ORIGINAL PAPER

THE CHARACTERISTIC MEDICINAL PLANTS OF DIFFERENT VEGETATION TYPES FROM THE NIRAJ VALLEY, ROMANIA

Erzsébet DOMOKOS[1*], Beáta CSIZMADIA[1], Tímea ELEKES[1], Andrea Krisztina KÁRP[1], József DOMOKOS[2]

[1]Department of Fundamental Pharmaceutical Sciences, Discipline of Pharmaceutical Botany, University of Medicine and Pharmacy of Tîrgu Mureș, Romania
[2]Department of Electrical Engineering, Faculty of Technical and Human Sciences, Sapientia University, Tîrgu Mureș, Romania

*Correspondence:
Erzsébet DOMOKOS
domokos.erzsebet@umftgm.ro

Received: 15 May 2018; **Accepted:** 15 June 2018; **Published:** 15 July 2018

Abstract: In this study the medicinal plants of some representative vegetation types from a human-modified Eastern European landscapes were investigated. The studied territory is part of a Special Protection Area for bird species. The following sampling areas were included in the study: humid grasslands; mountain hay meadows; semi-natural dry grasslands; Sub-pannonic steppic grasslands; fringe communities of mesothermophilic forest edges; grey willow scrubs; thickets of willow; forests of white willow; hornbeam-beech, oak-hornbeam, and sessile oak forests; scrubs of blackthorn and hawthorn; Subcontinental peri-Pannonic scrubs. The ordering of medicinal plants on the basis of presence/absence data and the abundance data presented the grouping in the following typical communities: to the deciduous forests, to the coppices and scrubs, and to the grasslands and meadows. A total of 208 medicinal plants were found from which 37 species are included in the European Pharmacopoeia, and 13 in the Romanian Pharmacopoeia. The existing list of medicinal plants of the Niraj Valley in the scientific literature was completed with 33 taxa. The medicinal plants containing tannins (18.93%) were in higher percentage followed by those with essential oils (10.68%), flavonoids (10.68%), saponins (9.71%), alkaloids (7.77%), mucilages (6.80%), coumarins (5.34%). However rational (sustainable) exploitation of these natural resources is necessary.

Keywords: medicinal plants, Niraj River, Jaccard index, Bray-Curtis index, indicator value, traditional medicine, active principles.

1. Introduction

The Niraj River springs from the Gurghiu Mountains from an altitude of 1239 m, and it flows into the Mureș near Ungheni (close to the locality Vidrasău). The Niraj is a left tributary of the Mureș River. The natural course of the Niraj River has a length of 79 km. The drainage basin of the Niraj River covers a surface of 625 km^2 and hosts 66 localities, therefore the valley is a very dense populated area (Hajdu, 2010). The soils are represented by luvosol, regosol and faeziom, and in the meadow part of valley by aluviosol and hydromorphic soil (Josan, 1979; Florea and Munteanu, 2000, Blaga et al., 2005). The climate is moderate continental and the annual rainfall is 600 mm (Roșu, 1980). The woody vegetation is represented by: oak

(*Quercus petraea, Q. robur*) and hornbeam forests forming the association *Querceto-Carpinetum transsilvanicum*; beech and hornbeam forests forming the association *Fagetum transsilvanicum*; narrow strips of shrubs and coppices along the river with *Salix purpurea, S. triandra, S. caprea, S. fragilis, S. viminalis,* or with *Populus* sp., *Salix* sp. and *Alnus glutinosa*; hedges with *Crataegus monogyna, Prunus spinosa, Rosa canina*.

On the sunny slopes, the herbaceous vegetation is formed by the following species combinations: *Brachypodium pinnatum-Carex humilis, Brahypodium pinnatum-Dorycnium herbaceum, Bromus erectus, Festuca sulcata-Festuca pseudovina, Festuca sulcata-Agrostis tenuis.*

On the shaded slopes heyfields with *Agrostis tenuis, Agrostis tenuis-Festuca rubra, Trissetum flavescens-Festuca rubra, Cynosurus cristatus-Festuca rubra, Poa pratensis-Festuca pratensis, Arrhenatherum elatius* are present. The floodplain herbaceous vegetation is characterized by meso-hydrophilic and hydrophilic meadows with *Agrostis stolonifera, Deschampsia cespitosa, Alopecurus pratensis, Poa trivialis, Festuca pratensis, Carex gracilis, C. acutiformis* (Csűrös, 1963). Studies about the vegetation from the Niraj Valley have been carried out by a few researchers (Oroian and Giurgiu 2003; Kovács 2008; Sămărghiţan and Oroian 2011; Domokos, 2015; Oroian, et al. 2016).

The main goal of the paper was the study of the medicinal plants in some representative plant communities from the Niraj Valley. In order to fulfill the main goal the following aims were proposed: (1) inventory of plants used in traditional medicine and/or in phytotherapy from the studied phytocoenoses; (2) verifying the presence of medicinal plants in the European and Romanian Pharmacopoeia; (3) determination of characteristic medicinal plants for each studied association; (4) classification of herbs according to the dominant active principles in the plant; (5) notation of the plant product (drugs) used in traditional medicine and/or phytotherapy for each species.

2. Materials and Methods

The inventory of plants used in traditional medicine and/or in phytotherapy was possible on the base of 175 relevés made in the Niraj Valley. The field trips were conducted in the period 2012-2017. Other 13 relevés made by Kovács (2008) and Sămărghiţan and Oroian (2011), were also used for the study. For the nomenclature of the taxa the work of Sârbu et al. (2013) was used. The determination of characteristic medicinal plants for each of the studied association was made by Principal coordinate analysis (PcoA) and Indicator value analysis (IndVal, Dufrêne and Legendre, 1997). All statistics were made in R (Roberts and Oksanen 2006). The presence of medicinal plants was verified in the European Pharmacopoeia (2018) and Romanian Pharmacopoeia (1993). Information about the part of the plants used in the traditional medicine or phytotherapy, the dominant active principle and harvesting period of the plants was obtained from the work of Csedő (1980), Pârvu (2000), Oroian (2011), Eșianu (2016), Eșianu and Laczkó-Zöld (2016), and Muntean (2016).

3. Results and discussions

In the studied plant communities from the Niraj Valley a total of 652 plant taxa were found from which 208 are used in the traditional medicine and/or in phytotherapy. From these medicinal plants 37 species are included in the European Pharmacopoeia, and 13 in the Romanian Pharmacopoeia. The ordering of medicinal plants on the base of the abundance-dominance data (Bray-Curtis index, PC1: 15.06%, PC2: 6.88%) presented three

typical medicinal plant communities in the Niraj Valley: medicinal plants of the deciduous forests, medicinal plants of the coppices and scrubs, and medicinal plants of the grasslands (**Fig. 1**). The ordering of medicinal plants on the basis of the presence/absence data (Jaccard index, PC1: 14.07%, PC2: 6.15%) confirms that these are grouped in the three already mentioned communities. The similitude between the medicinal plants typical to coppices and scrubs and those of grassland increase when presence/absence data are taken into consideration (**Fig. 2**). The Indicator value analysis (IndVal) shows the fidelity and specificity of medicinal plants to the studied plant communities: thickets of willow (*Salicetum triandrae* Malcuit 1929); forests of white willow (*Salici-Populetum* Meijer-Drees 1936); Subcontinental peri-Pannonic scrubs (*Prunetum tenellae* Soó 1951); scrubs of blackthorn and hawthorn (*Pruno spinosae-Crataegetum* Soó 1931); grey willow scrubs (*Frangulo-Salicetum cinereae* Graebner *et* Hueck 1931); hornbeam-beech (*Carpino-Fagetum* Paucă 1941), oak-hornbeam (*Carpino-Quercetum petraeae* Borza 1941), and sessile oak (*Melico uniflorae-Quercetum petraeae* Gergely 1962) forests; semi-natural dry grasslands (*Carici humilis-Brachypodietum pinnati* Soó ex Pop *et al.* 2001); Sub-pannonic steppic grasslands (*Agrostio-Festucetum valesiacae* Borisavljevič *et al.* 1955; *Festuco sulcatae-Caricetum humilis praerossicum* Soó 1947); fringe communities of mesothermophilic forest edges (*Inulo ensifoliae-Peucedanetum cervariae* Kozl. 1925 em. Gils *et* Kovács 1977); humid grasslands (*Agrostio stoloniferae-Deschampsietum caespitosae* Újvárosi 1947); mountain hay meadows (*Poo-Trisetetum flavescentis* Knapp 1951 em. Oberd. 1983, *Festuco-Agrostetum capillaris* Horv. 1951).

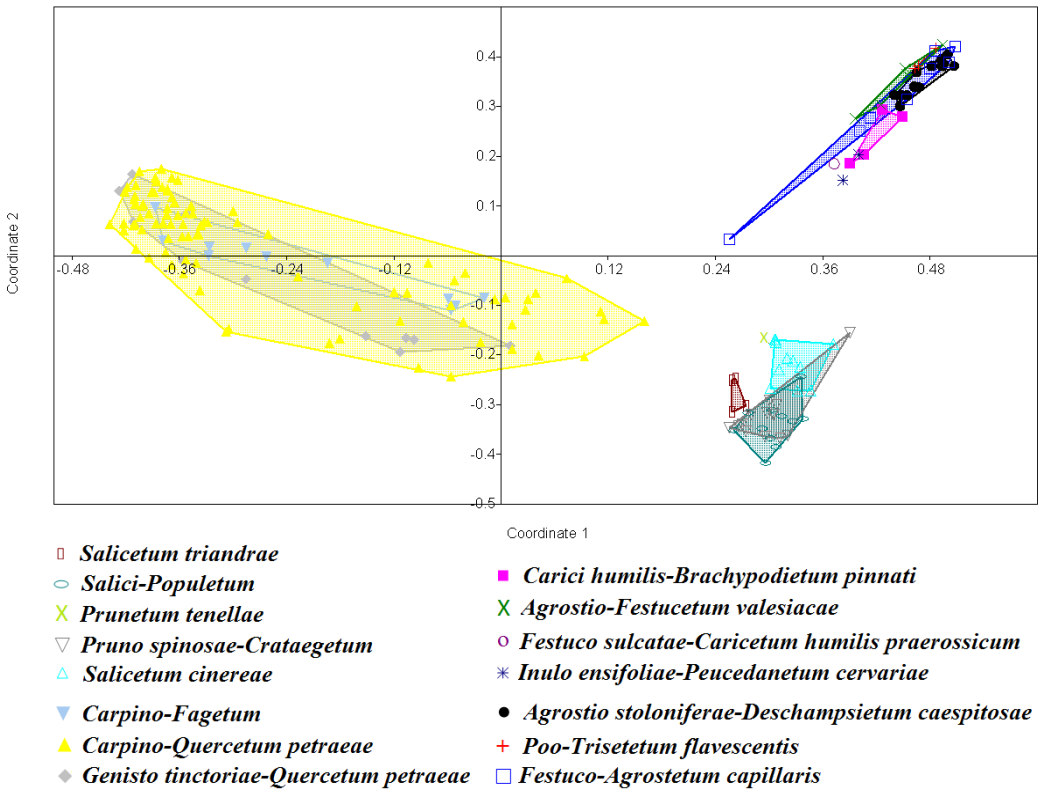

Fig. 1. Principal coordinate analysis (PcoA) of the medicinal plant communities from the Niraj Valley based on the Bray-Curtis index

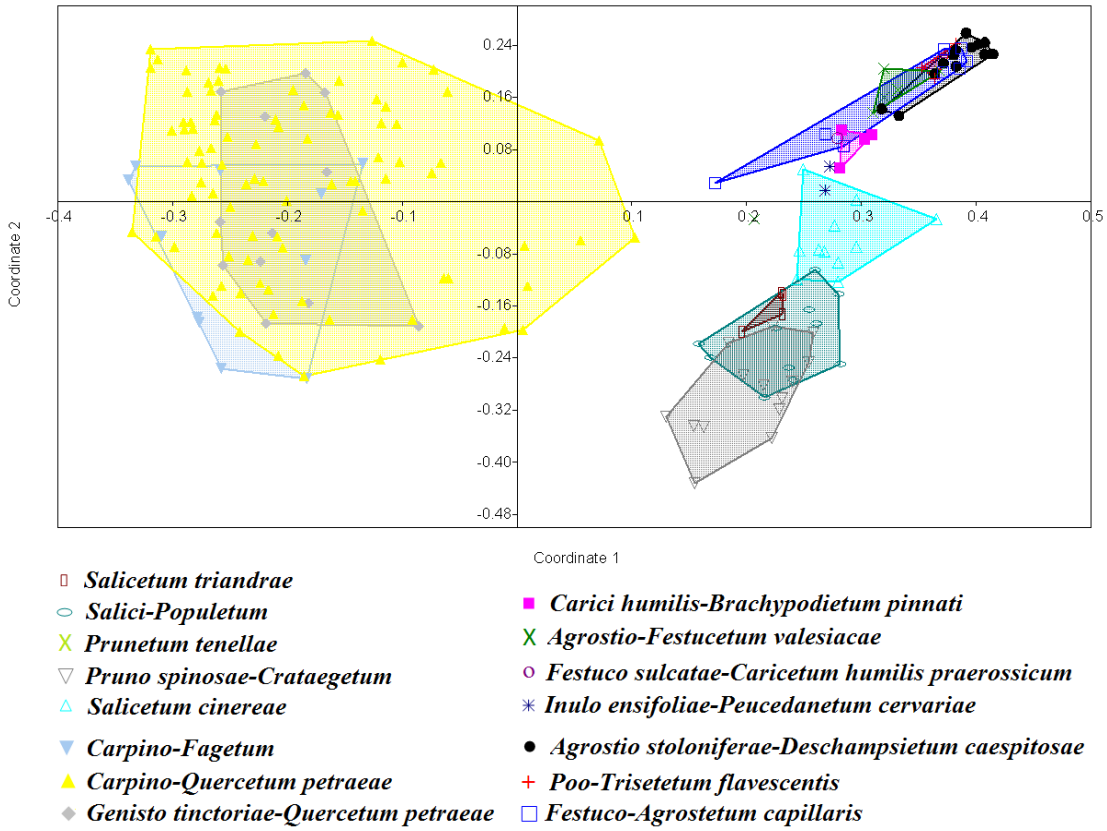

Fig. 2. Principal coordinate analysis (PcoA) of the medicinal plant communities from the Niraj Valley based on the Jaccard index

The indicator species value was calculated for identifying the characteristic medicinal plants of the different associations. The defined characteristic medicinal plants are those that are exclusively or almost exclusively in an association and have a high frequency and abundance-dominance value. The medicinal plants with a significant indicator value of the different plant associations are presented in **Table 1**.

According to our results the medicinal plant communities of the deciduous forests from the Niraj Valley are not differentiated by the type of forest. The associations *Carici humilis-Brachypodietum pinnati* and *Inulo ensifoliae-Peucedanetum cervariae* had the highest number of characteristic species (**Table 1**). The plant species with use in the traditional medicine and/or phytotherapy found in the studied associations from the Niraj Valley, their drugs, dominant active principles and harvesting periods are included in the Supplementary Material 1 (**Table 2**).

The medicinal plants containing tannins as the dominant active principle were in higher percentage (18.93%) followed by those with essential oils (10.68%), flavonoids (10.68%), saponins (9.71%), alkaloids (7.77%), mucilages (6.80%), and coumarins (5.34%) (**Fig. 2**).

Table 1. Plants used in traditional medicine and/or phytotherapy with significant indicator value from each studied association from the Niraj Valley

Salicetum triandrae				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Salix triandra*	Cortex	0.97	0.001
2.	*Salix viminalis*	Cortex	0.96	0.003
3.	*Tanacetum vulgare*	Flos	0.92	0.009
4.	*Artemisia vulgaris*	Herba	0.69	0.024
5.	*Rubus caesius*	Folium	0.66	0.035
Salici-Populetum				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Populus nigra*	Gemma	0.91	0.005
2.	*Alnus glutinosa*	Cortex, folium, gemma	0.89	0.004
3.	*Salix alba*	Cortex	0.85	0.006
4.	*Sambucus nigra*	Flos	0.68	0.021
5.	*Humulus lupulus*	Strobuli, glandulae	0.61	0.036
6.	*Salix fragilis*	Cortex	0.61	0.034
7.	*Saponaria officinalis*	Radix	0.45	0.042
Prunetum tenellae				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Prunus tenella*	Folium, semen	1	0.01
2.	*Asparagus officinalis*	Rhizoma, radix	0.96	0.013
3.	*Thalictrum minus*	Herba	0.93	0.015
4.	*Potentilla recta* ssp. *recta*	Rhizoma	0.67	0.019
5.	*Rosa canina*	Fructus	0.6	0.028
Pruno spinosae-Crataegetum				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Crataegus monogyna*	Folium, flos, fructus	0.98	0.001
2.	*Prunus spinosa*	Flos, fructus	0.61	0.04
3.	*Cornus sanguinea*	Cortex	0.45	0.048
4.	*Pyrus pyraster*	Folium	0.22	0.038
Salicetum cinereae				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Salix cinerea*	Cortex	1	0.001
2.	*Frangula alnus*	Cortex	0.63	0.026
3.	*Rubus caesius*	Folium	0.55	0.033
4.	*Lysimachia vulgaris*	Herba	0.36	0.037
5.	*Iris sibirica*	Rhizoma	0.27	0.043
6.	*Solanum dulcamara*	Stipes	0.18	0.047
***Carpino-Fagetum* Paucă 1941, *Carpino-Quercetum petraeae* Borza 1941, *Melico uniflorae-Quercetum petraeae* Gergely 1962**				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Fagus sylvatica*	Creosotum	0.94	0.001
2.	*Quercus petraea*	Cortex	0.71	0.033
3.	*Asarum europaeum*	Rhizoma	0.67	0.038

4.	*Convallaria majalis*	Herba	0.62	0.035
5.	*Ajuga reptans*	Herba, folium, flos	0.49	0.042
6.	*Galeobdolon luteum*	Herba	0.46	0.011
7.	*Tilia cordata*	Flos	0.42	0.001
8.	*Pulmonaria officinalis*	Folium	0.36	0.026
9.	*Vinca minor*	Herba	0.35	0.032
Carici humilis-Brachypodietum pinnati				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Peucedanum oreoselinum*	Rhizoma	0.75	0.019
2.	*Solidago virgaurea* ssp. *virgaurea*	Summitates	0.75	0.038
3.	*Euphrasia rostkoviana* ssp. *rostkoviana*	Herba	0.75	0.023
4.	*Elymus repens*	Rhizoma	0.68	0.034
5.	*Hypericum perforatum*	Herba	0.63	0.021
6.	*Anthyllis vulneraria* ssp. *vulneraria*	Herba, flos	0.5	0.022
7.	*Polygala comosa*	Herba	0.5	0.022
8.	*Heracleum sphondylium*	Radix, herba	0.5	0.02
9.	*Linum catharticum*	Semen	0.5	0.014
Agrostio-Festucetum valesiacae				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Achillea millefolium* var. *collina*	Herba	0.4	0.041
Festuco sulcatae-Caricetum humilis praerossicum				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Stachys germanica*	Herba	1	0.018
2.	*Trifolium campestre*	Herba	1	0.01
3.	*Calluna vulgaris*	Herba	1	0.011
4.	*Orchis morio*	Tuber	0.7	0.048
5.	*Senecio jacobaea*	Herba	0.67	0.021
6.	*Helianthemum nummularium*	Folium	0.67	0.022
7.	*Teucrium chamaedrys*	Herba	0.58	0.041
Inulo ensifoliae-Peucedanetum cervariae				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Genista sagittalis*	Herba	1	0.001
2.	*Nepeta nuda*	Semen	0.8	0.024
3.	*Vincetoxicum hirundinaria* ssp. *hirundinaria*	Radix	0.77	0.005
4.	*Origanum vulgare* ssp. *vulgare*	Herba	0.71	0.02
5.	*Rosa gallica*	Petalum	0.5	0.027
6.	*Veronica teucrium* ssp. *teucrium*	Herba	0.5	0.029
7.	*Veronica orchidea*	Herba	0.5	0.031
8.	*Digitalis grandiflora*	Folium	0.5	0.02
9.	*Melilotus officinalis*	Herba, flos	0.38	0.049
Agrostio stoloniferae-Deschampsietum caespitosae				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Sanguisorba officinalis*	Herba	0.91	0.001
2.	*Filipendula ulmaria*	Herba	0.68	0.036

3.	*Polygonum bistorta*	Rhizoma	0.59	0.02
4.	*Oenanthe aquatica*	Fructus	0.48	0.045
***Poo-Trisetetum flavescentis* Knapp 1951 em. Oberd. 1983, *Festuco-Agrostetum capillaris* Horv. 1951**				
	Plant taxa	**Drugs**	**IndVal [a]**	***p* Value [b]**
1.	*Convolvulus arvensis*	Herba	0.67	0.024
2.	*Potentilla argentea* ssp. *argentea*	Rhizoma	0.33	0.047

Note: a - Indicator value analysis; b - significance criterion

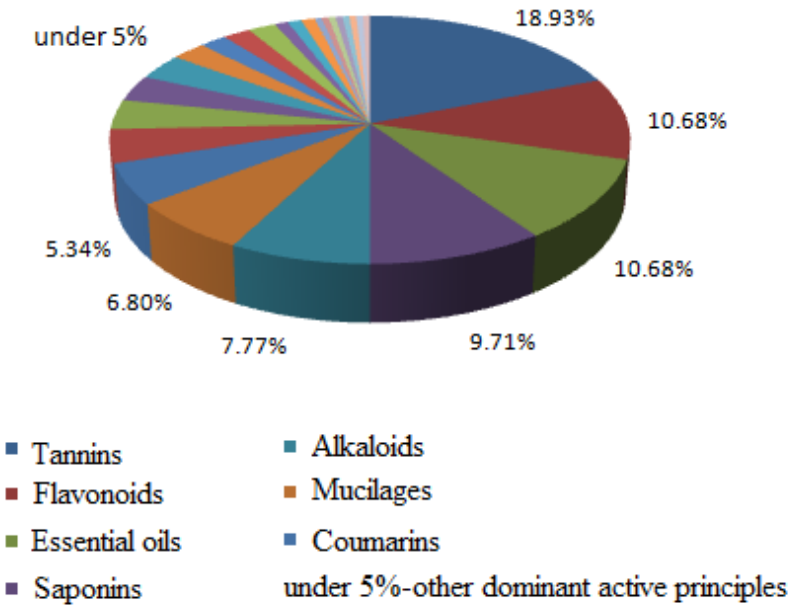

Fig. 3. Spectrum of the dominant active principles present in the medicinal plants of some representative plant communities of the Niraj Valley

Conclusions

The existing list of medicinal plants from the Niraj Valley in the scientific literature (Oroian and Giurgiu, 2003) was completed with 33 new taxa. From the 208 taxa, 37 plants are included in the European Pharmacopoeia (from which 4 taxa are reported for the first time in the Niraj Valley) and 13 in the Romanian Pharmacopoeia. The studied habitats provide shelter for 18 endangered, rare and vulnerable plant taxa, some of which are also medicinal plants (e.g. *Narcissus poeticus* ssp. *radiiflorus*, *Achillea ptarmica*, *Orchis laxiflora* ssp. *elegans*, *Orchis militaris*, *Orchis morio* ssp. *morio*, *Prunus tenella*, and *Iris sibirica*). However rational (sustainable) exploitation of these natural resources is necessary.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Blaga GH, Filipov F, Rusu I (2005) Pedologie-Manual Universitar, Ed. Academic Press, Cluj-Napoca
2. Csedő K (red.) (1980) Plantele medicinale şi condimentare din judeţul Harghita, Tipografia Tîrgu-Mureş
3. Csűrös Ş (1963) Scurtă caracterizare generală a vegetaţiei din Transilvania. Acta Horti Bot Bucurest 1961-1962 2:825–853.
4. Domokos E (2015) Vegetația lemnoasă și comunitățile de păsări din cursul mijlociu al văii Nirajului: Studiu biocenologic, Ed. Presa Universitară Clujeană, Cluj-Napoca
5. Eşianu S (2016) Manual de farmacognozie, Vol 2, University Press, Tîrgu-Mureş
6. Eşianu S, Laczkó-Zöld E (2016) Manual de farmacognozie, Vol 1, University Press, Tîrgu-Mureş
7. Florea N, Munteanu I (2000) Sistemul Român de Taxonomie a Solurilor, Ed. Univ. “Alexandru Ioan Cuza”, Iaşi
8. Hajdu Z (2010) Ivóvízkutak nitrátszennyeződése a Nyárád vízgyűjtőjében, Ed. Did. şi Ped., Bucureşti
9. Josan N (1979) Dealurile Târnavei Mici-Studiu geomorfologic, Ed. Acad. Române, Bucureşti
10. Kovács JA (2008) Xerothermic plant communities in the eastern part of the Transylvanian Basin (Szeklerland, Romania). Kanitzia 16:147–210
11. Muntean LS (coord.) (2016) Tratat de plante medicinale cultivate si spontane ed. II-a, Ed. Risoprint, Cluj-Napoca
12. Oroian S (2011) Botanică Farmaceutică, Ed. University Press, Tîrgu-Mureş
13. Oroian S, Giurgiu M (2003) Plante medicinale spontane din Valea Nirajului. Revista Medico-Chirurgicală a Societății de Medici și Naturaliști Iași 107(2):124–130
14. Oroian S, Sămărghiţan M, Hiriţiu M, Coşarcă S, Tănase C (2016) The diversity of medicinal and aromatic plants encountred in Natura 2000 6520 habitat from Gurghiu Mountains. Journal of Plant Development 23:179–186
15. Pârvu C (2000) Universul plantelor, mică enciclopedie, Ed. a III-a, Ed. Enciclopedică, București
16. Roberts DW, Oksanen J (2006) LabDSV: Laboratory for Dynamic Synthetic Vegephenomenology, R Package Version 1-2, Bozeman MT USA: Montana State University
17. Roșu A (1980) Geografia fizică a României, Ed. Did. și Pedag., București
18. Sămărghiţan M, Oroian S (2011) A new station for *Fritillaria meleagris* L. in Mureș county. Marisia Studii şi Mat Studia Scient Nat 31:25–35
19. Sârbu I, Ștefan N, Oprea A (2013) Plante vasculare din România-Determinator ilustrat de teren, Ed. Victor B Victor, București
20. ***European Pharmacopoeia Online 9.3 http://online6.edqm.eu/ep903/. Accessed 16 June 2018
21. ***Farmacopeea Română (1993) Ed. a X-a, Ed. Medicală, București