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Variations in the composition of essential oils of selected *Artemisia* species as a function of soil type

JOVANA D. ICKOVSKI[1], OLGA P. JOVANOVIĆ[1], BOJAN K. ZLATKOVIĆ[2], MILAN M. ĐORĐEVIĆ[3], KATARINA D. STEPIĆ[1], RADOMIR B. LJUPKOVIĆ[1] and GORDANA S. STOJANOVIĆ[1]*

[1]*Department of Chemistry, Faculty of Sciences and Mathematics, University of Niš, Serbia,* [2]*Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Serbia and* [3]*Department of Geography, Faculty of Sciences and Mathematics, University of Niš, Serbia*

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Abstract: Five *Artemisia* species (seven *A. alba* Turra samples and twelve samples of each four remaining species: *A. absinthium* L., *A. annua* L., *A. vulgaris* L. and *A. scoparia* Waldst. & Kit.) from Serbia were studied from the aspect of essential oil chemical composition, and potential correlations between essential oil composition with soil type determined using World Reference Base for Soil Resources (WRB). A great variety in essential oil composition was observed for *A. alba*, *A. absinthium* and *A. vulgaris* samples, while in the case of *A. annua*, as well as *A. scoparia*, the composition of the examined essential oils was more uniform. Principal component analysis (PCA) and agglomerative hierarchical clustering (AHC) showed that there is no significant effect of soil type on the *Artemisia* essential oil composition while Mantel test showed that there is a correlation between samples within *A. vulgaris*, as well as *A. scoparia* and the geographical distances of the localities from which these samples were collected.

Keywords: *Artemisia alba* Turra; *Artemisia annua* L.; *Artemisia absinthium* L.; *Artemisia vulgaris* L.; *Artemisia scoparia* Waldst. *et* Kit.; gas chromatography––mass spectrometry.

INTRODUCTION

The worldwide known genus *Artemisia* L., from the tribe Anthemideae, family Asteraceae, encompasses plants significant to the medicine, cosmetic, food and beverage industry, as well as to ethnopharmacology. Many representatives of this genus have found their application in traditional medicine in treatment of diseases such as malaria, hepatitis, cancer, inflammation and infect-

* Corresponding author. E-mail: gordana.stojanovic@pmf.edu.rs
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ions by fungi, bacteria, and viruses.[1] Two perhaps the most renowned members of the genus *A. annua* and *A. absinthium* are traditionally used in many cultures. *A. annua* is used as the source of antimalarial drug, treatment for fever, tuberculosis, dysentery,[2,3] while *A. absinthium* found application against gastrointestinal diseases, as anthelmintic.[4,5] *A. vulgaris*, for example, has been used for treating gynecological complications, antibacterial and antifungal infections.[6] Pharmacological studies revealed that *A. scoparia* manifests activity against inflammation, antitumor, analgesic, and protective effects on the liver.[7] *A. alba* has been deemed to heal burns and contusions.[8]

The essential oils of these plants show various healing and health-beneficial properties, biological activities and represent a source of a huge number of active components. For example, some of the proven activities would be the antimicrobial activity of *A. alba* essential oil,[9] the antipathogenic activity of *A. annua* essential oil,[10] the acaricidal activity of the essential oil from *A. absinthium*,[11] antifungal and antibacterial activity of *A. vulgaris* essential oil,[12] and the pesticidal activity of *A. scoparia* essential oil.[13]

Five above-mentioned species, members of this genus that are autochthonous to the Serbia, were collected (seven samples of *A. alba*, and twelve samples of each of the four remaining species: *A. absinthium*, *A. annua*, *A. vulgaris*, and *A. scoparia*), and studied from the aspect of essential oil chemical composition, and furthermore, statistically for potential correlations between essential oil composition and soil type determined using World Reference Base for Soil Resources (WRB). We deemed it necessary to contribute to a better and deeper understanding of correlations between the essential oil (EOs) composition and percentage of components with soil for such widely used species, for the purpose of assisting the manufacturers of drugs. Since the primary goal was to determine the dependence of the composition of the essential oils and the type of soil, no comparison was made with the published results on the composition of the essential oils of the examined species. Although there are papers about influence of various exogenous factors on the chemical composition of EOs such as altitude and soil characteristics[14], humidity[15] as well as geographical origin,[16] to the best of our knowledge, these are the first presented results on the correlation of the composition of *Artemisia* species EOs and soil type according to WRB classification.

EXPERIMENTAL

Plant material

Five selected *Artemisia* species were harvested at the blooming stage (seven specimens of *A. alba* Turra and twelve specimens of each *A. absinthium* L., *A. annua* L., *A. vulgaris* L. and *A. scoparia* Waldst. et Kit.). Voucher specimens have been deposited in the Herbarium Moesiacum Niš (HMN), Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Serbia. The labels of the samples, voucher specimen numbers, as well as habitat

specifications (locality, longitude, latitude, and soil type), are given in Table S-I of the Supplementary material to this paper.

Essential oil isolation

The aboveground part (buds, flowers, leaves and stems) of dry plant samples were hydrodistilled in a Clevenger-type apparatus for 2.5 h. The obtained essential oils were dried over anhydrous magnesium sulfate and analyzed by GC/MS. The essential oil yields were calculated using Eq. (1) and presented in Table S-I. In all experiments, the initial weight of the plant material was 500 g, so the yields are given as the mass (g) of the obtained essential oil per 500 g of plant material:

$$\text{Yield} = 100\frac{m\,(\text{essential oil})}{m\,(\text{dry plant material})} \quad (1)$$

GC/MS analysis

The essential oil samples were analyzed in triplicate by a 7890/7000B GC/MS/MS triple quadrupole system (Agilent Technologies, USA). The fused silica capillary column HP-5 MS (5 % phenylmethyl siloxane, 30 m×0.25 mm, film thickness 0.25 μm) was used. The injector and interface operated at 230 and 300 °C, respectively. Temperature program: from 45 to 290 °C at a heating rate of 4 °C/min. The carrier gas was helium with a flow of 1.0 mL/min. The injection volume of sample solutions was 1 μL and the split ratio was adjusted at 40:1. Post-run: back flash for 1.89 min, at 280 °C, with helium pressure of 50 psi. MS conditions were as follows: ionization voltage of 70 eV, acquisition mass range 40–440 Da, scan time 0.32 s. The percentage composition of the samples was computed from the total ion chromatogram peak areas without any corrections.

Identification of volatile compounds

Components of the essential oils were identified by comparison of their linear retention indices (relative to C8–C40 *n*-alkanes on the HP-5MS column) with literature values and their MS with those from Wiley 6, NIST11 and Agilent Mass Hunter Workstation B.06.00 software by the application of the Automated Mass Spectral Deconvolution and Identification System (AMDIS software), ver. 2.1 (DTRA/NIST, 2011).

Statistical analysis

For explaining the complex correlations between essential oil components and the WRB soil types (Pellic Vertisol – pv, Rendzic Leptosol – rl, Calcaric Fluvisol – cf; Haplic Leptosol – hlp, Dystric Cambisol – dc, Calcaric Phaeozem – cp, Eutric Cambisol – ec, Haplic Luvisol – hl), three statistical methods were used in XLSTAT 2021 (Addinsoft, 2021): principal component analysis (PCA), agglomerative hierarchical clustering (AHC) and Mantel test.

Principal component analysis. PCA enables the grouping of samples using reduced variables, obtained after mathematical transformations. Those transformations are performed to provide better insight into groupings and correlations between analyzed samples. Components with Eigenvalues are selected for the interpretation of results according to Kaisers' rule.[17] The distribution was determined by the Kolmogorov Smirnov test, with the significance level $\alpha = 0.05$. The original datasets were subjected to Grubbs' test for outliers before the application of PCA,[18] and the outliers were discarded from the used datasets.

Agglomerative hierarchical clustering. Agglomerative hierarchical clustering of the standardized variables was performed using the Ward method. The squared Euclidean distance was observed as a measure of the proximity between the samples.

Mantel test. Mantel test is used for overcoming the problem often encountered in an attempt to explain the relationships between species and environment, useful for testing the linear correlation between two proximity matrices (dissimilarity or similarity).

RESULTS AND DISCUSSION

Chemical composition

The results of the GC/MS analysis of the essential oil compositions are given in Tables S-II, S-IV, S-VI, S-VIII and S-X, while the quantities of different classes of the compounds are presented in Tables S-III, S-V, S-VII, S-IX and S-XI, all of the Supplementary material.

In the case of *A. alba* 220 components were identified in total, 81 of them were present only in one sample, while only 4 components: camphene (tr – 3.3 %), 1,8-cineole (1.9–19.7 %), camphor (1.6–51.6 %), and germacrene D (2.1––21.3 %,) were found in all seven samples. Worthy of mention is the presence of triquinane sesquiterpenes in AA2 (56.1 %) including silphiperfol-5-en-3-one A (35.0 %) as the main component. Sesquiterpenoids were the major class of compounds in two samples of *A. alba* while in the remaining five samples monoterpenoids were predominant.

A total of 234 components were identified in *A. absinthium* samples. Only 5 compounds were present in all samples with a percentage representation ≥1 %, sabinene (5.7–18.9 %), *o*-cymene (2.1–8.8 %), linalool (2.1–29.8 %), terpinen-4-ol (3.0–10.3 %) and lavandulyl isovalerate (1.2–5.7 %). In contrast, *trans*-thujone was present in traces in 5 samples while in 3 samples it was the most represented constituent (20.6–48.2 %). The situation is similar with (*Z*)-epoxy-ocimene, it was the component with the highest representation in 3 samples while in 3 samples it was not detected. In all *A. absinthium* samples, monoterpenoids were a highly dominant class of compounds, particularly oxygenated monoterpenes.

In total 153 components were identified in *A. annua* samples, 24 of them were present only in one sample (all present in traces), even 58 in all samples. The first or second represented in all samples were artemisia ketone (6.9–49.8 %), *α*-pinene (3.8–23.3 %) and camphor (2.5–18.8 %). The component present in the amount of over 5 % in all samples was 1,8-cineole. Artemisia alcohol, *trans*-pinocarveol and pinocarvone were also present in all samples but in the amount of over 1 %. As in *A. absinthium*, in all *A. annua* samples monoterpenoids were the dominant class of compounds, especially oxygenated monoterpenes.

In all samples of *A. vulgaris* a total of 315 components were found, 78 of them were present only in one sample, while 40 were present in all samples. In contrast to the relatively uniform composition of *A. annua*, in terms of the most represented compounds, composition of *A. vulgaris* essential oils was very diverse. An extreme example is the content of *cis*-chrysanthenyl acetate which was the most representative component in 4 samples (79.4–24.8 %), while in 3 samples it was present in traces, and in 3 samples it was not detected at all.

Davanon showed a similar distribution, three samples contained davanone in the highest amount (59.8–27.4 %) while in 6 samples it was not detected at all. In eight samples monoterpenoids, were the major class of compounds, while sesquiterpenoids were the major class in four samples.

A total of 156 components were identified in *A. scoparia* samples, 30 of them were present only in one sample, 43 in all samples among them *β*-pinene (4.7–14,8 %), limonene (2.0–4,2 %), (*Z*)-*β*-ocimene (4.6–8.5 %), and *γ*-terpinene (1.4 %–4.0 %), were present in percentage higher than 1 %. In all analysed samples the main component was capillene, followed by 2,4-pentadiynyl-benzene. The major class of compounds were phenyldiacetylenes with a representation of 57 % and more.

Statistical analysis regarding compound percentage in examined EOs

All statistical analysis were done with the same sets of data as for PCA, after normalization and with omitted outliers.

Principal component analysis (PCA). Kolmogorov–Smirnov test was used to check the normal distribution of the original dataset related to the percentages of compounds determined using GC/MS for each *Artemisia* species separately. None of the original datasets, except for *A. scoparia*, were normally distributed, so different mathematical functions were used in an attempt to normalize the data. The Sin function gave satisfying results, most data showed normal distribution, so transformed data were used for further work. Grubbs' test showed outliers for all datasets. The outliers were omitted from the data matrix and PCA analysis for each *Artemisia* species was performed. Due to unsatisfactory values according to Kaiser's criterion, each correlation matrix was subjected to the Varimax rotation with Kaiser normalization. Supplementary Material contains plots for samples from each investigated *Artemisia* species (Figs. S-1–S-5 of the Supplementary material), as well as tables with factor loadings after Varimax rotation (Tables S--XII–S-XVI).

In *A. alba* case, the first five factors explain more than 95 % of variability, with terpinolene, benzene acetaldehyde, *trans*-piperitol, davanone, bicyclogermacrene, *α*-eudesmol, terpinen-4-ol, *cis*-pinocamphone, *γ*-terpinene, chrysanthenone and *cis*-sabinene hydrate contributing the most.

A. alba samples from dc, cf and hlp soil type were grouped on the negative side of the plot, primarily on the basis of percentage of filifolone and *trans*-thujone. For samples from rl soil type the regularity in grouping was not observed.

For *A. absinthium* eight factors gave more than 95 % of the cumulative variability. The major contributors were 1-octen-3-ol, geraniol, *α*-fenchene, *n*-nonanal, *trans*-thujone, fragranol, neral, *n*-hexanol, *α*-terpinene, methyl salicylate and (*E*)-2--hexenal. In the case of *A. absinthium* samples, a good grouping of samples from cp soil could be noticed. What most influenced such grouping were monoterpenes

and oxygenated monoterpenes, primarily *α* and *β*-phellandrene, nerol, and neral, as well as terpinene and its derivatives. A solid grouping of samples from pv soil is also noticeable. The quadrant, in which the *x*-axis is positive and the *y*-axis negative, is predominantly determined by *α*-thujene and *trans*-thujone, *o*-cymene and ocimene derivatives.

For *A. annua* seven factors gave more than 95 % of the cumulative variability. Caryophyllene oxide, *trans*-sabinene hydrate, bicyclogermacrene, (*Z*)-jasmone, *α*-thujene, hexyl 2-methyl butyrate, tricyclene, *α*-campholenal, myrtenol, l pinocarvone, *trans*-pinocarveol, propyl 2-methyl butyrate, and *α*-humulene contributed mostly to those factors. In the case of *A. annua* all samples from pv soil were in the part of the plot where the *x*-axis is negative. Samples from the ec soil were located on opposite sides of the plot, and the component which influenced it the most was camphene. Almost all carbonic acid derivatives were located in the plot's quadrant where the *x*-axis was negative and the *y*-axis positive. There was no regularity among the samples from cf soil.

In the case of *A. vulgaris* eight factors gave more than 95 % of the cumulative variability, with terpinen-4-ol, *α*-pinene, 1,8-cineole, eugenol, *cis*-chrysanthenyl acetate, *trans*-thujone, torilenol, germacrene D, iso-3-thujanol, and *trans*--pinocarveol contributed mostly. *Artemisia vulgaris* samples from the same type of soil were on opposite sides of the plot (*e.g.*, specimens from dc, rl or cf). But, even in these cases, some regularity can be noticed. For example, in the case of two samples from cf soil: on the plot, from the opposite side to one sample from cf, it can be seen that the two grouped samples are partially determined by the percentage of *cis*-thujone, while the lone sample is determined by the percentage of *trans*-thujone and iso-3-thujanol. Also, two samples from cf soil were grouped on the basis of germacrene and its derivatives, which are responsible for grouping in the quadrant where the *x*-axis is negative, and the *y*-axis is positive. Furthermore, the position of the dc sample in the negative quadrant is defined by the percentage of chrysanthenone, while in contrast, the sample from dc soil is determined by the percentage of *cis*-chrysanthenol and *cis*-chrysanthenyl acetate. The positive quadrant is determined by both *trans*-and *cis*-sabinene hydrate.

For *A. scoparia* six factors gave more than 95% of the cumulative variability. The main contributors were *β*-pinene, *α*-pinene, sabinene, 2,4-pentadiynyl-benzene, limonene, capillene, 2,6-dimethyl-naphthalene, as well as (*Z*)-*β*-ocimene, *allo*-ocimene, butanoic acid, 2-methyl-2-methoxy-4-(2-propenyl)phenyl ester, *p*-cymene, γ-terpinene, *β*-eudesmol, *α*-humulene, and 1,8-cineole. The samples from cp soil are in opposite quadrants of the plot, and what makes that difference are the percentages of spathulenol, (*E*)-caryophyllene and *α*-humulene. The sample from pv soil, as well as four other samples from cf soils, were isolated in the negative quadrant of the plot due to the presence of butanoic acid, 2-methyl-2-methoxy-

-4-2-propenyl)phenyl ester, which was not identified in the remaining seven samples.

Agglomerative hierarchical clustering (AHC). Agglomerative hierarchical clustering (AHC) of the investigated *Artemisia* species showed three main clusters on all five dendrograms for all species based on the percentages of compounds determined by GC/MS. The same sets of data as for PCA were used (normalized, without outliers). Supplementary material contains dendrograms for samples from each investigated *Artemisia* species (Figs. S-6–S-10). Dendrogram for *A. alba* showed major irregularity in sample distribution. All samples from rl soils are located in separate clusters, yet there are some matches with PCA plots. Dendrogram for *A. absinthium* showed substantially the same as the PCA plot. At the dissimilarity level of 1, a cluster with two samples from pv soil (AB7 and AB12) was isolated, while the remaining sample from the same soil type (AB10) was in a separate cluster. Agglomerative hierarchical clustering analysis results for *A. annua* samples showed excellent grouping of samples from cf soil and interesting separation of four samples from pv soils in two clusters (each cluster contains two samples). Dendrogram of the analysed *A. vulgaris* samples revealed good correlations between cf soil type and EOs composition; three out of four samples are in one cluster. For other samples, no regularity in grouping was observed. In the case of *A. scoparia*, it can be seen that the samples from cp soil are in different clusters, as well as that one of them is in the same cluster with the sample from pv soil.

Mantel test. Mantel test was used to determine if the chemical composition distance between populations of *Artemisia* collected from different soil types is related to the geographical distance. The chemical composition distance is measured as a difference in individual component frequencies among various *Artemisia* samples. The geographical distance is calculated from the distance in longitude and latitude between the sites of interest. Proximity matrices were formed using Euclidean distance, while the Pearson's correlation was used for Mantel test, with significance level 5 %.

Mantel test revealed that the matrices for *A. vulgaris*, as well as for *A. scoparia* correlated as the computed two-tailed *p*-values (0.0273 and 0.0295) are lower than the significance level $\alpha = 0.05$. This means that there is a correlation between different samples within *A. vulgaris*, as well as *A. scoparia* and the geographical distances of the localities from which these samples were collected.

Statistics concerning the percentage of classes of compounds in the tested essential oils

All statistical investigations were done with the same sets of data as for PCA, without transformation (Sin function was done only for *A. scoparia* dataset) and with omitted outliers. Seven classes of compounds were used for statistical analysis

of both *A. alba* and *A. annua* (monoterpene hydrocarbons – M, oxygenated monoterpenes – MO, sesquiterpene hydrocarbons – S, oxygenated sesquiterpenes – SO, phenylpropanoids – PP, carbonic acid derivatives – CD and others – O), while for *A. scoparia* matrix, in addition to the mentioned seven classes of compounds, another class was used (phenyldiacetylenes – P). For *A. absinthium* six classes of compounds took place in the dataset (M, MO, S, SO, CD and O), while for *A. vulgaris* five classes were considered (M, MO, S, SO and PP).

Principal component analysis (PCA). Kolmogorov–Smirnov test was used to check the normal distribution of the original dataset related to the percentages of classes of compounds for each *Artemisia* species separately. All of the original datasets, except for *A. scoparia*, were normally distributed, so original matrixes were used for further tests. The Sin function with *A. scoparia* data showed normal distribution, so the transformed *A. scoparia* matrix was used in the statistical analyses. Grubbs' test showed outliers for all datasets. The outliers were omitted from the data matrix and PCA analysis for each *Artemisia* species, separately, was performed. Supplementary Material contains plots for the samples of each investigated *Artemisia* species (Figs. S-11–S-15).

For *A. alba* three factors gave more than 95 % of the cumulative variability, with S (0.9929), SO (0.9711), MO (–0.9932), M (–0.9382), O (0.9872), PP (0.9749) and CD (0.9479) as contributors to the factors. Biplot showed that samples from rl soil are in three different quadrants. The negative quadrant was determined by S and SO, and on the other hand, the positive one was determined by M.

For *A. absinthium* five factors gave more than 95 % of the cumulative variability. The major contributors to the factors were M (0.9286), MO (–0.6451), CD (0.9318), O (0.9278), SO (0.8387) and S (0.8705). *Artemisia absinthium* biplot differs samples from cp soil from other samples, the same was observed for samples from ec. Samples from cp well separated predominantly because of the percentages of S and SO.

For *A. annua* three factors gave more than 95 % of the cumulative variability. All classes (SO-0.9783, O-0.9242, S-0.7904, M-0.9294, CD-0.8973, MO-0.7793, PP-0.6926) contributed to the factors. Poorly grouped samples from the same soil type could be seen on the biplot. Two samples out of four from cf soil are on the side of the biplot where the *x*-axis is negative and the *y*-axis is positive, opposite to them is one sample from cf, and on the positive quadrant of the plot is the fourth sample. It is noticeable that two samples with cf soil were grouped by the percentage of S. Also, it could be seen that the samples from rl soil are very statistically close, and that proximity is determined by the percentage of PP.

For *A. vulgaris* three factors gave more than 95 % of the cumulative variability. The major contributors were SO (0.9067), MO (–0.8701, PP (0.9920), S (0.7415) and M (0.9213). Pearson's correlation matrix for *A. vulgaris* showed the highest correlation between MO and SO (–0.8592). Poorly grouped samples from

the same soil type could be seen on the biplot. Two samples out of four from cf soil are on the side of the biplot where the *x*-axis is negative and the *y*-axis is positive, opposite to them is one sample from cf, and on the positive quadrant of the plot is the fourth sample. It is noticeable that two samples with cf soil were grouped by the percentage of S. Also, it could be seen that the samples from rl soil are very statistically close, and that proximity is determined by the percentage of PP.

For *A. scoparia* four factors gave more than 95 % of the cumulative variability. The main contributors were MO (0.9632), M (0.7929), S (–0.7614), P (0.9131), O (0.9469), PP (–0.7706), and SO (0.9644). Pearson's correlation matrix for *A. scoparia* showed a very poor correlation between all percentages of classes of compounds. The scattering of samples from cf soil to all quadrants is observed on the biplot, while both samples from cp soil are very close as determined by percentages of M and MO.

Agglomerative hierarchical clustering (AHC). Dendrograms for samples of each investigated *Artemisia* species are given as Figs. S-16–S-20. Agglomerative hierarchical clustering (AHC), of the investigated *Artemisia* species, showed three main clusters for *A. alba*, *A. vulgaris* and *A. scoparia* each based on the percentages of classes of compounds, while for *A. absinthium* and *A annua* AHC grouped four main clusters. AHC analyses for classes of compounds in *A. alba* samples revealed major irregularity in sample distribution, as well as AHC based on the percentages supporting the results obtained by PCA analysis. All samples from rl soils are located in separate clusters. Dendrogram for *A. absinthium* showed a good grouping of samples. Samples from ec and rl soils are grouped in separate clusters, as well as two out of three samples from both pv and cp. AHC analysis for *A. annua* samples showed weak clustering of all samples, four very heterogenic clusters are formed. It is noticeable that the sample from dc soil was separated from all other samples. Dendrogram of the analyzed *A. vulgaris* samples revealed some correlations between cf soil type and percentages of classes of compounds; two out of four samples are in one cluster. Similar obsedvations were made for samples from rl soil. No regularity in clustering was observed for other samples. A similar grouping is on the PCA plot for this plant species. In the case of *A. scoparia*, the samples from cp soil are in the same cluster at a level of dissimilarity 1, contrary to the clustering with individual components as variables. The sample from pv soil was not separated from the samples from cf soil.

Mantel test. Mantel test was used to determine if the classes of compounds distance between populations of *Artemisia* collected from different soil types is related to the geographical distance. Proximity matrices were formed using Euclidean distance, while the Pearson's correlation was used for Mantel test, with significance level 5 %. Mantel test results showed that the classes of compounds distances and geographic distances are not correlated.

CONCLUSION

Gas chromatography/mass spectrometry analysis of fifty-five samples in total (seven samples of the essential oils of *A. alba* and twelve samples of the essential oils of each *A. annua* L., *A. absinthium* L., *A vulgaris* L. and *A. scoparia* Waldst. et Kit.) was done. Plant samples were collected from different soil types, which were determined using World Reference Base for Soil Resources (WRB). A great variety in composition was observed for *A. alba*, *A. absinthium* and *A. vulgaris* samples, while in the case of *A. annua*, as well as *A. scoparia*, the composition of the examined essential oils was more uniform. Principal component analysis and AHC, were used for a testing correlation between EO composition and soil type according to WRB. Both analyses showed that there is no significant effect of soil type on the *Artemisia* essential oil composition. According to Mantel test there is a correlation between samples within *A. vulgaris*, as well as *A. scoparia* and the geographical distances of the localities from which these samples were collected, while harvesting sites' geographic distances are not correlated to the classes of compounds of all examined *Artemisia* essential oils.

SUPPLEMENTARY MATERIAL

Additional data and information are available electronically at the pages of journal website: https://www.shd-pub.org.rs/index.php/JSCS/article/view/11025, or from the corresponding author on request.

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ИЗВОД

ВАРИЈАЦИЈЕ У САСТАВУ ЕТАРСКИХ УЉА ОДАБРАНИХ ВРСТА *Artemisia* У ЗАВИСНОСТИ ОД ТИПА ЗЕМЉИШТА

ЈОВАНА Д. ИЦКОВСКИ[1], ОЛГА П. ЈОВАНОВИЋ[1], БОЈАН К. ЗЛАТКОВИЋ[2], МИЛАН М.ЂОРЂЕВИЋ[3], КАТАРИНА Д. СТЕПИЋ[1], РАДОМИР Б. ЉУПКОВИЋ[1] и ГОРДАНА С. СТОЈАНОВИЋ[1]

[1]*Департман за хемију, Природно–математички факултет, Универзитет у Нишу, Ниш,* [2]*Департман за биологију и екологију, Природно–математички факултет, Универзитет у Нишу, Ниш и* [3]*Департман за географију, Природно–математички факултет, Универзитет у Нишу, Ниш*

Пет врста *Artemisia* (седам узорака *A. alba* Turra и по дванаест узорака сваке од четири преостале врсте: *A. absinthium* L., *A. annua* L., *A. vulgaris* L. и *A. scoparia* Waldst. & Kit.) са територије Србије проучавано је са аспекта хемијског састава етарског уља и потенцијалних корелација између састава етарског уља и типа земљишта, одређеним на основу Светске референтне базе за земљишне ресурсе (WRB). Код узорака *A. alba*, *A. absinthium* и *A. vulgaris* примећена је велика разноликост у погледу састава, док је у случају *A. annua*, као и *A. scoparia*, састав испитиваних етарских уља био униформнији. Анализа главних компоненти (PCA) и агломеративно хијерархијско груписање (AHC) показале су да нема значајног утицаја типа земљишта на састав испитиваних *Artemisia* етраских уља, док је Мантелов тест показао да постоји корелација између узорака унутар *A. vulgaris*, као и *A. scoparia* и географске удаљености локалитета са којих су ови узорци прикупљени.

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