Analele ştiinţifice ale Universităţii "Al. I. Cuza" Iaşi
Tomul LVI, fasc. 1, s.II a. Biologie vegetală, 2010

STUDIES REGARDING THE CHEMICAL COMPOSITION OF VOLATILE OILS FROM SOME SPONTANEOUS AND CULTIVATED *LAMIACEAE* SPECIES

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Abstract: The *Lamiaceae* plant family comprises numerous species that have medicinal and/or aromatic properties, many of these species having glandular secretory trichoms placed on their aerial vegetative organs and on their reproductive organs too, that produce volatile oils. The objective of this paper is to determine the chemical composition of the volatile oils of *Mentha aquatica* L. , *Perovskia atriplicifolia* Benth. and *Thymus zygioides* Griseb. and to correlate the obtained data with those regarding the specific ecological conditions of the originating locations for the investigated species and comparing them with those found in the literature.

Key words: *Lamiaceae, Thymus zygioides, Mentha aquqtica, Perovskia atriplicifolia*, volatile oil

Introduction

The family *Lamiaceae* is rich in aromatic species, which are used as culinary herbs, folk medicines and fragrant scents (Gairola et al., 2009). These are due to the essential oils produced in glandular hairs distributed on the aerial vegetative and reproductive organs (Marin et al., 2006; Werker, 1993). The structure and function of trichomes from different species of the *Lamiaceae* is well documented (Ascensão and Pais, 1998, Bosabalidis, 1990, Corsi and Bottega, 1999, Combrinck et al., 2007, Zamfirache et al., 2009).

Thymus zygioides is a perennial shruby plant. In Romanian flora it is generally distributed in Dobrogea area (Oprea, 2005).

Mentha aquatica L. is a herbaceous rhizomatous perennial plant with tiny, densely crowded, purple, tubular flowers, occurring in the shallow margins and channels of streams, rivers, pools, ditches, wet meadows, currently occurring on mildly acid to calcareous mineral or peaty soils (Flora of NW Europe).

Perovskia atriplicifolia (Russian sage) is a silver-grey half-shrubby plant, with medicinal application and ornamental value. It grows 1.0 to 1.5 m high and the flowers appear in July and August. The flowers are large airy spires made up of many tiny florets. The florets are very similar to the individual flowers of lavender. All parts of *Perovskia* have silvery hairs, including the flower heads. This plant that is native to central Asia in an area that includes Afghanistan, Iran, Pakistan, and Tibet.

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Material and methods

The investigated species (*Mentha aquatica* L., *Perovskia atriplicifolia* Benth. and *Thymus zygioides* Griseb.) were collected from different areas in Romania. *Mentha aquatica* was collected from Caraorman area and *Thymus zygioides* was collected from Constanta district, both situated in Dobrogea region. *Perovskia atriplicifolia* has been cultivated and collected from Iasi area. All the vegetal material has been collected during anthesis stage of plant development.

The volatile oils of these species have been obtained by hidro-distillation using a Clevenger apparatus in the Laboratory of Plant Physiology of the Faculty of Biology of "Al. I. Cuza" University of Iasi. The chemical analysis of the volatile oils has been carried out using gas chromatography coupled with massspectrometry (GC-MS), using a 6890 Agilant GC-MS and the volatile compound identification was made using the NIST spectral bank and Kovats indexes, at the Faculty of Horticulture, U.S.A.M.V. Bucharest.

Results and discussions

The presence, yield and composition of secondary metabolites in plants such as volatile oils, can be affected in many ways by several factors that include: physiological variations, environmental conditions, geographic variations, genetic factors and evolution (Figueiredo et al., 2008).

Mericli and Tanker, in a study carried out in 1986 on *T.* zygzoides from Turkey, obtained thymol 24.6%, linalool 12.2% as the main constituents of the volatile oil, followed by borneol, charvacrol and 1,8-cineole. Baser et. al. (1996), obtained four different sets of data regarding the chemical composition of this species:

(1) charvacrol 48.1%, y-terpinene 12.0%, thymol, p-cimene, β -bisabolene

(2) geraniol 68.6%, geranil acetate, β-bisabolene, nerole, 8-cariophilene

(3) α-terpinil acetate, 36.2%, α-terpineole 19.5%, β-bisabolene, bornil acetate, limonen

(4) thymol 41.8-57.2%, y-terpinene 1.3-19.5%, β-bisabolene 1.2-15.9%, p-cymene 4.1-12.09%, charvacrol

In 1999 Baser et al. obtained linalool 33.7%, (E)-nerolidole 12.5%, neral, geranial and camfor as main constituents of the volatile oil of *T.* zygzoides studied.

In our study, the main chemical compounds obtained from the volatile oil of *T.* zygzoides were: camphene (18.12%), α-pinene (9.45%), germacrene D (7.67%), α-limonene (6.46%), β-caryophyllene (5.48%) (Fig. 1, Fig. 2).

Hefendehl and Murray (1971) obtained the following chemical compounds analyzing the volatole oil of *Mentha aquatica*: cineol (7%), limonene (4-9%), traces of terpinolene şi pulegone, menthone (0-1%), menthol (0-2%), menthofuran (66-64%) and 18-19% of other 12 different compounds.

Recent studies regarding the cehmical composition of the same species but collected from Iran showed that the main constituents found were: β-caryophyllene (22.4%), viridiflorole (11.3%) and 1, 8-cineole(10.9%) (Akbar et al., 2006).

The analysis of the volatile oil of *Mentha aquatica* that we obtained shows that the main constituents are: menthofuran (51.27%), limonene (12.06%), izomenthone (8.11%), β – cis – ocimene (7.92%), ledol (3.01%) (Fig. 3, Fig. 4).

In 1926 Rao found α-pinene, β-pinene, camphene, borneol, bornyl acetate, α-caryophyllene and aromadendrene in the volatile oil of *P. atriplicifolia*. Later studies on the volatile oil of *P. atriplicifolia* from Afghanistan confirmed Rao's results and found, in addition, α-terpinene, 1,8-cineole, camphor, menthol and cedrol but not aromadendrene (Younos et al., 1972). In the essential oil obtained from the glandular trichomes of *P. atriplicifolia* cultivated in Italy, camphor (14.9%) was the main constituent (Mucciarelli et al., 1993).

More recently, the essential oil of *P. atriplicifolia* cultivated in Iran has been described (Sefidkon et al., 1997). Out of 19 compounds identifed by Jassbi et al. (1999) in the volatile oil of *P. atriplicifolia* from Pakistan, the monoterpenes, D3-carene (22.3%) and 1,8-cineole (27.5%) amounted to 50% of the total oil. β-caryophyllene (10.8%) and α-humulene (5.7%) were the dominant sesquiterpenes.

The compounds with the highest concentrations in the volatile oil of *P. atriplicifolia* analyzed in our study are: limonene (17%), γ-terpinene (16%), β-caryophyllene (13%), α-caryophyllene (12%), cimen (11%) (Fig. 5, Fig. 6).

Conclusions

The highest number of chemical compounds has been identified in the volatile oil of the species *Mentha aquatica* (28 chemical compounds), followed by the volatile oil from *Perovskia atriplicifolia* (27 chemical compounds), the volatile oil of *Thymus zygioides* having the least chemical compounds (25 chemical compounds).

The environmental factors such as temperature, radiation and light play an important role in the quantity and quality of volatile oil (Yamaura et al., 1989). The indispensable nutrients for plants such as water, mineral compounds and nitrogen have also a great importance for the chemical composition and quality of volatile oils (Rajeswara , 1990).

As a perspective of this study, the chemical composition of the analyzed volatile oil will be correlated with their antimicrobial effect, enhancing thus the presence of some compounds that have inhibitory effect on the multiplication and development of pathogenic microorganisms.

Acknowledgements. This study was supported by a research grant (IDEI 2100, no. 1040/2009) funded by the National Council of Scientific Research and University Education (CNCSIS), Romania.

REFERENCES

1. ASCENSÃO L., PAIS M.S., 1998 - The leaf capitate trichomes of Leonotis leonurus: Histochemistry, ultrastructure and secretion, Ann. Bot. 81, pp. 263–271
2. AKBAR E., ABDOLHOSSEIN R., SHIVA M., KOBRA N., 2006 - Composition of the Essential Oils of Mentha aquatica L. and Nepeta meyeri Benth. from Iran, Journal of Essential Oil Research
3. BASER K, .H.C., KIIRKSUOGLU M., TUME, G. AND SEZIK E., 1996 - Composition of the essential oil of Thynzw eigii (M. Zohary et. P.H. Davis) Jalas from Turkey. J. Essent. Oil Res., 8, pp. 85-86
4. BASER K.H.C., KIRIRNER N., ERRNIN N. AND KIIRKSIIOGLU M., 1996 - Essential oils from four chemotypes of Thymus zygioides Griseb. var. lycaonicus (Celak) Ronniger. J. Essent. Oil Res., 8, pp.615-618

5. BASER K.H.C., KIRIMER N., ERMIN N., OZEK T. AND TUMEN G., 1996 - Composition of essential oils from three varieties of Thymuspraecox Opiz growing in Turkey. J. Essent. Oil Res. 8, 3, pp.19-32
6. BASER K.H.C., KURKGUOGLU M., ERMIN N., TUMEN, G. AND MALYER H., 1999 - Composition of the essential oil of Thymus pseudopulegioides Klokov et Des.-Shost. from Turkey. J. Essent. Oil Res., 11, pp. 86-88
7. BAGER, K.H.C., DEMIRCI B., KURKGUOGLU M. AND TUMEN G., 1999 - Essential oil of Thymus zygioides Griseb. var. zygioides from Turkey. J. Essent. Oil Res., 11, pp. 409-410
8. BASER K .H.C., OZEK T., KIIRKGUOGLU M., TURNEN G. AND YILDIZ B., 1999 - Composition of the essential oils of Thymus leucostomw Hausskn. et Velen. var. gypsacem Jalas and Thymuspubescens Boiss. et Kotschy ex Celak. var. crutericola Jalas. J. Essent. Oil Res., 11, pp. 776-778
9. BASER K.H.C., DEMIRCI B., KURKGUOGLU M. AND TUMEN G., 1999 - Composition of the essential oils of Thymus pectinatus Fisch. et May. var. pectinattls at different stages of vegetation J. Essent. Oil Res., 11, pp. 333-334
10. BASER K.H.C., KURKGUOGLU M. AND TIIMEN G., 1999 - Essential oils of Thymw striutus Vahl var. interruptus Jalas from Turkey. J. Essent. Oil Res., 11, pp. 253-256
11. BOSABALIDIS A.M., 1990 - Glandular trichomes in Satureja thymbra leaves, Ann. Bot. 65, pp. 71–78
12. COMBRINCK S., DU PLOOY G.W., MCCRINDLE R.I., BOTHA B.M., 2007 - Morphology and histochemistry of the glandular trichomes of Lippia scaberrima (Verbenaceae), Annals of Botany 99, pp. 1111-1119.
13. CORSI G., BOTTEGA S., 1999 -Glandular hairs of Saliva officinalis: new data on morphology, localization and histochemistry in relation to function, Ann. Bot. 84, pp. 657–664
14. FIGUIEREDO A. C., BARROSO J. G., PEDRO L. G., SCHEFFER J. J. C., 2008 - Factors affecting secondary metabolite production in plants: volatile components and essential oils, Flavour Fragr. J., 23,pp. 213-226
15. GAIROLA S., NAIDOO Y., BHATT A., NICHOLAS A., 2009 - An investigation of the foliar trichomes of Tetradenia riparia (Hochst.) Codd [Lamiaceae]: an important medicinal plant of Southern Africa, Flora 204, pp. 325–330
16. HEFENDEHL F. W., MURRAY M., 1972 - Changes in monoterpene composition in Mentha aquatica produced by gene substitution, Phytochemistry, 11, pp. 89-195
17. JASSBI A. R., AHMAD V. U., TAREEN R. B., 1999 - Constituents of the essential oil of *Perovskia atriplicifolia* Benth., Flavour Fragr. J., 14, pp. 38-40
18. MARIN M., KOKO V., DULETIC-LAUSEVIC S., MARIN P.D., RANCIC D., DAJIC-STEVANOVIC V., 2006 - Glandular trichomes on the leaves of Rosmarinus officinalis: morphology, sterology and histochemistry, S. Afr. J. Bot. 72, pp. 378–382
19. MERICLI F.I. AND TANKER M., 1986 - The volatile oils of some endemic Thynzus species growing in Southern Anatolia. Planta Med., 52, pp. 340-341
20. MUCCIARELLI M., MATEI M., SACCO T., 1993 - Riv. Ital. EPPOS, 4, 3; Chem. Abstr., 123, 296201k 1995
21. OPREA A., 2005 - Lista critică a plantelor vasculare din România, Ed. Univ. Al.I.Cuza, Iaşi, pp. 306-311
22. RAJESWARA R., BHASKARUNI R., KAKARAPARTHI P. SASTRY, 1990 - Variation in Yields and Quality of Geranium, under Varied Climatic and Fertility Conditions, J. Ess. Oil Res., 2, pp. 73-79
23. RAO M. G., 1926 – Essential oil from the flowerheads of *Perovskia atriplicifolia* Benth., Quart J. Indian Chem. Soc., 3, pp. 141
24. SEFIDKON F., AHMADI L., MIRZA M., 1997 - Volatile components of *Perovskia atrilpicifolia* Benth., J. Essent. Oil Res., 9, pp. 101
25. WERKER E., 1993 - Function of essential oil-secreting glandular hairs in aromatic plants of the Lamiaceae – a review, Flavour Fragrance J. 8, pp. 249–255
26. YAMAURA T., TANAKA S. AND TOBANA M., 1989 - Light Dependent Formation of Glandular Trichomes and Monoterpenes in Thyme Seedlings. Phytochemistry, 28,pp. 741-744
27. YOUNOS CH, LORRAIN M., PELT J. M., 1972 – Chemistry and pharmacology of essential oil from Afganistan *Labiatae*. Essential oils from two Perovskia species., *P. abratanoides* and *P. atriplicifolia*, Plant Med. Phytother., 6, pp. 178
28. ZAMFIRACHE M. M., BURZO I., GOSTIN I. , IVANESCU L. BERCIU I., GALES R., PADURARIU C., OLTEANU Z., MIHASAN M., TRUTA E, 2009 - Micromorphology, anatomy and volatile constituents of leaf in some *Lamiaceae* species, Planta Medica, pp. 75
29. http://ip30.eti.uva.nl/BIS/flora.php?selected=beschrijving&menuentry=soorten&id=3521

Exlanation of plates

PLATE I

Gas chromatogram of the volatile oil of *Thymus* zygzoides (Fig. 1)

Percentage of chemical compounds of the volatile oil of *Thymus* zygzoides (Fig. 2)

Gas chromatogram of the volatile oil of *Mentha aquatica* (Fig. 3)

PLATE II

Percentage of chemical compounds of the volatile oil of *Mentha aquatica* (Fig. 4)

Gas chromatogram of the volatile oil of *Perovskia atriplicifolia* (Fig. 5)

Percentage of chemical compounds of the volatile oil of *Perovskia atriplicifolia* (Fig. 6)

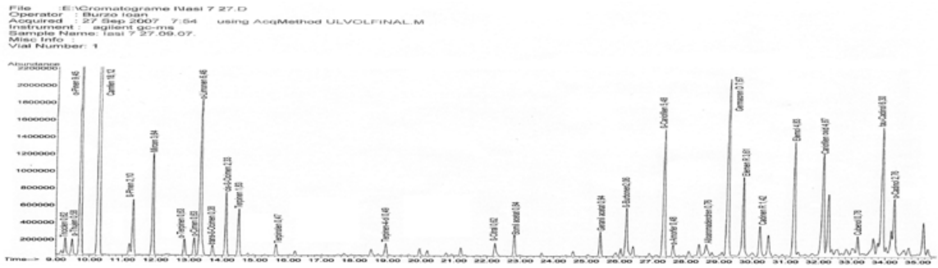

Fig.1

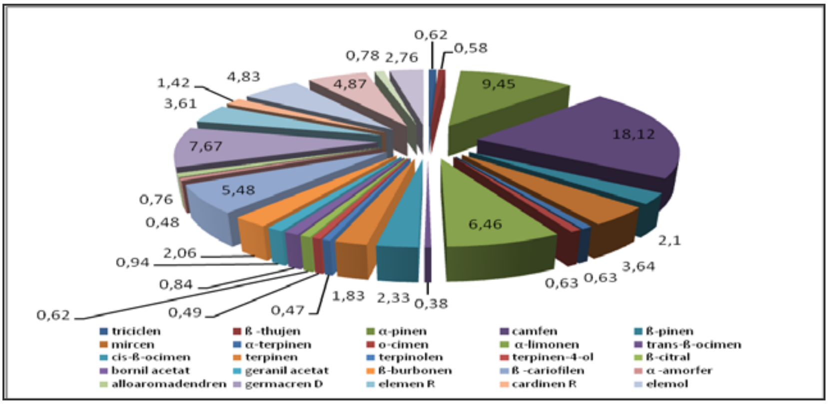

Fig. 2

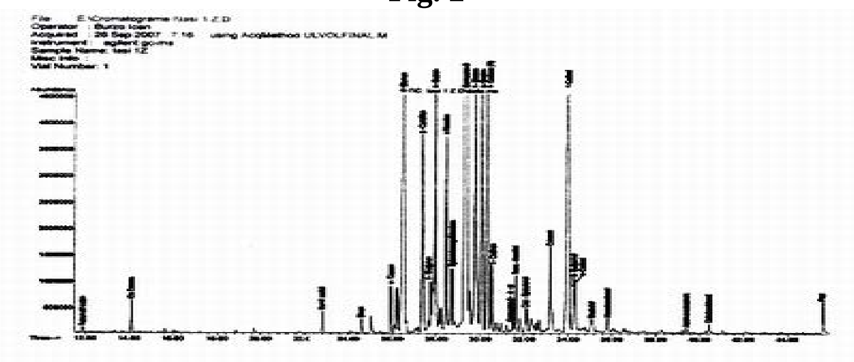

Fig. 3

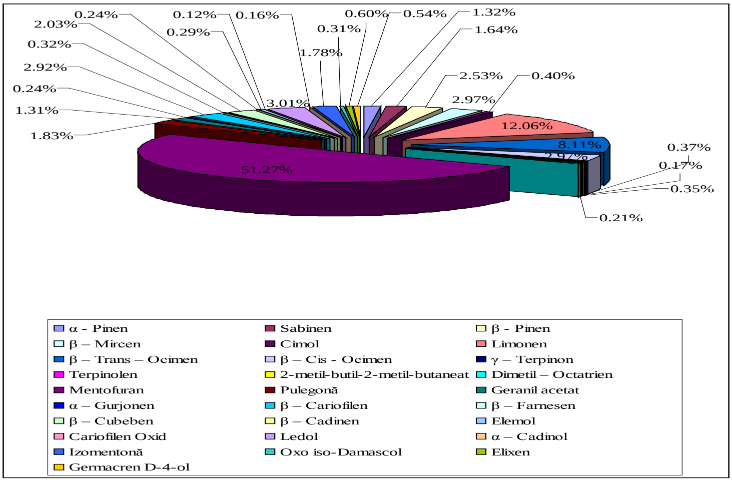

Fig. 4

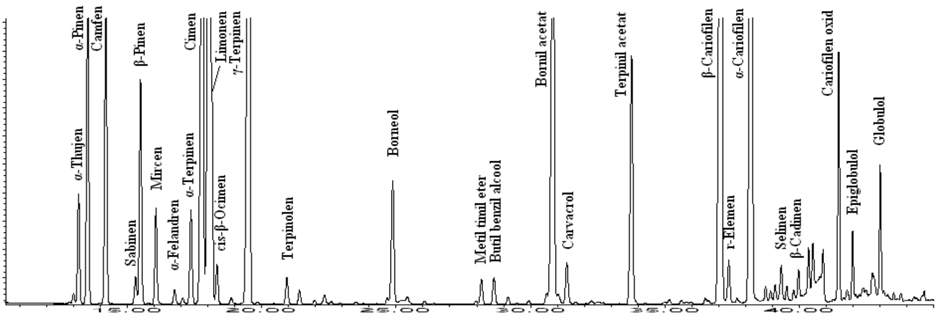

Fig. 5

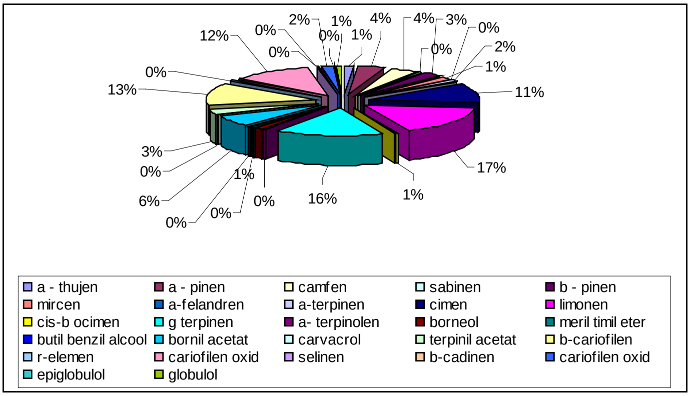

Fig. 6