: retention index on apolar methyl silicone column.
$RI_{(2)}$: retention index on polar CP-Sil 88 (Chromopack) column.
Identified by: [a]Davies N.W. 1990 (62); [b]Nist98 Mass Spectral Database.

TABLE 2. Effect of *Nepeta foliosa* Essential Oil and Positive Controls on *in vitro* Free Radical (DPPH test) and Lipid Peroxidation Generation

Sample	DPPH IC_{50} (mg/mL)	Lipid peroxidation IC_{50} (μg/mL)
Essential oil	20.10±1.85	2.13±1.27
Ascorbic acid	0.110±0.07	18.63±1.31
BHT	0.086±0.007	3.86±0.85
Trolox	0.011±0.001	11.88±1.22

The values are the average of three determinations (±S.D.).

Concerning the antioxidant activity, the data obtained in two tests showed that, in the reduction of the stable radical DPPH, the results obtained with the essential oil were not comparable to those of known antioxidants, while the inhibition of lipid peroxidation was more effective than that of BHT.

The scavenging capacity of *N. foliosa* essential oil detected by the DPPH test was considerably lower when compared to the antioxidant effect on lipid peroxidation (lipoxygenase assay). These differences are probably due to their different antioxidative mechanisms. The DPPH method does not discriminate between radical species, but gives a general idea of the radical quenching ability [13]. The higher antioxidant effect of *N. foliosa* essential oil was observed on lipid peroxidation, as indicated by the lipoxygenase assay. This inhibition of lipoxygenase activity could be due either to the scavenging activity of the oil against oxygen radicals or to other antioxidant mechanisms. In fact, lipid peroxidation is a complex process involving a variety of radicals; it is influenced by temperature, light, air, physical and chemical properties of the substrate, and the presence of oxidation catalysts or initiators [14]. The protection of lipids against oxidative damage is likewise a complex process. Antioxidants can exert their protective properties at different stages of the oxidation process and by different mechanisms, which can include free radical scavenging activity but also the activation of metals, inhibition of the breakdown of lipid hydroperoxides to unwanted volatile products (termination of chain reaction in the lipid phase involving peroxyl radicals and hydroperoxides), regeneration of "primary" antioxidants, singlet oxygen quenching, etc. [15, 16].

Therefore, the different results on the scavenging capacity of the oil obtained by these two assays may be due to their different sensitivity and specificity.

Moreover, the antioxidant activity of this essential oil can be attributed to the presence of 1,8-cineole, as reported previously by Tepe et al. [11].

REFERENCES

1. O. Tzakou, C. Haruda, E. M. Galati, and R. Sanogo, *Flav. Fragr. J.,* **15**, 115 (2000).
2. S. Pignatti, *Flora d'Italia,* Ed agricole: Bologna, 1982, p. 470.
3. A. Inouye, K. Uccida, and S. Abe, *J. Aromather.*, **16**, 159 (2006).
4. G. Stojanovic, N. Radulovic, J. Lazarevic, D. Miladinovic, and D. Dokovic, *J. Essent. Oil Res.,* **17**, 587 (2005).
5. A. Sonboli, P. Salesi, and M. Yousefzadi, *Z. Naturforsch., C: Biosci*., **59**, 653 (2004).
6. E. Kalpoutzakis, A. N. Eleftherios, A. Mentis, S. Mitaku, and C. Charvala, *Planta Med.*, **67**, 880 (2001).
7. H. L. De Pooter, B. Nicolai, L. F. De Buyck, P. Goetghebeurand, and N. M. Schamp, *Phytochem*istry, **26**, 2311 (1987).
8. F. Senatore, N. Apostolides Arnold, and F. Piozzi, *J. Essent. Oil Res.,* **17**, 268 (2005).
9. A. Kaya, B. Demirci, and K. H. C. Baser, *S. Afr. J. Bot*., **73**, 29 (2007).
10. M. Kobaisy, M. R. Tellez, F. E. Dayan, L. K. Mamonov, G. S. Mukanova, G. T. Sitpaeva, and N. G. Gemejieva, *J. Essent. Oil Res.,* **17**, 704 (2005).
11. B. Tepe, B. Daferera, A. Tepe, M. Polissiou, and A. Sokmen, *Food Chem.,* **103**, 1358 (2007).
12. A. Dapkevicius, R. Venskutonis, T. A. van Beek, and J. P. H. Linssen, *J. Sci. Food Agric.,* **77**, 140 (1998).
13. N. W. Davies, *J. Chromatogr.,* **503**, 1 (1990).
14. G. F. Sud'ina, O. K. Mirzoeva, M. A. Pushkareva, G. A. Korshunova, N. V. Sumbatyan, and S. D. Vafolomeev, *FEBS Lett.,* **329**, 21 (1993).
15. A. Mellors and A. L. Tappel, *J. Biol. Chem.,* **241**, 4353 (1966).
16. I. Koleva, T. A. van Beek, J. P. H. Linssen, A. deGroot, and L. N. Evstatieva, *Phytochem. Anal.,* **13**, 8 (2002).