



Traditional use of medicinal plants in Jablanica district (South-Eastern Serbia): ethnobotanical survey and comparison with scientific data

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Abstract Ethnobotanical survey presents the first step in the identification of new bioactive compounds. This study aimed to collect, document and analyse data on the traditional use of medicinal plants in Jablanica district (South-Eastern Serbia) and to compare traditional knowledge with scientifically proven data. Ethnobotanical study was carried out using semi-structured interviews with 103 informants. Discussion of the results was performed after the quantitative ethnobotany factors were calculated. Comparison of the data was done with those of European Medicines Agency (EMA), Yugoslav Pharmacopoeia 1984 (Ph. Jug. IV) and relevant scientific papers. The informants reported data on 89 medicinal plants belonging to 49 families in Jablanica district. The dominantly used families were *Lamiaceae* and *Asteraceae*, while *Hypericum perforatum L.*, *Mentha × piperita L.* and *Matricaria chamomilla L.* were the species with the highest number of use reports. The most frequently reported indications were respiratory, gastrointestinal, dermatologic, and psychological diseases. The species with most diverse uses were *Taraxacum campylodes*

G.E.Haglund, *Achillea millefolium L.* and *Rosa canina L.* According to our results, medicinal plants in Jablanica district are mainly used for treating minor health issues as a mode of primary health care. The wide application of species belonging to *Lamiaceae* and *Asteraceae* families can be partially attributed to the fact that many cosmopolitan medicinal plant species belongs to these families and also to their predominance in the flora of Jablanica districts.

Keywords Medicinal plants · Ethnobotany · Jablanica · European Medicines Agency

Introduction

According to the World Health Organization (WHO), traditional medicine (TM), which has a long history, represents the sum of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness. The WHO Traditional Medicine Strategy 2014–2023 (World Health Organization 2013) aims to support Member States in developing proactive policies and implementing action plans that will strengthen the role that TM plays in keeping populations healthy. TM is still widely used in most of the developing countries (Buenz et al. 2018).

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Ethnobotanical survey presents the first step in acquiring data on traditional use of medicinal plants and is preliminary screening tactic of great importance in the identification of new bioactive compounds (Menković et al. 2011).

Traditional medicine in Serbia has a very long history. According to the literature, numerous health problems have been treated with medicinal plants since the medieval times in Serbia (Sarić 1989). The oldest documents treating medicinal plants date back from the 14th century such as The Hodoch Codex or The Chilandar Medicinal Codex from the 16th century (Katić 1980).

In Serbia, the poverty level is the highest in South-East regions where the economy relies on small farming, poor infrastructure and inadequate public services. As a result of economic failures, the entire region is witnessing decade-long depopulation. This fact testifies about the potential disappearance of traditional knowledge. The most common diseases in Serbia, according to the Brief health system review (<http://www.hpi.sk/en/2014/01/serbia-brief-health-system-review/>) were cardiovascular and respiratory but, increase in the number of neurological and substance abuse patients was also noticed. In recent years, several ethnobotanical studies have been conducted covering countries on Balkan peninsula including Serbia (Menković et al. 2011; Jarić et al. 2007, 2014, 2015, 2018; Šavikin et al. 2013; Pieroni et al. 2011; Mustafa et al. 2012; Redžić 2007). Despite long and strong tradition of plants use for different purposes (Dajić-Stevanović et al. 2014), detailed ethnobotanical studies are still lacking and traditional knowledge is not adequately documented in South-East Serbia. Moreover, Srithi et al. (2009) also pointed out that there is an ongoing generational loss of TM knowledge. This is also supported by the data of the Serbian Medicines Agency. According to them, remedies that have a non-prescription regimen, dominantly herbal preparations, are represented only with 10.28% in the total drug turnover in 2016 (https://2016.export.gov/industry/health/healthcareresourceguide/eg_main_108616.asp). Thus, efforts to intensify and document the ethnobotanical use of natural products are time critical (Buenz et al. 2018).

The aim of our study was to collect and preserve ethnobotanical and ethnopharmacological knowledge from Jablanica district, a poorly developed region in South-Eastern Serbia, and to compare traditional

knowledge with scientifically proven data, especially those accepted by the European Medicines Agency.

Materials and methods

Research area

South-Eastern part of Serbia is characterized by highlands, mountains and valleys. Terrain is dominantly acidic with numerous flowing and stagnant waters. The climate is moderate continental, with local differences in the character due to diversity of terrain. Such diversity and climatic impacts as well as specific geological and pedological characteristics conditioned great floristic diversity. It is primarily reflected in the number of plant species present, but also in the presence of different endemic, subendemic or endangered and rare plant species (Randelović et al. 2005).

The special value and specificity of the flora are Balkan's endemic, subendemic and relict taxa. The taxonomic analysis shows that in endemic flora of these areas the largest family is Compositae (42 taxa). Other families with significant number of endemic plants are Caryophyllaceae (22 taxa), Leguminosae (15 taxa), Scrophulariaceae (11 taxa) and Labiatae (9 taxa) (Tomović and Stevanović 2010). Cherry laurel (*Prunus laurocerasus* L.), tertiary relict and endemic present only in a few localities in the world, grows on mountain Ostrozub, near Vlasotince town. *Drosera rotundifolia* L., one of carnivorous plant species, grows on peat land in this region (Avramović et al. 2005). Some of rare plant species are critically endangered (*Allium paczoskianum* Tuzs., *Allium guttatum* subsp. *dalmaticum* (A.Kern. ex Janch.) Stearn, *Stachys milanii* Petrov ex Magnier, *Cirsium helenioides* (L.) Hill, *Cystopteris montana* (Lam.) Bernh. ex Desv. and other) (Randelović et al. 2005). For some species, this is the northernmost or southernmost boundary of distribution on Balkan Peninsula (*Fritillaria graeca* Boiss. et Spr., *Linaria simplex* Desf. (Willd.) D.C., *Loranthus europaeus* Jacq., *Stachys plumosa* Griseb., *Teesdalia coronopifolia* (J.P.Bergeret) Thell., *Ranunculus psilostachys* Griseb., *Scorzoneroides cichoriacea* (Ten.) Greuter (Biv.) Nym. *Clypeola jonthlaspi* L. subsp. *microcarpa* (Mor.) Fior., *Armeria cariensis* var. *rumelica* (Boiss.) Boiss., *Selaginella helvetica* (L.) Spreng). *Crocus rujanensis* Randjel. et D.A.Hill, is endemic plant that grows on

Rujan mountain. *Betula pendula* Roth. and *Drosera rotundifolia* L. are strictly protected species growing on Vlasina plateau. On Rudina mountain 20 endemic and subendemic species are registered, and many of them are for the first time described for Flora Serbia, namely: *Genista carinalis* Griseb., *Agrostis castellana* subsp. *byzantina* (Boiss.) Hack. ex Kneuck., *Trifolium affine* C. Presl., *Arabis recta* Vill., *Silene flos-cuculi* subsp. *subintegra* (Hayek) Greuter & Burdet Hayek, *Silene spergulfolia* (Willd.) M.Bieb., *Anthyllis aurea* Welden, *Fritillaria orientalis* Adam Bieb., *Edraianthus serbicus* (A.Kern.) Petrovic., *Crocus biflorus* subsp. *adamii* (J.Gay) K.Richt. J. Gay, *Stachys scardica* (Griseb.) Hayek Griseb., *Stachys plumosa* Griseb., *Helichrysum plicatum* DC. and others (Avramović et al. 2005).

Ethnobotanical study was conducted in the area of Jablanica district (Fig. 1). Jablanica district is located in South-Eastern part of Serbia covering an area of 2770 km² (3.13% of the territory of the Republic of Serbia). It represents mainly rural and economically underdeveloped part of the country. The district encompasses the city of Leskovac and five other municipalities: Bojnik, Vlasotince, Medvedja, Lebane and Crna Trava. The name comes from Jablanica River that flows through the district.

Jablanica district is the regions in Republic of Serbia which is extremely poor. Negative demographic trends are present, population is old, and high level of depopulation is present. Moreover, socio-economic development is low as well as literacy level, especially in rural households. Region is also characterized by the absence or low quality of road infrastructures and traditional agricultural production on small scale.

Ethnobiological survey

Data was collected using ethnobotanical semi-structured interviews during May–October 2018. A total number of 103 informants were interviewed orally. As for nationality, the majority of informants were Serbian (99), three did not declare and one was Macedonian. Informants age ranged between 22 and 85 (average value of 50) (Table 1). The number of male informants was 40 (37.6%) while the number of female was 63 (62.4%).

Potential informants were provided by the explanations of the aim of the study before starting the surveys. Only those who claimed to know medicinal plants and their uses were interviewed. For the correct identification of plant species, researchers were equipped with Flora of Serbia (Josifović 1970–1977; Sarić and Diklić 1986) and Flora of Europe (Tutin et al. 1964–1980; Tutin et al. 1993), photos of the medicinal plants as well as herbarium.

The interview covered the following information: informants' sex, age, nationality, residence, occupation, local names of plants they use, plant part(s) they used, indication (traditional medicinal uses) and type of preparation/administration.

According to the International Classification of Primary Care which are accepted by the WHO (<http://www.kith.no/upload/2705/ICPC-2-English.pdf>), reported plant species were classified into ailment categories (15 out of 17): general and unspecified (A), blood, blood-forming organs and immune mechanisms (B), digestive (D), eye (F), ear (H), cardiovascular (K), musculoskeletal (L), neurological (N), psychological (P), respiratory (R), skin (S), endocrine/metabolic and nutritional (T), urological (U), pregnancy, childbearing, family planning (W), female genital (X) and male genital (Y).

All plants cited have been considered, even mentioned by a sole informant. Plants were lined up based on the number of citations by the informants. Each time when plant species was mentioned as “used” it was regarded as one “use-report”. Also, if the same plant was used by the same informant to treat more than one disease in the same WHO category, it was considered as a single use-report (Quave and Pieroni 2015).

Data analysis

Analyze of collected ethnobotanical data included calculation of frequency and percentage of families reported, the number of most cited plant species and their uses, the most commonly used parts of the plants as well as preparation methods for the application. Ethnobotanical data that were collected during the field survey was sorted in Microsoft Excel and further evaluated by quantifying the use reports according to

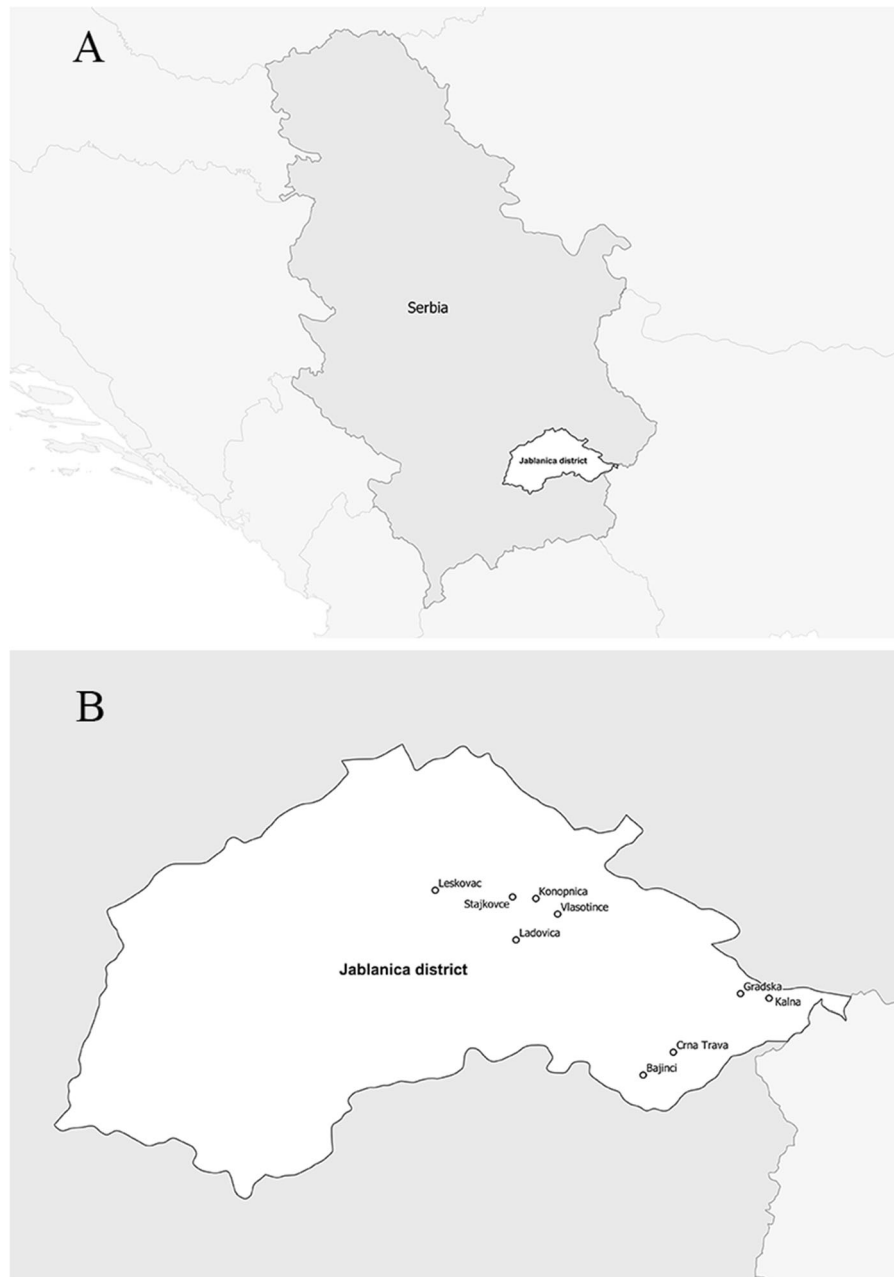


Fig. 1 Map of researched area. **a** Location of Jablanica district in Serbia. **b** Location of settlements where semi-structured interviews were conducted

previously published literature (Trotter and Logan 1986).

Use value (UV) was calculated according to the following formula developed by Phillips and Gentry (1993):

$$UV = (\sum UV_{is}) / (n_{is}),$$

where UV_{is} represents the total number of use citations by all informants for a given species, and n_{is} is the total number of informants in the study.

Cultural value (CV) index which takes into account the use categories, is calculated according to the following formula (Reyes-Garcia et al. 2006):

Table 1 Demographic features of informants in Jablanica district

	Jablanica district
Total number of informants	103
< 20	0
20–40	24
41–60	61
61–80	17
> 80	1

$$CVs = UCs \times ICs \times IUCs$$

where CVs is the cultural value of ethnospesies s. UCs is the total number of uses reported for ethnospesies s divided by the number of categories of potential uses considered in the study.

ICs expresses the number of participants who listed the ethnospesies s as useful divided by the total number of people participating in free listing. IUCs expresses the number of participants who mentioned each use of the ethnospesies s divided by the total number of participants.

Informant consensus factor (FIC) was calculated according to the equitation $FIC = (Nur - Nt) / (Nur - 1)$, where Nur is a number of use citations in each disease category while Nt is a number of plant species used (Trotter and Logan 1986). This means that FIC values will be low (near 0) if plants were chosen randomly or in the case that the informants do not exchange information about their use. On the other hand, FIC values will be high (near 1) if there are well-defined selection criteria and/or if informants exchange information about plant species usage (Teklehaymanot and Giday 2007).

Results and discussion

Ethnobotanical survey

The aim of this study was to analyze traditional usage of medicinal plants in Jablanica district in South-Eastern Serbia using data obtained through the ethnobotanical semi-structured interviews of autochthonous population and to compare those results with European Medicines Agency (EMA)

monographs, Yugoslav Pharmacopoeia (Ph. Jug. IV) monographs, studies conducted in neighboring areas and with current scientific data. The results are presented in Table 2. Plants are arranged in alphabetical order according to their botanical names. For each plant species, the botanical name and family, local names, part(s) used, voucher number, preparation/administration, folk medical uses and total number of use reports were reported.

Flora of Serbia possesses around 4000 taxa (Stevanović et al. 1995) which make it a country with very high floristic diversity as well as density per unit compared to other European countries. Sarić (1989) reported that about 700 wild growing plant species have been used as medicinal in Serbia and among them, 420 are officially registered, and about 270 are available on the market (Jarić et al. 2018).

According to our study, botanical remedies comprise 89 plant species belonging to 49 families in Jablanica district. *Lamiaceae* (23%), *Asteraceae* (17%) and *Rosaceae* (17%) were the most dominant botanical families cited (Fig. 2). The wide application of such species in traditional medicine can be partially attributed to the fact that many cosmopolitan medicinal plant species belongs to mentioned families and also to their predominance in the flora of studied region. *Lamiaceae* and *Asteraceae* families have been also reported by Jarić et al. (2015) as predominant families in ethnobotanical studies they conducted in other parts of Serbia. Although, the flora of Balkan is characterized by high endemism (14.94%), traditional use of endemic plants was not recorded in studied Jablanica district. Among 89 recorded plant species, 62 species were exclusively wild-harvested, 12 were grown in homegardens, 2 were bought in pharmacy, while 13 were both grown in gardens and sourced in the wild.

In Jablanica district the average number of cited plants was 6.6 per informant. UV for mentioned species ranged from 0.01 to 0.81 and plant species with the highest UV were: *Hypericum perforatum* L., *Mentha × piperita* L., *Matricaria chamomilla* L., *Thymus serpyllum* L., *Achillea millefolium* L., *Salvia officinalis* L., *Melissa officinalis* L. and *Urtica dioica* L.. Having in mind calculated CV the order of plant species is slightly changed and it decreased in the following manner: *Hypericum perforatum*, *Thymus serpyllum*, *Mentha piperita*, *Achillea millefolium*, *Matricaria chamomilla*, *Urtica dioica* L. and *Salvia*

Table 2 Plant species used in traditional medicine of Jablanica district

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Achillea millefolium</i> L., hajdučka trava, stolisnik, sporiš, Asteraceae, IPLB36/13, WH	Herb	D: 24 (I: stomach disorders, liver problems, loss of appetite) X: 4 (I: menstrual complaints) R: 5 (I: cough, bronchitis) S: 3 (E: against wounds) T: 2 (diabetes, thyroid gland disorders (in combination with <i>Calendula officinalis</i>) B: 2 (I: for weakened immune system) K: 3 (I: heart complaints, against hemorrhoids, cleaning the blood) P: 2 (I: anxiety)	Infusion Tincture Juice Compress Oil extract	45	0.08	0.44
<i>Acorus calamus</i> L., idirot, Acoraceae, IPLB44/13, WH	Root	D: 1 (I: gastrointestinal complaints) T: 1 (I: for slow metabolism) U: 1 (I: kidney diseases)	Decoction	3	0.00	0.03
<i>Aesculus hippocastanum</i> L., kesten, Hippocastaneaceae, IPLB11/13, WH	Seed Leaf Flower	K: 4 (E: varicose veins, circulation disorders) L: 2 (E: rheumatism) S: 1 (E: burns)	Tincture Infusion Ointment	7	0.00	0.07
<i>Agrimonia eupatoria</i> L., petrovac, Rosaceae, IPLB37/14, WH	Herb	U: 10 (I: kidney stones and sand) K: 1 (I: heart and circulation complaints) D: 1 (I: liver disorders) R: 1 (I: respiratory disorders) U: 2 (I: urinary tract inflammation)	Decoction Ointment Infusion	13	0.00	0.13
● <i>Agropyron repens</i> L., pirevina, Poaceae, IPLB9/13, WH	Root	U: 2 (I: urinary tract inflammation)	Decoction	2	0.00	0.02
<i>Alchemilla vulgaris</i> L., virak trava, Rosaceae, IPLB41/13, WH	Herb	X: 2 (I: menstrual problems) S: 1 (E: wounds) L: 1 (I: muscle relaxant)	Infusion Compress	4	0.00	0.04
<i>Allium cepa</i> L., crni luk, Alliaceae, IPLB22/13, G	Bulb	R: 1 (I: cough)	Infusion	1	0.00	0.01
<i>Allium schoenoprasum</i> L., vlašac, Alliaceae, IPLB13/13, WH, G	Herb	T: 1 (I: detoxification)	Spice	1	0.00	0.01
<i>Allium ursinum</i> L., sremuš, Alliaceae, IPLB26/14, G	Leaf Root Flower	T: 5 (I: hypercholesterolemia, detoxification) K: 2 (I: high blood pressure) B: 1 (I: for weakened immune system)	Fresh, Tincture	8	0.00	0.08

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Althaea officinalis</i> L., beli slez, Malvaceae, IPLB32/14, WH, G	Root Leaf	R: 7 (I: cough)	Infusion Macerate	7	0.00	0.07
<i>Arctostaphylos uva-ursi</i> (L.) Spreng., medvede grozde, uva, Ericaceae, IPLB17/14, WH	Leaf	U: 3 (I: urinary tract infections)	Infusion	3	0.00	0.03
<i>Armoracia rusticana</i> G. M. Sch., hren, Brassicaceae, IPLB18/13, G	Root Leaf	R: 1 (I: respiratory disorders) L: 1 (E: rheumatism) F: 1 (I: for better sight)	Fresh	3	0.00	0.03
<i>Aronia melanocarpa</i> , aronija, Rosaceae, IPLB25/13, G	Fruit Leaf	K: 2 (I: circulation disorders, cleaning the blood, high blood pressure) B: 1 (I: weakened immune system) D: 1 (I: diarrhea)	Fresh Juice Infusion Macerate	4	0.00	0.04
<i>Artemisia absinthium</i> L., pelin, Asteraceae, IPLB17/13, WH	Leaf Flower	D: 5 (I: gastrointestinal complains, gastritis) N: 1 (I: headache)	Infusion Tincture Decoction	6	0.00	0.06
• <i>Asarum europaeum</i> L., kopitnjak, Aristolochiaceae, IPLB31/14, WH	Flower Stem	D: 1 (I: stomach disorders) K: 1 (I: hemorrhoids)	Infusion	2	0.00	0.02
<i>Betula pendula</i> Roth., breza, Betulaceae, IPLB7-2/13, WH	Leaf Buds Bark	U: 8 (I: urinary infections, kidney stones) T: 1 (I: detoxification)	Infusion Decoction	9	0.00	0.09
<i>Brassica oleracea</i> L., kupus, Brassicaceae, IPLB33/13, G	Leaf	K: 1 (E: varicose veins) S: 1 (E: inflammation on skin)	Compress	2	0.00	0.02
<i>Calendula officinalis</i> L., neven, Asteraceae, IPLB53/13, WH, G	Flower Leaf	S: 11 (E: against burns, wounds and skin complaints, psoriasis) K: 11 (E: hemorrhoids, vein disorders) T: 1 (thyroid gland disorder (in combination with <i>A. millefolium</i>) D: 1 (I: colitis)	Ointment Infusion Tincture	24	0.01	0.23
• <i>Camellia sinensis</i> L., zeleni čaj, Theaceae, IPLB1-T/13, B	Leaf	T: 2 (I: to fast metabolism)	Infusion	2	0.00	0.02
<i>Capsella bursa-pastoris</i> L., hoću-neću, Brassicaceae, IPLB46/14, WH	Herb	K: 3 (I: antihemorrhagic) L: 2 (I: muscle and joint pain) U: 1 (I: uterine prolapse)	Infusion Tincture	6	0.00	0.06

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Centaureum erythraea</i> Rafn, kičica, <i>Gentianaceae</i> , IPLB58/13, WH	Herb	D: 2 (I: loss of appetite, digestive disorders) A: 1 (I: antipyretic)	Infusion	3	0.00	0.03
<i>Chelidonium majus</i> L., rusopas, rusa, <i>Papaveraceae</i> , IPLB8/13, WH	Leaf Stem	S: 3 (E: against warts, skin complications, herpes, lichens) X: 2 (I: ovarian cyst) B: 1 (I: weakened immune system) A: 1 (I: strong pain)	Juice Infusion Tincture	7	0.00	0.07
<i>Cichorium intybus</i> L., vodopija, cikorija, gologuza, <i>Asteraceae</i> , IPLB40/14, WH	Root	D: 1 (I: loss of appetite, liver disorders)	Decoction	1	0.00	0.01
<i>Crataegus monogyna</i> Jacq., glog, <i>Rosaceae</i> , IPLB10/13, WH	Leaf, flower, fruit	K: 9 (I: heart failure, high blood pressure, arrhythmia)	Infusion Decoction Tincture	9	0.00	0.09
<i>Crataegus oxyacantha</i> L., crni glog, <i>Rosaceae</i> , IPLB15/13, WH	Flower fruit	K: 2 (I: for a “stronger” heart)	Decoction Tincture	2	0.00	0.02
<i>Epilobium parviflorum</i> Wither., mala mlečika, vrbovica <i>Oenotheraceae</i> , IPLB69/14, WH	Herb	Y: 4 (I: prostate disorders)	Infusion Decoction Tincture	4	0.00	0.04
<i>Equisetum arvense</i> L., rastavić, preslica <i>Equisetaceae</i> , IPLB6/13, WH	Herb	U: 16 (I: urinary tract infections, kidney stones and sand) A: 1 (I: tuberculosis) D: 1 (I: ulcers) S: 1 (E: hangnails)	Infusion Decoction Tincture	19	0.01	0.18
<i>Ficus carica</i> L., smokva, <i>Moraceae</i> , IPLB116/14, WH	Leaf	D: 1 (I: diarrhea)	Fresh Juice	1	0.00	0.01
<i>Galium verum</i> L., ivanjsko cveće, jovanova trava, <i>Rubiaceae</i> , IPLB42/14, WH	Flower	T: 3 (I: thyroid gland disorders) B: 1 (I: anemia) D: 2 (I: liver problems) U: 1 (I: kidney problems) P: 1 (I: insomnia)	Infusion Decoction Juice	8	0.00	0.08
<i>Gentiana lutea</i> L., lincura, <i>Gentianaceae</i> , IPLB12/12, WH, G	Root Leaf Flower	K: 1 (E/I: vein problems)	Tincture Compress	1	0.00	0.01
• <i>Geranium robertianum</i> L., robertova trava, <i>Geraniaceae</i> , IPLB68/13, WH	Herb Root	T: 2 (I: hormone disorder) W: 1 (I: infertility)	Infusion Decoction Tincture	3	0.00	0.03

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Hedera helix</i> L., bršljan	Leaf	R: 1 (I: cough)	Syrup Infusion	1	0.00	0.01
<i>Araliaceae</i> , IPLB105/13, WH						
<i>Hibiscus sabdariffa</i> L., hibiscus,	Flower	R: 2 (I: cold)	Infusion	2	0.00	0.02
<i>Malvaceae</i> , IPLB2-T/14, B						
<i>Humulus lupulus</i> L., hmellj,	Cones	P: 3 (I: anxiety, insomnia)	Infusion Tincture	3	0.00	0.03
<i>Cannabaceae</i> , IPLB112/14, WH						
<i>Hypericum perforatum</i> L., kantaron,	Herb	S: 34 (E: against burns, wounds and skin complaints) D: 36 (I: gastrointestinal ailments, gastritis) P: 10 (I: depression, insomnia) R: 2 (I: cold) X: 1 (I: gynecological complaints)	Infusion, Oil extract	83	0.19	0.81
<i>Hypericaceae</i> , IPLB9/12, WH						
<i>Inula helenium</i> L., oman,	Leaf Flower	R: 1 (I: cough)	Infusion	1	0.00	0.01
<i>Asteraceae</i> , IPLB60/13, WH						
<i>Juglans regia</i> L., orah,	Fruit Leaf	T: 3 (I: source of iodine, detoxification)	Tincture Infusion	6	0.00	0.06
<i>Juglandaceae</i> , IPLB94/14, G						
<i>Juniperus communis</i> L., kleka,	Fruit	D: 1 (I: digestive complaints) B: 2 (I: cleaning the blood, anemia) B: 7 (I: cleaning the blood) U: 1 (I: diuretic) R: 1 (I: bronchitis, asthma)	Tincture Infusion Spice	9	0.00	0.09
<i>Cupressaceae</i> , IPLB12/13, WH						
<i>Lavandula angustifolia</i> Mill., lavanda,	Flower	P: 1 (I: anxiety, depression) D: 1 (I: stomach disorders) X: 1 (I: uterus stimulant)	Infusion	3	0.00	0.03
<i>Lamiaceae</i> , IPLB19/13, WH,G						
• <i>Lycopodium clavatum</i> L., prečica,	Herb	D: 2 (I: liver disorders)	Infusion	2	0.00	0.02
<i>Lycopodiaceae</i> IPLB41/14, WH						
• <i>Lythrum salicaria</i> L., potočnjak,	Leaf Flower	D: 1 (I: stomach problems, diarrhea, nausea)	Infusion	1	0.00	0.01
<i>Lythraceae</i> , IPLB80/14, WH						
<i>Matricaria chamomilla</i> L., kamilica,	Herb	S: 22 (E: skin and mucose inflammation, mouthwash) D: 7 (I: digestive problems) R: 20 (I: cough) P: 1 (I: anxiety) F: 2 (E: eyewash)	Infusion	52	0.07	0.50
<i>Asteraceae</i> , IPLB74/13, WH, G						

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
● <i>Melilotus officinalis</i> L., kokoc, kokotac, <i>Fabaceae</i> , IPLB97/14, WH	Herb	K: 1 (I: circulation disorders)	Infusion Tincture	1	0.00	0.01
<i>Melissa officinalis</i> L., matičnjak, <i>Lamiaceae</i> , IPLB43/13, WH	Leaf	P: 37 (I: anxiety, depression, insomnia) K: 2 (I: heart complaints)	Infusion Juice Tincture	39	0.02	0.38
<i>Mentha x piperita</i> L., pitoma nana, <i>Lamiaceae</i> , IPLB15/13, WH, G	Herb	D: 47 (I: digestive problems, meteorism, flatulence, spasms, liver problems) R: 10 (I: cold, cough, inhalation agent) P: 5 (I: insomnia, anxiety) N: 2 (I: headache)	Infusion Juice	64	0.09	0.62
<i>Mentha spicata</i> L., divlja nana, <i>Lamiaceae</i> , IPLB30/13, WH	Herb	N: 2 (I: headache) R: 2 (I: cold) D: 1 (digestive problems)	Infusion	5	0.00	0.05
● <i>Morus nigra</i> L., crni dud, <i>Moraceae</i> , IPLB103/14, WH	Leaf Fruit	T: 3 (I: diabetes) B: 2 (I: anemia)	Infusion Juice	5	0.00	0.05
<i>Ocimum basilicum</i> , bosiljak, <i>Lamiaceae</i> , IPLB24/13, G, WH	Herb	R: 11 (I: inhalation agent, cough) P: 4 (I: anxiety) D: 2 (I: loss of appetite, digestive complaints) X: 1 (I: menstrual complaints)	Infusion Spice	18	0.01	0.17
● <i>Orchis morio</i> L., salep, kaćun, <i>Orchidaceae</i> , IPLB110/ 14, WH	Root	Y: 1 (I: aphrodisiac)	Decoction	1	0.00	0.01
<i>Origanum vulgare</i> , vranilova trava, oregano, <i>Lamiaceae</i> , IPLB27/13, WH	Herb	D: 1 (I: digestive problems) P: 1 (I: anxiety) R: 1 (I: respiratory disorders) T: 1 (I: diabetes)	Infusion Macerate	4	0.00	0.04
<i>Petroselinum crispum</i> , peršun, <i>Apiaceae</i> , IPLB34/13, WH, G	Leaf Root	U: 4 (I: urinary tract infections) X: 4 (gynecological infections) K: 1 (I: high blood pressure) T: 1 (I: source of vitamins)	Infusion Spice Fresh	10	0.00	0.10
● <i>Phaseolus vulgaris</i> L., pasulj, <i>Fabaceae</i> , IPLB88/14, G	Pod	T: 1 (I: diabetes)	Decoction	1	0.00	0.01
<i>Pinus sylvestris</i> L., beli bor, <i>Pinaceae</i> , IPLB38/14, WH	Needle	R: 1 (I: bronchitis)	Syrup	1	0.00	0.01

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Plantago major</i> L., ženska bokvica, <i>Plantaginaceae</i> , IPLB16/13, WH	Leaf	R: 10 (I: cough, bronchitis) S: 8 (E: against wounds and ulcers) D: 4 (stomach disorders, gastritis, diarrhea) K: 1 (I: hemorrhoids, bleedings) T: 1 (I: diabetes)	Infusion Compress Syrup Macerate	24	0.01	0.23
● <i>Polypodium vulgare</i> L., slatka paprat, <i>Polypodiaceae</i> , IPLB107/14, WH	Root	R: 1 (I: bronchitis) A: 1 (I: tuberculosis) D: 1 (I: liver problems)	Infusion Fresh Juice	3	0.00	0.03
<i>Primula veris</i> L., jaglika, jagorčevina, <i>Primulaceae</i> , IPLB29/13, WH	Leaf Flower Root	R: 9 (I: cough) K: 1 (I: “for strengthening heart muscle”)	Infusion Decoction Tincture	9	0.00	0.09
<i>Prunus spinosa</i> L., trnjina, <i>Rosaceae</i> , IPLB56/13, WH	Fruit Flower	K: 1 (I: “for strengthening heart muscle”)	Infusion, Fresh	1	0.00	0.01
<i>Pulmonaria officinalis</i> L., plućnjak <i>Boraginaceae</i> , IPLB45/13, WH	Leaf	R: 1 (I: “for lungs cleaning”)	Decoction	1	0.00	0.01
<i>Rosa canina</i> L., šipurak, divlja ruža, <i>Rosaceae</i> , IPLB20/13, WH, G	Fruit	T: 11 (I: source of vitamin C, detoxification) R: 7 (I: cold) B: 4 (I: weakened immune system) L: 2 (I: osteoporosis, joint pain) D: 1 (I: diarrhea) U: 1 (I: renal complaints) N: 1 (I: epilepsy)	Decoction	27	0.02	0.26
<i>Rosmarinus officinalis</i> L., ruzmarin <i>Lamiaceae</i> , IPLB5/13, WH	Herb	K: 6 (I: cardiovascular complaints) P: 4 (I: insomnia, anxiety)	Infusion Tincture Spice	10	0.00	0.10
<i>Rubus fruticosus</i> L., kupina, <i>Rosaceae</i> , IPLB31/13, WH	Leaf, Stem Fruit	R: 3 (I: cough, bronchitis) D: 2 (I: diarrhea)	Infusion Decoction Juice Fresh	5	0.00	0.05
<i>Rubus idaeus</i> L., malina, <i>Rosaceae</i> , IPLB87/13, WH, G	Fruit Leaf	K: 1 (E: hemorrhoids) B: 1 (I: weakened immune system) X: 1 (I: menopause)	Infusion Ointment	3	0.00	0.03
● <i>Rumex acetosa</i> L., kiseljak, <i>Polygonaceae</i> , IPLB84/14, WH	Leaf	T: 1 (I: rich in nutrients)	Fresh	1	0.00	0.01

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
● <i>Salix purpurea</i> L., crvena vrba, <i>Salicaceae</i> , IPLB118/14, WH	Bark	K: 1 (I: prevent blood coagulation)	Infusion	1	0.00	0.01
<i>Salvia officinalis</i> L., žalfija, <i>Lamiaceae</i> , IPLB4/13, WH	Herb	R: 36 (E: mouth and throat wash, cold) B: 1 (I: cleaning the blood, weakened immune system) D: 2 (I: stomach disorders)	Infusion Decoction Syrup Fresh	39	0.03	0.38
● <i>Sambucus ebulus</i> L., burjan, <i>Caprifoliaceae</i> , IPLB72/13, WH	Root	A: 1 (I: strong pain)	Tincture	1	0.00	0.01
<i>Sambucus nigra</i> L., zova, <i>Caprifoliaceae</i> , IPLB23/13, WH	Flower, Fruit	R: 21 (I: cold, bronchitis) U: 1 (I: diuretic)	Infusion Juice	22	0.00	0.21
● <i>Satureja hortensis</i> L., čubrica, čubar, <i>Lamiaceae</i> , IPLB65/13, WH	Herb	P: 1 (I: anxiety) T: 1 (I: diabetes)	Infusion Decoction	2	0.00	0.02
<i>Sempervivum tectorum</i> L., čuvarkuća, <i>Crassulaceae</i> , IPLB49/14, G	Leaf	H: 1 (E: earache) D: 2 (I: stomach problems) S: 1 (E: burns, herpes)	Juice Fresh	4	0.00	0.04
● <i>Solanum tuberosum</i> L., krompir, <i>Solanaceae</i> , IPLB106/14, G	Tuber	A: 1 (E: antipyretic)	Fresh	1	0.00	0.01
<i>Solidago virgaurea</i> L., zlatica, <i>Asteraceae</i> , IPLB96/14, WH	Leaf Flower	D: 2 (I: diarrhea, stomach disorders)	Infusion	2	0.00	0.02
<i>Symphytum officinale</i> L., gavez, <i>Boraginaceae</i> , IPLB50/13, WH	Root Leaf	L: 3 (E: bone fractures, rheumatism)	Infusion Tincture Compress	3	0.00	0.03
<i>Tamus communis</i> L., bljušt, <i>Dioscoreaceae</i> , IPLB113/14, WH	Root Fruit	L: 1 (E: rheumatism) B: 1 (I: weakened immune system)	Tincture	2	0.00	0.02
<i>Taraxacum campyloides</i> G.E.Haglund Weber., maslačak, <i>Asteraceae</i> , IPLB70/13, WH	Root, leaf, flower	D: 4 (I: loss of appetite, stomach and liver disorders) T: 3 (I: diabetes, detoxification) R: 2 (I: respiratory problems) K: 3 (I: hemorrhoids) B: 2 (I: cleaning the blood) U: 2 (I: renal complaints, diuretic) X: 1 (I: menopause) S: 2 (E: skin problems) L: 2 (I: rheumatism, gout)	Infusion Decoction Spice	21	0.02	0.20

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Teucrium chamaedrys</i> L., podubica, Lamiaceae, IPLB54/14, WH	Herb	D: 5 (I: loss of appetite, ulcer)	Infusion Decoction	5	0.00	0.05
<i>Thymus serpyllum</i> L., majkina dušica, Lamiaceae, IPLB3/13, WH	Herb	P: 28 (I: anxiety, alcoholism, insomnia) R: 13 (I: cold, cough) D: 13 (I: stomach problems, meteorism) S: 2 (E: burns, wounds) K: 1 (I: vein problems) B: 1 (I: cleaning the blood) X: 1 (I: gynecological complaints) W: 1 (I: infertility)	Infusion Juice Spice Tincture Oil extract Ointment	59	0.11	0.57
● <i>Thymus vulgaris</i> L., Timijan, Lamiaceae, IPLB2/13, WH	Leaf Flower	R: 1 (I: respiratory disorders) P: 1 (I: anxiety)	Infusion Tincture	3	0.00	0.03
<i>Tilia cordata</i> Miller., lipa, Tiliaceae, IPLB64/13, WH	Flower	L: 1 (E: muscle pain) A: 4 (I: fever, diaphoretic) D: 5 (I: stomach disorders) P: 2 (I: anxiety)	Oil extract Infusion	11	0.00	0.11
● <i>Tribulus terrestris</i> L., babin zub, Zygophyllaceae, IPLB59/13, WH	Herb	L: 1 (I: increasing muscle strength) T: 1 (I: hypercholesterolemia) Y: 1 (I: inflammation of the prostate gland)	Decoction	3	0.00	0.03
<i>Tussilago farfara</i> L., podbel, Asteraceae, IPLB37/13, WH	Leaf Flower	R: 10 (I: cough, bronchitis) K: 1 (E: leg edema)	Infusion Syrup Compress	11	0.00	0.11
<i>Urtica dioica</i> L., kopriva, Urticaceae, IPLB14/13, WH	Herb Stem Root Seed	B: 29 (I: anemia, blood cleaning, weakened immune system) L: 2 (E: rheumatic disorders) S: 1 (E: loss of hair) U: 1 (I: urinary infections) Y: 1 (I: prostate problems) T: 6 (I: rich source of Fe)	Infusion Spice Tincture Juice Fresh Seed mixed with honey Compress	39	0.05	0.38
<i>Vaccinium myrtillus</i> L., borovnica, Ericaceae, IPLB51/13, G, WH	Fruit Leaf Flower Root	T: 5 (I: diabetes) B: 3 (I: anemia, weakened immune system) K: 3 (I: circulation complaints) R: 1 (I: cold) D: 1 (I: diarrhea)	Infusion Juice Fresh	13	0.00	0.13
<i>Vaccinium vitis-idaea</i> , brusnica, Ericaceae, IPLB8-T/14, G	Fruit Leaf Flower	U: 10 (I: urinary tract infections)	Decoction Infusion Fresh	10	0.00	0.10

Table 2 continued

Scientific name, local Serbian name, family name, voucher number	Part(s) used	Medical use ^a	Preparation form	Number of use reports	Cultural value (CV)	Use value (UV)
<i>Valeriana officinalis</i> L., odoljen, macina trava, valerijana, <i>Valerianaceae</i> , IPLB55/13, WH	Root	P: 6 (I: anxiety, insomnia)	Infusion Tincture	6	0.00	0.06
<i>Verbascum densiflorum</i> , divizma, <i>Scrophulariaceae</i> , IPLB91/ 14, WH	Flower	R: 2 (I: cough, bronchitis)	Infusion Syrup	2	0.00	0.02
<i>Viola odorata</i> L., divlja ljubičica, <i>Violaceae</i> , IPLB93/13, WH	Leaf	K: 1 (I: heart failure) A: 1 (I: malignant diseases)	Decoction	2	0.00	0.02
<i>Viola tricolor</i> L., dan i noć, <i>Violaceae</i> , IPLB89/14, WH	Herb	A: 1 (I: malignant diseases)	Decoction	1	0.00	0.01
<i>Vitis vinifera</i> L., vinova loza, <i>Vitaceae</i> , IPLB62/14, G	Leaf Fruit	B: 1 (I: cleaning the blood, anemia)	Juice	1	0.00	0.01
<i>Zea mays</i> L., kukuruzna svila, <i>Poaceae</i> , IPLB90/13, G	Stigma	U: 2 (I: urinary complaints)	Infusion	2	0.00	0.02

● Not reported in previously conducted ethnobotanical studies in Serbia (Šavikin et al. 2013; Jarić et al. 2007, 2015; Zlatković et al. 2014)

WH Wild-harvested, G grown in homegardens, B bought in pharmacy

^aMethods of employment: I, internally; E, externally

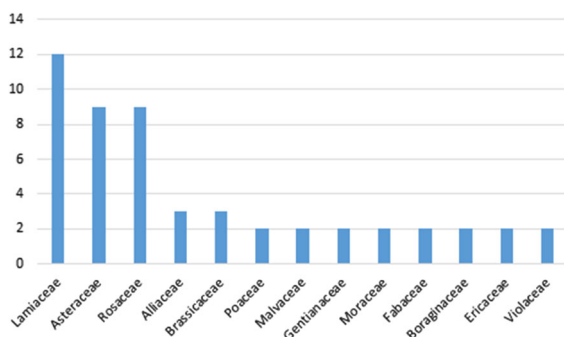


Fig. 2 Plant families with the highest number of recorded species

officinalis. We can conclude that strong correlation exists between these two indices, UV and CV.

According to the WHO (https://www.who.int/nmh/countries/srb_en.pdf), non-communicable diseases

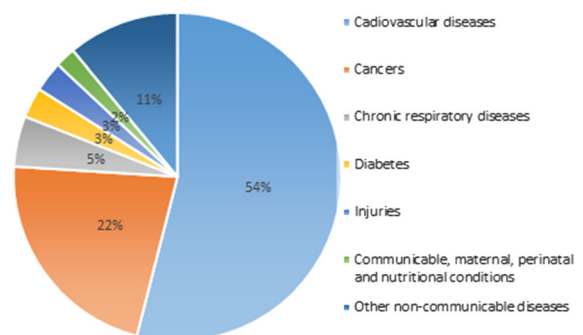
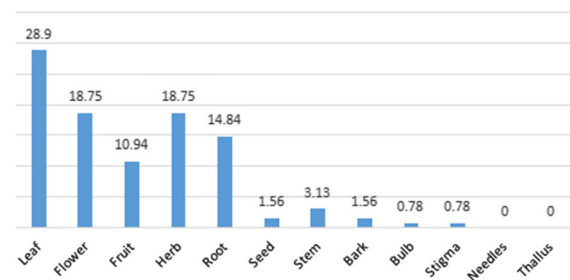


Fig. 3 Proportional mortality in Serbia (% of total deaths, all ages)

are estimated to account for 95% of all deaths in Serbia and leading causes of death are cardiovascular diseases and cancers (Fig. 3). In Jablanica district, the most frequent medicinal uses were recorded for

Table 3 Informants consensus factor (FIC) for different ailment categories (according to International Classification of Primary Care)

Ailment category	Abbreviation	Jablanica district			
		% of use reports	Nt	Nur	FIC
General and unspecified	A	1.4	9	12	0.37
Blood, blood-forming organs and immune mechanism	B	6.9	18	60	0.71
Endocrine/metabolic and nutritional	T	6.4	22	56	0.62
Psychological	P	12.2	16	107	0.86
Neurological	N	0.7	4	6	0.67
Eye	F	0.3	2	3	0.50
Ear	H	0.1	1	1	0.00
Cardiovascular	K	7.3	26	64	0.60
Respiratory	R	21.1	30	184	0.84
Digestive	D	20.7	34	181	0.82
Skin	S	10.4	14	91	0.86
Musculoskeletal	L	2.1	11	18	0.41
Urological	U	7.3	16	64	0.76
Female genital	X	2.1	10	18	0.47
Male genital	Y	0.8	4	7	0.50
Pregnancy, childbearing, family planning	W	0.2	2	2	0.00

**Fig. 4** Plants parts used in traditional treatment of different diseases

treating respiratory diseases, digestive ailments, dermatologic diseases and psychological diseases. FIC values of the category of ailment are presented in Table 3. For the most ailment categories, the level of informants' agreement was high which points out the great uniformity in the use of some plant species to treat diseases. This can be due to a relatively low number of species used in investigated districts (Cavero et al. 2011). One to three different usages were reported for the majority of the plant species (66). The species with most diverse uses were *Taraxacum campyloides*, *Achillea millefolium* and

Rosa canina. These medicinal plant species occupy important place in the Serbian traditional medicine.

The most used plant part was leaf (28.91%) (Fig. 4) and these findings are in accordance with our previous ethnobotanical data collected on the territory of Serbia (Šavikin et al. 2013). One of the reasons of such finding can be their collection convenience. Other parts used in investigated district were: herb, root, flower, fruit, seed, stem, bark, bulb and stigma.

The most of the plant species (74.12%) were used internally, 22.35% of mentioned species were used both internally and externally and 3.53% were applied only externally. Infusion was the major type of internal consumption followed by the use of tincture, decoction, and juice and by eating of fresh plant parts. As for the external application, our informants cited infusions for gargling and rinsing, and also the ointments, oil extracts, tinctures and compresses as well as fresh plant parts used as cataplasm. Also, several medicinal plants were reported to be used for the preparation of syrups and macerates as well as to be used as a spice.

Of all reported species (89), plants were mainly used alone and we have recorded combination of

medicinal plants used to treat one ailment. Namely, *Achillea millefolium* in combination with *Calendula officinalis* was used for thyroid gland disorders.

Informants (103) in Jablanica district confirmed that there was tradition of collecting medicinal plants in their family. Rational and moderate use of medicinal plants in Serbia is guaranteed by special environmental legislation which protects numerous medicinal and aromatic plant species. Some of these plant species are reported to be used by informants in investigated district (*Alchemilla* sp., *Arctostaphylos uva-ursi*, *Betula pendula*, *Gentiana lutea*, *Juniperus communis*, *Satureja* sp. and *Vaccinium myrtillus*) (Jarić et al. 2014).

Comparison with EMA and Ph. Jug. IV

The final herbal monographs for 46 out of 89 reported plant species have been published by European Medicines Agency (EMA) while 15 of 89 cited species are listed in Yugoslav pharmacopoeia (Ph. Jug. IV). Thirty-eight plant species were reported with indications equal, similar or related to the ones listed in EMA monographs, while for the following some different indications have also been reported.

- In Jablanica district *H. perforatum* is primarily used in the treatment of gastrointestinal ailments, skin complaints and depression which is in line with its traditional and well-established use according the EMA monograph (www.ema.eu). It is also used against insomnia, cold and gynecological complaints. The German Commission E has approved the use of *H. perforatum* against anxiety. The use in the treatment of gynecological complaints can be related to anxiolytic effect, since the positive effects on menopausal symptoms of *H. perforatum*, as monotherapy or in combination with *Agnus castus*, have not been shown (Laakmann et al. 2012).
- The majority of informants reported the use of *M. piperita* in the treatment of digestive complaints which corresponds to its traditional use (www.ema.eu). Other uses include respiratory ailments, anxiety, insomnia and headache. According to German Commission E monograph, the *Menthae piperitae aetheroleum* is used against catarrhal diseases of respiratory tract. The scientific data show that leaves and essential oil of *Mentha* sp.

exhibit carminative, tonic, anti-cough, anti-seizure, astringent, analgesic and sedative properties. In Ayurvedic medicine *Mentha* sp. are used to treat headache (Mahboubi 2018).

- *Matricaria chamomilla* is traditional herbal product used in symptomatic treatment of gastrointestinal complaints, cold and ulcers, inflammations and irritations of skin or mucosa (www.ema.eu). In Jablanica district it is dominantly used externally for washing skin and mucosa (e.g. mouthwash, eyewash). One informant reported use against anxiety which can be based on apigenin—flavonoid with anxiolytic and sedative effects (Sharifi et al. 2014).
- Besides being used in treatment of gastrointestinal disorders, menstrual complaints and wounds, as reported in EMA monograph (<https://www.ema.eu>), *A. millefolium* is cited by informants to have positive effects against respiratory ailments, cardiovascular complaints, anxiety and endocrine disorders such as diabetes and thyroid gland disorders (in combination with *C. officinalis*). It is also used in Jablanica district to strengthen immunity. The antidiabetic activity of *A. millefolium* can be explained by anti-hyperglycemic (α -glucosidases inhibition), hypoglycemic (insulin secretion) and potential insulin sensitizer (PPAR γ /GLUT4) actions (Chávez-Silva et al. 2018). Freysdottir et al. (2016) showed that polysaccharide fraction isolated from *A. millefolium* possesses immunoenhancing properties.
- In the investigated district *S. officinalis* is mostly used as antiseptic for mouth and throat wash and as stomachic. These indications are cited in both, EMA and Ph. Jug. IV monographs. One informant reported the use of sage for cleaning the blood and to strengthen immune system.

The species with totally different indications are: *Agrimonia eupatoria*, *Camellia sinensis*, *Gentiana lutea*, *Juglans regia*, *Phaseolus vulgaris*, *Salix purpurea*, *Solidago virgaurea* and *Viola tricolor*. *Agrimonia eupatoria* has traditional use for the symptomatic treatment of mild diarrhea (www.ema.eu), but the main indication reported by 10 out of 14 interviewers was related to kidney stones and sand. *C. sinensis* leaf is used to speed up metabolism, whereas its traditional use is to relief fatigue and sensation of weakness (www.ema.eu). *Juglandinis folium* is

traditional herbal product used for the relief of minor inflammatory conditions of the skin and in excessive perspiration of hands and feet, but none of the cited uses is related to that (www.ema.eu). One interviewer cited the use of *G. lutea*, both internally and externally, in the treatment of vein problems, although *Gentiana radix* is traditionally used for mild dyspeptic/gastrointestinal disorders and/or in temporary loss of appetite (www.ema.eu). *Phaseolus vulgaris* and *Solidago virgaurea* are traditional medical herbal products used to increase the amount of urine—as adjuvant in treatment of minor urinary complaints (www.ema.eu). The cited indications for *S. virgaurea* were diarrhea and stomach disorders, while *P. vulgaris* was used for diabetes. Two informants reported the use of *V. tricolor* in the treatment of malignant diseases.

The following herbal drugs are included in Yugoslav Pharmacopoeia 1984 (Ph. Jug. IV): *Althaeae radix*, *Althaeae folium*, *Uvae-ursi folium*, *Absinthii herba*, *Centaurii herba*, *Gentianae radix*, *Juniperi fructs*, *Chamomillae flos*, *Melissae folium*, *Menthae piperitae folium*, *Petroselini radix*, *Primulae radix*, *Salviae folium*, *Thymi folium*, *Tiliae flos* and *Valerianae radix*. The indications cited for this species are identical or related to indications stated in Yugoslav Pharmacopoeia 1984 (Ph. Jug. IV) with the exception of *G. lutea* which is used as bitter drug (*amara pura*) (Ph. Jug. IV).

Comparison with neighboring areas and scientific data

Four previously published ethnobotanical studies that were conducted on the territory of Republic of Serbia were considered in order to compare traditional plant use in Jablanica district with neighboring areas (Šavikin et al. 2013; Jarić et al. 2007, 2015; Zlatković et al. 2014). This comparison recorded significant level of similarity regarding use of medicinal plant and modes of their application. This can be explained by the fact that compared areas share similar flora, and by the possible exchange of cultural knowledge in the past. Having in mind 89 plant species recorded in Jablanica district, 19 of them are not mentioned in analyzed studies from neighboring areas. Moreover, one of reported species (*Camellia sinensis*) is not characteristic for the Flora of Serbia. Species mentioned in Jablanica district, as well as in neighboring areas are: *Hypericum perforatum*, *Matricaria chamomilla*, *Achillea millefolium*, *Mellisa officinalis*, *Urtica dioica*, *Allium ursinum*, *Althaea officinalis*, *Cichorium intybus*, *Equisetum arvense*, *Plantago major*, *Primula veris*, *Sambucus nigra* and *Sempervivum tectorium*. The similarity find between data from our study and previously conducted studies in surrounding areas is presented in Table 4. Number of cited species per informant in Jablanica district is lower compared to areas of Kopaonik, Suva planina and Rtanj suggesting the disappearance of ethnobotanical knowledge.

Table 4 Comparison between the medicinal plant uses in Jablanica district and those previously recorded in ethnobotanical studies conducted in surrounding regions

Area	Year(s) when the field studies were conducted	Number of study participants	Number of recorded plant species	Number of plant species cited per informant	% of plant species also quoted in Jablanica district
Zlatibor district (Šavikin et al. 2013)	2011	220	69	0.31	62.32
Kopaonik (Jarić et al. 2007)	2002–2005	60	83	1.38	50.60
Suva planina (Jarić et al. 2015)	2012–2014	66	128	1.94	41.41
Rtanj (Zlatković et al. 2014)	2011–2012	37	45	1.27	40.00
Jablanica district	2015	101	89	0.88	–

Collected data were also compared with regional, national and global uses of medicinal plants aimed to highlight new or rare uses of medicinal plants. Most of the recorded species are traditionally well known, but after comparison with PDR for Herbal Medicine some of them were found to have new uses. Few examples are presented below:

- *Artemisia absinthium* is well known digestive stimulant. The decoction of *Artemisia absinthium* leaves is used in Jablanica district in the treatment of headaches. In folk tradition of Eastern Serbia this plant is also used for making the amulet for curing migraine (Dajić-Stevanović et al. 2014). The results of some studies support this kind of traditional usage. Namely, prostaglandin E₂ has been detected as a significant contributor in the pathogenesis of migraine (Antonova et al. 2013). According to previous study, 5,6,3',5'-tetramethoxy 7,4'-hydroxyflavone, a flavonoid isolated from the aerial parts of *A. absinthium* significantly inhibited PGE₂ activity in LPS-stimulated macrophages (Lee et al. 2004).
- Previous studies have showed that supplementation with natural antioxidants decrease bone loss induced by oxidative stress. These results present a good support for the traditional use of rose hips (*Rosa canina*) in the osteoporosis treatment in Jablanica district. Marmol et al. (2017) have suggested that due to a similar phytochemical profile to blueberries (*Vaccinium myrtillus* L.), rose hips can reduce the damage caused by an excess of ROS in bone tissue and play an important role in osteoporosis prevention (Marmol et al. 2017).
- Although the antidiabetic activities of *Morus alba* L. are well known, in Jablanica district *M. nigra* leaves are used in treatment of diabetes mellitus. Such application was also recorded in other parts of Serbia. Namely, professor Tucakov wrote down that the leaf of black mulberry was used among the people for treatment of diseases of urinary tract as well as diabetes (Tucakov 1997). Araujo et al. (2015) confirmed the potential of *M. nigra* in prevention and treatment of this chronic disease. Namely, according to this group of authors leaf extract of *M. nigra* significantly improved oxidative stress and complications in diabetic female Fischer rats after 30 days treatment. It decreased

the matrix metalloproteinase (MMP)-2 activity, increased insulinemia, and alleviated hyperglycemia-induced diabetes.

- According to belief of old Serbs *Ocimum basilicum* has “properties to relieve cramps and calms nerves, as well as to free from gloomy thoughts and elevates the spirit” (Tucakov 1997). In Jablanica district basil is used in the treatment of menstrual complaints such as menstrual cramps. Venancio et al. (2011) confirmed central and peripheral antinociceptive effects of basil essential oil in Swiss mice. In the acetic acid-induced writhing test basil essential oil was effective in reducing the abdominal contractions (48–78%) at all doses (50–200 mg/kg body weight). In the hot-plate test, this oil significantly increased the latency at 50 mg/kg body weight. In the formalin test, it significantly reduced paw licking time in the first (38%) and second (75%) phases of pain at 200 mg/kg body weight. These effects are related to the inhibition of pain mediators' prostaglandins and prostacyclins, and the ability of basil essential oil to interact with opioid receptors (Venancio et al. 2011).
- Juice of *Sempervivum tectorum* has been reported in earache treatment which has also been previously reported for other regions in Serbia (Šavikin et al. 2013; Jarić et al. 2007). Stojkovic et al. (2015) reported that the juice of *S. tectorum* possesses antimicrobial activity towards few clinical isolates of bacteria linked to otitis. Antimicrobial activity was tested on *Proteus mirabilis*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* isolated from ear swabs of the patients suffering from the ear pain. In the same study quorum sensing functions in *Pseudomonas aeruginosa* were effectively controlled with *S. tectorum* leaf juice.

Conclusion

In the scope of the present study 89 plant species belonging to 49 families were reported in Jablanica district to have ethnomedicinal use in treating different health issues. *Lamiaceae*, and *Asteraceae* were the most cited families while the most reported diseases were respiratory, gastrointestinal, dermatologic and psychological problems. The species most used are

Hypericum perforatum, *Mentha piperita* and *Matricaria chamomilla*. Thirty-eight plant species were reported with indications equal, similar or related to the ones listed in European Medicines Agency (EMA) monographs, while 8 species had completely different indications. When compared to other studies carried out in neighboring regions, information obtained during this study has shown lower number of used medicinal plant species. Although, self-medication is popular among inhabitants in Jablanica district as well as simultaneous use of herbs together with conventional drug therapy, the knowledge of medicinal plants uses lasts mostly as a cultural heritage of aging people, and is likely to disappear in a short time. Due to this, our current study contains useful data which can contribute to the preservation of ethnobotanical knowledge in South-Eastern Serbia.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human rights This research involved human participants who gave a verbal informed consent prior to the interview.

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