Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 1, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INVESTIGATION THE QUANTITY AND QUALITY OF ESSENTIAL OIL OF *ARTEMISIA VULGARIS* L.

Monica Luminița BADEA, Elena DELIAN, Aurelia DOBRESCU, Liliana BĂDULESCU, Cosmin Alexandru MIHAI

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd., District 1, Bucharest, Romania

Corresponding author email: badea.artemisia@gmail.com

Abstract

Artemisia genus strong and aromatic smell is due mainly to high concentrations of volatile terpenes, constituents of their essential oils and extensive studies have been done on this issue. In this research, the analysis of the essential oil from the quantitative and qualitative point of view has been carried out for leaves, stems and flowers of Artemisia vulgaris L. species in Romania. The oil has been extracted during the flowering period, by hydro distillation and analyzed by gas chromatography–mass spectrometry (GC-MS). The obtained results emphasized the presence of some major chemical compounds in leaves, such as eucalyptol, germacrene D and β-pinene. Flowers contained higher amounts of eucalyptol and borneol, while in stems, especially beta-pinene and eucalyptol have been determined. The common chemical compounds in the three vegetative organs, were β-pinene and eucalyptol, for which different values have been recorded. The highest amount of β-pinene has been recorded in the volatile oil extracted from stems (11.9%), followed by leaves (4.49%) and flowers (3.02%), respectively.

Key words: *Asteraceae, chromatography, essential oils, flowers.*

INTRODUCTION

The genus *Artemisia (Asteraceae*) consists of about 500 species, occurring throughout the world. *Artemisia vulgaris* L. (commonly known as mugwort) is a perennial herb wide-spread throughout temperate regions of the Northern Hemisphere. The plant is also known as an aggressive weed. *A. vulgaris* exhibits wide morphological and physiological variability. Fresh plants have a strong odor, and a spicy-bitter taste (Judzentiene et al., 2016). *Artemisia* has a vast range of biological activities including antimalarial, cytotoxic, antihepatotoxic, antibacterial, antifungal and antioxidant activity (Bora et al., 2011). The large genus *Artemisia* L., from the tribe Anthemideae, comprises important medicinal plants which are currently the subject of phytochemical attention due to their biological and chemical diversity. *Artemisia* species, widespread throughout the world, are one of the most popular plants in Chinese traditional preparations and are frequently used for the treatment of diseases such as malaria, hepatitis, cancer, inflammation and infections by fungi, bacteria and viruses. (Abad et al., 2012).

Essential oils make a major contribution into the plant's biological activity as well. For that reason the chemical composition of mugwort oils has been investigated in several studies (Judžentienė et al., 2006; Zhigzhitzhapova et al., 2016; Pandey et al., 2017; Janaćković et al., 2019). The strong and aromatic smell of some species of *Artemisia* genus is due mainly to high concentrations of volatile terpenes, constituents of their essential oils, especially in leaves and flowers. Williams et al. (2012) states that the major constituents of essential oil extracted from *A. vulgaris* L. are: Germacrene D (25%), Caryophyllene (20%), α - Zingiberene (15%) and Borneol (11%), while the buds are rich in 1,8-Cineole (32%), Camphor (16%), Borneol (9%), and Caryophyllene (5%). The essential oils from *A. vulgaris* can be used for various medicinal purposes (Malik et al., 2019). As reported, the essential oils from *A. vulgaris* showed bactericidal and fungicidal properties against *Staphylococcus aureus* and *Candida albicans*, respectively. Instead, any anthelmintic activity of essential oil against *Haemonchus contortus* was observed.

The objective of this study was to analyze the volatile oil from a quantitative, as well as qualitative, point of view.

MATERIALS AND METHODS

The research was carried out on *Artemisia vulgaris* plants (stems, leaves, flowers), harvested from spontaneous flora - Vitănești (Teleorman County) from Romania, in a fresh state. The aerial parts of the plant were collected during full blossoming. The extraction and analysis of the volatile oil were implemented within the Faculty of Horticulture, Bucharest. Fresh herbal parts of the collected plant were subjected to hydrodistillation for 3 h using a Singer-Nickerson equipment to extract the oil. The separation and identification of components has been carried out using an Agilent 6890 GC coupled with a 5973 Network single quadruple mass spectrophotometer detector in Electron Ionization (EI) mode and a 7673 injector. A capillary column 452 DB-5 (25 m length x 0.25 mm i.d. and 0.25 µm film thickness) and helium as carrier gas (1 mL/min) were used (Bădulescu et al., 2010). The initial oven temperature was 50°C for 8 min, then a 4°C/min ramp to 280°C. The NIST spectra library was used for to identify the essential compounds, and the Kovats indices were verified using an alkane mixture purchased from Sigma-Aldrich.

RESULTS AND DISCUSSIONS

Regarding the volatile oil content, the same amount of oil was found for leaves and flowers (0.10 mL/100 g). The determinations made in the stems revealed that they had such a low content of volatile oil that it had to be captured in hexane, in order to be chemically analyzed. After the volatile oil, extracted from the vegetative organs of *Artemisia vulgaris* species, had been analyzed, it was found a greater number of chemical components in the volatile oil obtained from flowers (31), and in the case of leaves and stems, the number of chemical components was lower (29, respectively 23).
The common chemical compounds, in all three vegetative organs, were beta-pinene and eucalyptol, which recorded different values. The highest amount of beta-pinene being recorded was in the volatile oil extracted from stems (11.93%) (Figure 1), in the volatile oil extracted from leaves and flowers, the amount of beta-pinene decreased (4.49% and 3.02%, respectively) (Figure 3 and Figure 5).

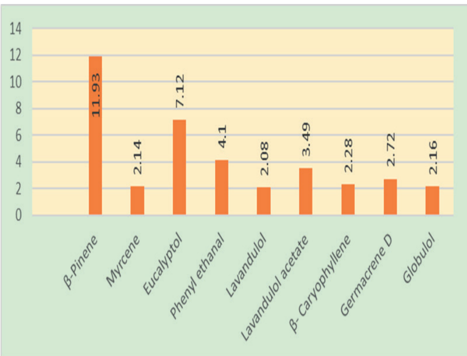

Figure 1. Major chemical compounds of stems, %

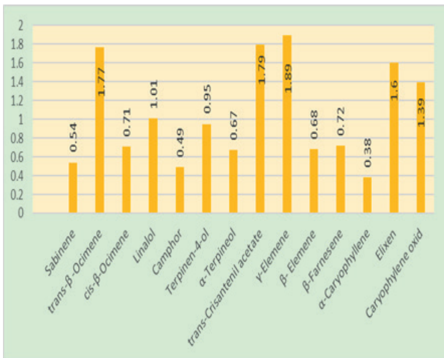

Figure 2. Minor chemical compounds of stems, %

The eucalyptol ranged from 6.29% to 12.39% in the volatile oil extracted from, leaves, stems and flowers, most of it being found in the volatile oil which was taken from flowers. Eucalyptol (1,8-cineole) is one of the major essential oils in *Artemisia vulgaris* (Jiang et al., 2019). The amount of eucalyptol (6.29%) in the leaves is approximately equal to that of germacrene D (6.42%). In the essential oil extracted from flowers the amount of eucalyptol (12.39%) is equal to that of borneol (12.39%) (Figure 5). Eucalyptol has been used as an antibacterial and expectorant (Giamakis et al., 2001), and as an anti-inflammatory (Juergens et al., 1998) or antihypertensive agent (Lahlou et al., 2002). As for the data presented in Figures 1 and 3, it can be noticed the presence of some common substances in the three organs, determined in significant quantity, such as germacren D, myrcene and sabinene. With regard to germacrene D, a higher quantity is observed in the volatile oil extracted from the leaves (6.42%), and in the case of myrcene and sabinene, a higher content is observed in the volatile oil obtained from flowers (4.70-4.24%) and approximately equal amounts of myrcene from stems and leaves (2.14-2.17%). It seemed that the borneol was determined in greater quantity only in the volatile extract which was taken out of flowers (12.39%).

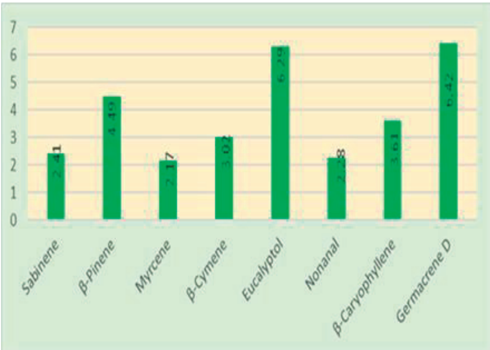

Figure 3. Major chemical compounds of leaves, %

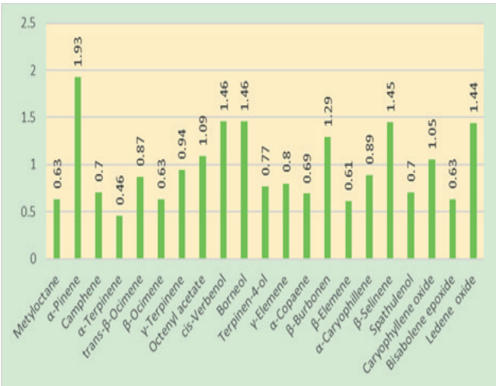

Figure 4. Minor chemical compounds of leaves, %

The major constituents of the oil from plants of *Artemisia vulgaris* collected from different places were reported to be α-pinene, menthol, beta-eudesmol, and spathulenol (Alizadeh et al., 2012, Iran- aerial plants), germacrene D and β-caryophyllene (Burzo et al., 2008, Romania - aerial plants), camphor, α-thujone, germacrene D, camphene, 1,8-cineole and β-caryophyllene (Govindaraj et al., 2008, fresh leaves were collected from greenhouse-grown plants), sabinene, β-pinene, 1,8-cineole, artemisia ketone, cis and trans-thujone, chrysanthenyl acetate, germacrene D and caryophyllene (Judžentienė et al., 2006, Lithuania- aerial plants), 1,8-cineole, camphor, α-terpineol (Thao et al., 2004, Vietnam - leaf and flower), camfor, camphene, α-thujone, 1,8-cineo, γ-muurolene, and β-caryophyllene (Govindaraj et al., 2013, vitro raised stems), caryophyllene, germacrene D and humulene (Malik et al., 2019, Brazil - aerial parts, before the onset of flowering). The quality and yield of essential oils from *Artemisia* species is influenced by the harvesting season, fertilizer, soils pH, the choice and stage of drying conditions, geo-graphic location, chemotype or subspecies, choice of plant part or genotype, or extraction method (Abad et al., 2012).

Figure 5. Major chemical compounds of flowers, %

Regarding the minority substances identified in the composition of the volatile oil, it can be stated that there were some significant diffe-rences, depending on the studied organ: thus, trans-β-ocimene, caryophyllene oxide, β-elemene, γ-elemene, terpinen 4-ol and α-caryophyllene were present in the stems (Figure 2) and leaves (Figure 4), whereas camphene, α-terpinene, γ-terpinene, α-copaene, β-selinene and spathulenol were found in leaves (Figure 4) and flowers (Figure 6), γ-elemene, cayophyllene oxide, β-elemene, terpinen-4-ol were found in stems, leaves and flowers.

It is also noted the existence of compounds which were characteristic of each organ, such as: trans-linalool, β-farnesene, elixen in the composition of the volatile oil derived from stems, methyl-octane, β-ocimene, octenyl-acetate, cis-verbenol, β-bourbonene, bisabolene epoxide, ledene oxide in leaves and α-thujene, α-phellandrene, isopropenyl methyl cyclohexen-1-ol, α-terpinolene, isopropenyl methyl-bicyclo-hexane-2-ol, dimethyl-hexahydro benzofuran, isogeraniol, and bornyl acetate in flowers (Figure 6).

Figure 6. Minor chemical compounds of flowers, %

CONCLUSIONS

The studies carried out by the researchers indicate that the volatile oil extracted from *Artemisia* plants contains chemical compounds of particular importance in the treatment of various diseases. The data obtained in this study showed a remarkable quantitative and qualitative variation of constituents in the oils obtained from different plants organs. To the major constituents belonged β-pinene, eucalyptol (1,8-cineole) and borneol. Most of these constituents dominated in mugwort oils in other countries.

ACKNOWLEDGMENTS

We thank Professor Emeritus Burzo Ioan for his support in identifying chemical compounds and technical assistance with the GC-MS measurements

REFERENCES

Abad, M. J., Bedoya, L. M., Apaza, L., Bermejo, P. (2012). The *Artemisia* L. Genus: a review of bioactive essential oils. *Molecules*, 17(3), 2542-66.

Abiri,R., Silva, A.L.M., de Mesquita, L.S.S., de Mesquita, J.W.C., Atabaki, N., de Almeida, E.B., Shaharuddin, N.A., Malik, S. (2018). Towards a better understanding of *Artemisia vulgaris*: Botany, phytochemistry, pharmacological and biotechnological potential, *Food Research International*, 109, 403-415.

Alizadeh, M., Aghaei, M., Saadatian, M., Sharifian, I. (2012). Chemical composition of essential oil of *Artemisia vulgaris.* from west Azerbaijan, Iran. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 11, 493-496.

Bădulescu, L., Săvulescu, E., Delian, E., Dobrescu, A., Georgescu, M., Badea, M., Ciocârlan, V. (2010). The secretory structures and volatile oil composition of *Mentha aquatica* L. from Danube Delta. *Lucrări ştiinţifice USAMVB, Seria B*, LIV, 625-628.

Bora, K. S., Sharma, A. (2011). The Genus Artemisia: A Comprehensive Review, *Pharmaceutical Biology*, 49(1), 101-109.

Burzo, I., Ciocârlan, V., Delian, E., Dobrescu, A., Bădulescu, L. (2008). Species researches regarding the essential oil composition of some *Artemisia* L. *Analele ştiinţifice ale Universităţii "Al. I. Cuza" Iaşi Tomul LIV*, fasc. 2, s.II a. *Biologie vegetală*, 86-91.

Giamakis, A., Kretsi, O., Chinou, I., Spyropoulos, C. G. (2001). *Eucalyptus camaldulensis*: volatiles from immature flowers and high production of 1,8-cineole and beta-pinene by *in vitro* cultures. *Phytochemistry*, 58(2), 351-355.

Govindaraj, S., Kumari, B. D., Cioni, P. L., Flamini G. (2008). Mass propagation and essential oil analysis of *Artemisia vulgaris*. *Journal of Bioscience and Bioengineering*, 105(3), 176-183.

Govindaraj, S., Kumari, B. D. R. (2013). Composition and larvicidal activity of *Artemisia vulgaris* L. stem essential oil against Aedes aegypti. *Jordan Journal of Biological Sciences*, 6(1), 11–16.

Janaćković, P., Rajčević,N., Gavrilović, M., Novaković, J., Giweli, A., Stešević, D., Marin, P. D. (2019). Essential oil composition of five *Artemisia* (*Compositae*) species in regards to chemophenetics, *Biochemical Systematics and Ecology,* 87, 103960, https://doi.org/10.1016/j.bse.2019.103960.

Jiang, Z., Guo, X., Zhang, K., Sekaran, G., Cao, B., Zhao, Q., Zhang, S., Kirby, G. M., Zhang, X. (2019). The Essential Oils and Eucalyptol From *Artemisia vulgaris* L. Prevent Acetaminophen-Induced Liver Injury by Activating Nrf2–Keap1 and Enhancing APAP Clearance Through Non-Toxic Metabolic Pathway. *Frontiers in Pharmacology*, 10, 1-15.

Judžentienė, A., Buzelytė, J. (2006). Chemical composition of essential oils of *Artemisia vulgaris* L. (mugwort) from North Lithuania, *CHEMIJA*. 17(1), 12-15.

Judžentienė, A., Garjonyte, R. (2016). Compositional variability and toxic activity of mugwort (*Artemisia vulgaris*) essential oils. *Natural Product Communications*, 11(9), 1353-1356.

Juergens, U. R., Stobe, M., Schmidt-Schilling, L., Kleuver T., Vetter, H. (1998). Antiinflammatory effects of eucalyptol (1,8-cineole) in bronchial asthma: inhibition of arachidonic acid metabolism in human blood monocytes ex vivo. *European Journal of Medical Research,* 3(9), 407-412.

Lahlou, S., Figueiredo, A. F., Magalhaes, P. J., Leal-Cardoso, J. H. (2002). Cardiovascular effects of 1,8-cineole, a terpenoid oxide present in many plant essential oils, in normotensive rats. *Canadian Journal of Physiology and Pharmacology*, 80(12), 1125-1131.

Malik, S., de Mesquita, L., Silva, C., De Mesquita, J., De Sá Rocha, E., Bose, J., Abiri, R., Figueiredo, P., Costa, L. (2019). Chemical Profile and Biological Activities of Essential Oil from *Artemisia vulgaris* L. Cultivated in Brazil, *Pharmaceuticals*, 12(2), 49.

Pandey, B.P., Thapa, R., Upreti, A. (2017) Chemical composition, antioxidant and antibacterial activities of essential oil and methanol extract of *Artemisia vulgaris* and *Gaultheria fragrantissima* collected from Nepal. *Asian Pacific Journal of Tropical Medicine* 10(10), 952-959

Thao, N. T. P., Thuy, N. T., Hoi, T. M., Thay, T. M., Muselli, A., Bighelli, A., Castola, V, Casanova, J. (2004). *Artemisia vulgaris* L. from Vietnam: Chemical variability and composition of the oil along the vegetative life of the plant. *Journal of Essential Oil Research*, 16(4), 358-361.

Williams, J. D., Saleh, A. M., Acharyaa, D. N., (2012). Composition of the Essential Oil of Wild Growing *Artemisia vulgaris* from Erie, Pennsylvania. *Natural Product Communications*. 7(5), 637-640.

Zhigzhitzhapova, S.V., Radnaeva, L.D., Gao, Q., Chen, S., Zhang, F. 2016. Chemical composition of volatile organic compounds of *Artemisia vulgaris* L. (*Asteraceae*) from the Qinghai–Tibet Plateau, *Industrial Crops and Products*, 83, 462-469.