

CZECH UNIVERSITY OF LIFE SCIENCE PRAGUE

Faculty of Tropical AgriSciences



Czech University of Life Sciences Prague

**Faculty of Tropical
AgriSciences**

Ethnobotanical inventory of medicinal plants used in

Central Serbia

Bachelor thesis

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Agriculture in Tropics and Subtropics

Thesis title

Ethnobotanical inventory of medicinal plants used in Central Serbia

Objectives of thesis

The aim of the bachelor thesis will be the inventory of medicinal plants used in traditional medicine in Central Serbia, more specifically in the region of Rtanj, Kopaonik and Rudnik.

Methodology

The information will be acquired in the form of a questionnaire from local people and subsequently processed in a table form. In the first survey, questions will focus on local names of medicinal plants, plant parts, which are used for treating diseases, methods of use and dosage. The second questionnaire will focus primarily on demographic data like the place of residence, age, profession and personal opinion of the current traditional medicine.

The proposed extent of the thesis

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Keywords

Balkanpeninsula, Ethnobotany, Indigenousknowledge, Medicinalplants, Serbia, Traditionalmedicine.

Recommended information sources

DUKE, J.A. *CRC handbook of medicinal herbs*. Boca Raton, Fla.: CRC Press, 1985. ISBN 0849336309. Medicinal herbs.(Edition Health).Lekovito bilje.(Biblioteka zdravlja).Lilić,J.,Beograd(Serbia),Logos ART.2009
Medicinalplantresourceforanimalsandhumanhealth/lekovitobiljeresurszdravljaživotinja i ljudi.Zaječar (Serbia),Fakultet za menadžment,2011

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Declaration

I declare that I have worked on my bachelor thesis titled "Name of the bachelor thesis" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 18th April 2019

Vuk Antić

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Abstract

Traditional medicine is defined as the set of traditional knowledge about the uses of plants, practices, treatments and methods shared within the human societies in order to improve the health of its inhabitants. This traditional knowledge has been reduced due to the modern medicine and kept in the most rural areas of Serbia.

Ethnobotanical and sociodemographical data was collected using 100 interviews to the studied area inhabitants between 20 and 61 years old. A 64% of the studied population were women and 36% were men.

The results show that 60 plant species belonging to 23 families are used for medicinal purposes in Central Serbia. The most used families of plants are Asteraceae (12 species, 20%); and Lamiaceae (11 species, 18.33%). Those species are used the most for skin diseases, digestive tract diseases and respiratory diseases. According to the index "MUV", the most used species are *Mentha spicata* and *Ocimum basilicum* (6.66%), *Saturea montana* (5.55%) and *Hypericum perforatum* (5.26%). Regarding the most used parts of the plant, the most popular are the leaves (31.25%) and flowers (21.43%). Medicinal herbs are mostly used in form of infusion (51.38%) and tincture (12.84 %). There is also a consumption as spices (9.17%). The oldest people in the villages still keep the knowledge on the less and less frequent medicinal use of plants. Younger people can hardly identify the traditional uses of them.

That is why the conservation of this traditional knowledge of the plants' applications can be considered important in order to not to lose the valuable heritage that our predecessors left for the future generations.

Key words: *Asteraceae*, Balkan Peninsula, *Hypericum perforatum*, *Saturea montana*, traditional medicine.

Abstrakt

Tradiční medicína je definována jako soubor tradičních znalostí o používání rostlin, zkušeností a metod léčby sdílený v lidské společnosti v rámci zlepšování zdraví obyvatel. Tyto tradiční znalosti byly redukovány důsledkem moderní medicíny a udržely se ve venkovských oblastech Srbska.

Etnobotanická a sociodemografická data ve zkoumaných oblastech byla sbírána za použití 100 rozhovorů s obyvateli ve věku mezi 20 až 60 lety. 64% z dotazovaných byly ženy a 36% muži.

Výsledek ukázal, že v Srbsku je 60 rostlinných druhů náležících do 23 rodů používáno k léčebným účelům. Nejužívanější rostlinným rodem jsou Asteraceae (12 druhů, 20%) a Lamiaceae (11 druhů, 18,33%). Tyto druhy jsou nejčastěji užívány na kožní choroby, choroby zažívacího traktu a choroby cest dýchacích. Dle „MUV“ indexu nejužívanější druhy jsou *Menta spicata* a *Ocimum basilicum* (6,66%), *Saturea montana* (5,55%) a *Hypericum perforatum* (5,26%). Co se týče nepoužívanější části rostlin, nepoužívanější jsou listy (31,25%) a květy (21,43%). Léčivé rostliny jsou nejčastěji používány ve formě odvaru (51,38%) a tinktury (12,84%). Je zde také spotřeba dle druhu (9,17%). Nejstarší lidé ve vesnicích doposud udržují vědomosti o stále méně a méně častém využívání léčivých rostlin. Mladší lidé stěží dokáží identifikovat jejich tradiční použití.

To je důvod, proč by měly být tradiční vědomosti užívání léčivých rostlin považovány za důležité, aby nedošlo ke ztrátě cenného dědictví, které předci zanechali budoucím generacím.

Klíčová slova: Asteraceae, Balkánský poloostrov, *Hypericum perforatum*, *Saturea montana*, tradiční medicína.

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1.Introduction

Ethnobotany is the science that establishes the relationship between the study of the plants, their applications to the human needs and the cultural knowledge and heritage about their use by the different human societies.

The World Health Organization estimated that between 65% and 80% of the population of developing countries use mostly medicinal plants for their primary health care needs. Also, modern medicines still have at least 25% derived from plants and compounds from plants (Oyebode et al. 2016).

Ethnobotany demonstrates a strong connection between medicinal herbs and people, and their everyday lifestyle. This connection is especially present in the Southeastern region of Europe, like in Serbia, which is located in the Balkan Peninsula and it has been under the influence of multiple civilizations and cultures.

Most of the population of the Balkan Peninsula lived primarily in villages and rural areas, and most of the people used medicinal herbs as different treatments and remedies for health problems. There was an excellent knowledge of those medicinal herbs.

Jarić already mentioned in 2013 a statement from Sarić, written in 1989, where it was proven the existence of more than 700 species of plants in Serbia that can be used as medicinal herbs (Jarić 2013). There are 420 of those medicinal species officially registered, and about 270 are available to buy (Kišgeci et al. 2000).

Even though in the actual times the use of medical herbs has been reduced in favor of the modern and more efficient drugs, there is still a tradition on their use mainly in the villages, thanks to the eldest people who keep orally the knowledge about the herbs applications as well as the new alternative trends between the youngest generations that seek for more natural remedies to reduce the use of industrial medicines for different reasons like personal beliefs and concerns about ecology and the environmental preservation. Serbia has a big potential to produce medicinal plants due to its richness but it has a lack of modern technology for the collection and cultivation of them (Stevanovic 2011).

The World Health Organization states that the demand for medicinal plants is increasing in developing and developed countries, and most traded materials come still from wild harvested sources on forest lands and only a very small number of species are cultivated. The expanding trade in medicinal plants has serious impact on the survival of several plant species, some of them threatened to become extinct (WHO 2013).

The study is focused specifically in the region of Central Serbia. This is the best example of the botanical local traditions conservation in the rural areas of Serbia, those are the municipalities of Rtanj (East of Serbia), Kopaonik and Rudnik (Central Serbia).

The local traditional remedies for health problems and even the use of plants for the local gastronomy keeps the study of the ethnobotany alive in this region of Europe. This traditional knowledge has been reduced to the eldest people that keep it thanks to the oral tradition. The increase of the migration of the younger population to the cities will make it more difficult to be kept as there is a lack of interest between the younger generations. However, by contrast to the general trend, there are economic initiatives and programs devoted to rural development which are based on medicinal plants (Quave et al. 2012).

2. Aim of the thesis

The main aim of this study is to elaborate an inventory of medicinal plants used in Serbia, more specifically in the central regions of Rtanj, Kopaonik and Rudnik. The aim of the inventory has been based in the next questions:

- I. Is there a direct relationship between the use of medicinal plants and the residence, age and gender of the users?
- II. What are the main methods of consumption of medicinal plants by the interviewed and for what kind of health problems?
- III. The research results are showing a general pattern of use of medicinal plants, not only in the studied area but also in the Balkan region?

3. Literature review

3.1 Serbia

Serbia is a country which is situated in Southeastern Europe in Central Balkan Peninsula having a location $41^{\circ} 52'$ and $42^{\circ} 11'$ north longitude and $18^{\circ} 06'$ $23^{\circ} 01'$ east longitude. Serbia shares border with Hungary in the north, in the east with Romania and Bulgaria, in the West with Croatia and Bosnia, and in the South it is connected with Montenegro, Albania and Republic of Northern Macedonia.

The total area of Serbia is $88,499 \text{ km}^2$ (Including Kosovo and Metohija). The largest border Republic of Serbia is shared with her Eastern neighbor Romania (547.9 km) and the shortest border is with Albania (111 km) (Ministry of Foreign Affairs of the Republic of Serbia 2009).

In spite of the fact that it is landlocked country, there is an easy access to the Adriatic Sea through Montenegro.

The climate of Serbia is moderate-continental, with the influence of the continental climate in the North of the country and with a strong influence from the Adriatic Sea. The most significant geographic factors together with comprehensive situations that are important for Serbia's climate and weather are among others: The Alps, Mediterranean Sea and Genoa Bay, Pannonian Plain and the Morava valley, Carpathian and Rhodope Mountains as well as hilly – mountainous areas with valleys and highland meadows (Smailagić et al. 2013).

In terms of land use, the total agriculture area of Serbia is 5,718,599 ha and from this extension 4,674,622 ha are arable surface, then 1,006,473 are pastures and 37,504 are fishponds and ponds (Serbian Government 2011).

3.1.1. Demographics

According to the Statistics Institute of the Republic of Serbia (stat.gov.rs), the population of Serbia in 2017 is 7,020,858 people, being the 140th most populated State in the world (Excluding the Province of Kosovo i Metohia). A 51.3% of the population are women (3,601,043), and the 48.7% (3,419,815) are men, according to the statistics of 2017.

Within Serbia, there is a rich amount of different cultural and ethnical groups with specific traditions and religious differences.

A 83.3% of the population in Serbia define themselves as Serbs (5,988,093), but there are 20 ethnic communities inhabiting the national territory as well. The second ethnic population is the Hungarians as the 3.53% (253,899). The next ethnic group are Roma with 2.5% (147,604). They are followed by Bosniacs 2.02% (145,278) and Croats 0.81% (57,900).

There are other minorities like Slovaks, Montenegrins, Macedonians, Vlachs, Gorans, Romanians, Albanians, Bulgarians, Bunjevci, Yugoslavs, Germans, Ukranians, Slovenes, Ashkali, Italians, Czechs, Aromanians, Greeks and Panonian Rusyns as the most important (Statistics Office of the Republic of Serbia 2011)

In the studied areas as Rtanj, Kopaonik and Rudnik, the majority of the population is considered ethnically Serbian orthodox. However, as Rtanj is in the municipal term of Boljevac, a 25.26% of the municipal population are Vlachs (population who was original from the Roman province of Tracia and keep their traditions until noaways) (Census of Population, Households and Dwellings in the Republic of Serbia 2011). In Rudnik and Kopaonik, practically all the population is considered as Serbs.

3.2. Ethnobotany

Following the definition of the ethnobotanist Kuipers, Ethnobotany is the field that studies the interaction between people and plants, mainly focused on the interaction within the traditional tribes and well defined ethnic cultures (Kuipers 2016). Also, Ethnobotany is closely related to natural medicine whose uses focus on healing practices for humans and even animals (Hong et al. 2015).

Also, as the traditional medicine is linked to traditional societies, its use is more predominant in developing countries and low economy standard communities as its obtention and use is cheaper than the modern drugs, and the modern medicine is very restricted (Awoyemi et al. 2012). To have an idea, according to the World Health Organization (WHO), around 65% to 80% of the population in developing countries depend on the use of medicinal plants as first health remedies.

Ethnobotanists try to document, describe and explain the complex relationship between human beings, culture and plants, focusing on the use of plants in human society (food and medicine, cosmetics, natural color production, textiles, construction materials, tools, currency, and rituals of social lifestyle) (Acharya et al. 2008).

A strong relation between biotechnology and ethnobotany has been found on research with pistacia plant (Goldhirish 2009).

Ethnobotany has its role in some specific infection diseases like is AIDS in Mozambique, in solving some opportunistic infections related with this virus infection, like diarrhea, different skin problems and pneumonia (Banderia et al. 2011).

Ethnopharmacology can be defined as a research of new and rare plant species for advancements in phytomedicine. Besides that, ethnomedicine and ethnopharmacology includes beliefs, ideas and practice by ethnic groups, village people and races in order to prevent, reduce and cure illnesses or pain. Additionally, any details on these branches of sciences can give us insight into medicinal uses of any plants which are locally accessible (Diksha et al. 2011). The main duty of ethnobotanists is the preservation of information for the future generations in these communities. Ethnobotanical study is supported by six disciplines: Botany, Ethnopharmacology, Anthropology, Ecology, Economics and Linguistics (Martin 1995).

3.3. Medicinal ethnobotany

The Chilandar Medical Codex (CMC) is the biggest reference for medicinal use of plants in Serbia. Its importance comes from the clear comprehension of the manuscript and reference for the pharmacology knowledge in the 14th century in the Balkans. It has been considered as one of the most significant documents about medicinal botany used in Europe until the 18th century.

The Chilandar Medical Codex was found in 1951 in the library at Chilandar Monastery on Mount Athos, in Greece. Nowadays, it is still conserved there and its author is still unknown, that is why it is considered that there might be more than one author of the manuscript.

Since medieval times and up to 13th and 14th centuries, the pharmacological and botanical knowledge in the territory of Serbia was very restricted, so there was not a general access to it. Since the arrival of the Turks, they buildt hospitals, however they did not allow the Christian Serbs to access to them. For this reason, the Christian hospitals were buildt in the monasteries, so the monks were the experts in medicinal uses of plants (Bošković 1962). That is why, as the monks were in charge of manuscripts translations like the CMC, their role on curing people was essential until the arrival of the modern medicine, thanks to the Italian doctors working in Serbia, more specifically in Kotor (currently Montenegro), so they had a very important role in spreading the modern Western medicine knowledge in Serbia (Kovijanić 1954; Kovijanić et al. 1957).

3.4. Traditional Medicine

The traditional medicine from medieval times, as before stated, was kept in Christian monasteries due to the historical context of the Balkan Peninsula. However, this does not mean that the villagers were completely isolated about the use of plants for healing illnesses or curing other kind of health problems. The use of plants for

medical purposes has been also mixed with magical beliefs. Mostly in the Eastern region of Serbia there is an ethnic group, the Aromanians or Vlachs (Jović 2011: 3; Ružica 2006: 2), who still keep traditional medical methods based in plants and connected with a set of beliefs in white and black magic.

A Serbian ethnologist called Mirko Barjaktarević did a great contribution of the knowledge of the traditional medicine and its uses for these beliefs in magical cures and the study of magic in general in Serbia.

There is also another of the most important ethnical minorities in Serbia, the Vlachs, whose culture is also related to the use of plants on traditional medicine and mystical beliefs. It is very characteristic the figure of the shamans, who are the experts in the use of the “magical” plants for the treatment and healing of different diseases (Ivkov-Džigurski et al. 2012).

The most used “magical” plant by the Vlach shamans is the *Thymus serpyllum*, that was mainly applied to the young girls on their menarche, that mitigated the pain of their first menstruation. The *Thymus serpyllum* is consumed as an infusion that must be drunk by the patient and later, it is needed to wash all her body with the same infusion (Jojić 2009).

4. Methodology

4.1. Study area

The ethnobotanic study was focused in the Serbian municipalities of Rtanj, Kopaonik and Rudnik. Rtanj and Kopaonik are situated in the Central-Souther part of Central Serbia, and Rudnik in the Central-East. A latitude of 43° 46'34" North, 21° 53'36" East for Rtanj; 43°16'09" North, 20°49'21" East for Kopaonik; and 44°07'53" North, 21°32'25" East for Rudnik (Figure 1).

Rtanj belongs to the known Rtanj mountains which are well known for their medicinal flora. The Rtanj mountains are part of the Carpatian mountains (Jovanović et al. 2006).

However, Kopaonik is part of the largest mountains range in Serbia that belong to the Dinaric range from Northwest to Southeast of the country with a length of 75 km. The total extension of the region is about 2.750 km² (Bursać 1991).

In the other side, Rudnik mountains are settled in the Center-East of Serbia (Figure 3). Rudnik is well known mainly for its mines rich in Anthimony, Copper, Gold, Silver, Bismuth and Wolframium.

Regarding the climate classification, each of the three locations have a similar climate but having specific local characteristics. The region around Rtanj is considered part of the continental climate with Mediterranean influence. The temperatures range from the coldest as -3°C in winter and not more than 22°C in summer (Rakićević 1980). This temperate climatology and the limestone substrate allows the existence of an interesting variety of plants and flora in the area.

Kopaonik, as the largest mountainous region in Serbia, its climate is considered also continental, but it is very characteristic that its climate is marked by more than 200 sunny days per year, making it one of the sunniest regions in Europe (Živković et al. 2017). The maximum temperature measured has been of 30°C in July 24, 2017, and the minimum temperature was registered on January 25, 1954 with -26.6°C. (Love Kopaonik, Official Kopaonik Tourism Webpage 2019).

On the other side, Rudnik, located in the Šumadija region, has a humid continental climate, having a microclima focused in diverse zones of Rudnik (Marković 1970). Within Šumadija region, Rudnik is the most humid part having an average of 907mm/m³ of rainfalls per year (Brković 2017).

The average yearly temperature in Rudnik ranges between 9.5°C and 11.3°C. The maximum temperatures in summer are around 20°C and the minimum in winter, around -2.1°C. Then, the clima from the Rudnik region is template (Marković 1970).

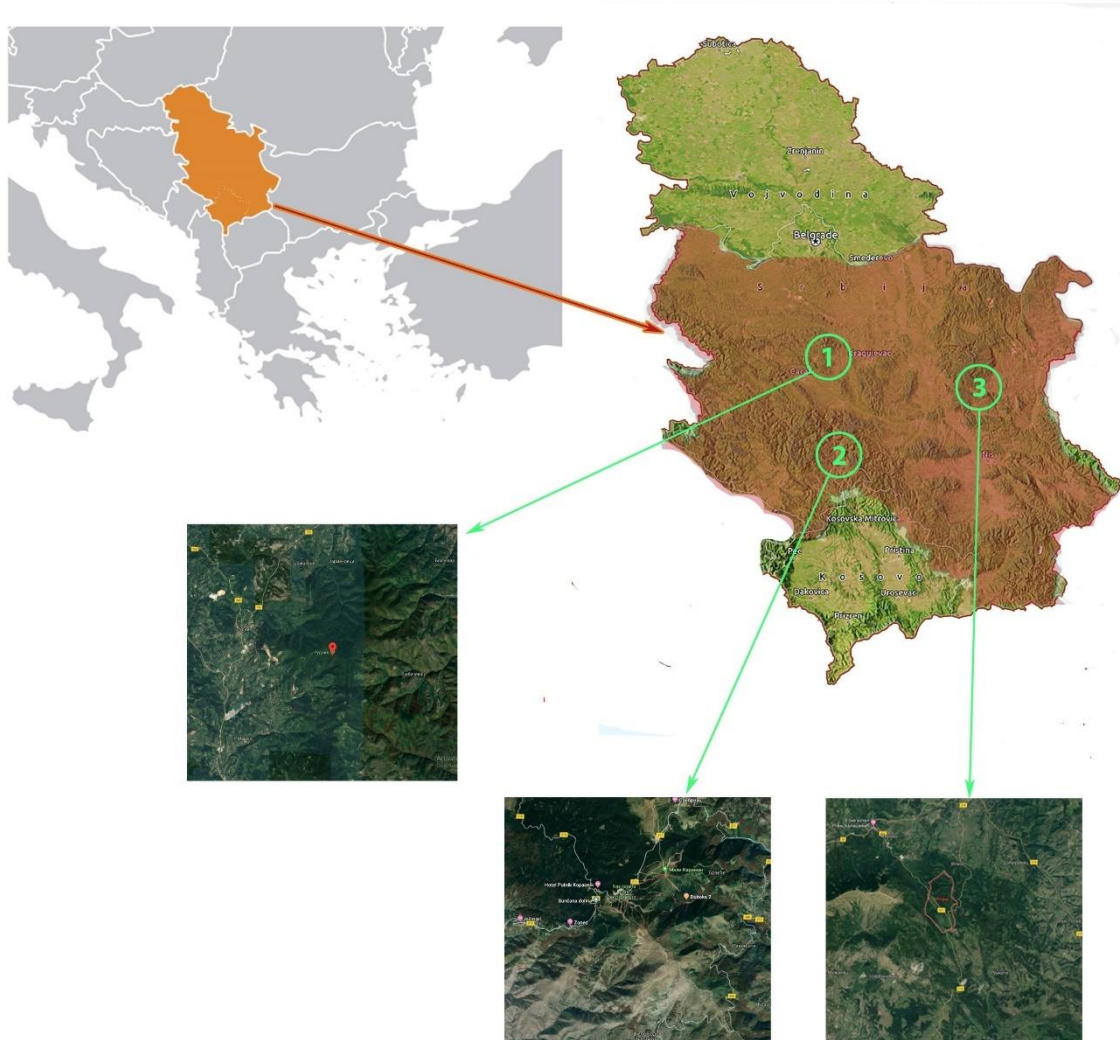


Figure 1: Map of study area

Map of Serbia located in Balkan peninsula with highlighted central Serbia where the research was realized: 1. Rudnik; 2. Kopaonik; 3. Rtanj

4.2. Data collection

In order to obtain the data for this ethnobotanical study, there were 100 people who gave the consent to be interviewed about the use of plants on their daily life. The study was carried out between August and September 2017 in collaboration with the Faculty of Agronomy of the University of Kragujevac, settled in Čačak. Our purpose was not only to know who were using the medicinal plants but also to know the average age of the most frequent users. As well as establish a comparison between the inhabitants from the cities and from the rural areas.

The interviews were done in Serbian language and the questions were semi-open (Attachment 1: Questionnaire) in order to let the responders to tell us whether they use medicinal plants for health reasons, if they know the common name of the plant, and even the scientific name in case they know it. Also, they were asked about the exact use of the plants, the frequency of use, how they prepare and consume them, and where they obtain them, in pharmacies, herbal markets or they are collected from the nature.

In order to establish the comparisons, they were asked also for their gender, age, and if they live in a rural or urban area.

In Rtanj region, there were 36 people interviewed. A 44.4% were men and 55.6% were women.

This study was taken in the next villages that belong to the Rtanj area: Krivi Vir (10 people), Kriva Reka (10 people), Jablanica (6 people), Rtanj (10 people) (Figure 4).

Regarding Kopaonic, there were 26 people who were interviewed. A 73% of them were women and a 27% were men. The visited villages of the region around Kopaonik were Ravnište (5 people), Brzeće (6 people), Badanj (5 people) and Kopaonik (10 people) (Figure 2).

In Rudnik, and Šumadijan area that belongs to Rudnik, there were 38 interviewed people. A 63.16% were women and a 36.84% were men. The study was carried out in the next villages: Cerovac (15 people), Čumić (5 people), Dobrača (2 people), Vračevšnica (2 people), Rudnik (4 people), Ljuljaci (3 people) and Kragujevac (5 people).

In the area around Rudnik, it was found that the use of medicinal plants was more frequent than in the rest of studied areas (Figure 5). This region, called Šumadija, is very rich

on monasteries that even nowadays keep the traditional knowledge about botanic applications to the health. Concretely, the Vračevšnica Monastery is well known in the area because they produce their own natural balms, made mainly by the Orthodox nuns from *Calendula officinalis*, *Symphytum officinale*, *Hypericum perforatum* for diverse uses on the skin like skin burn healing and other kind of wounds that affect the epidermis.

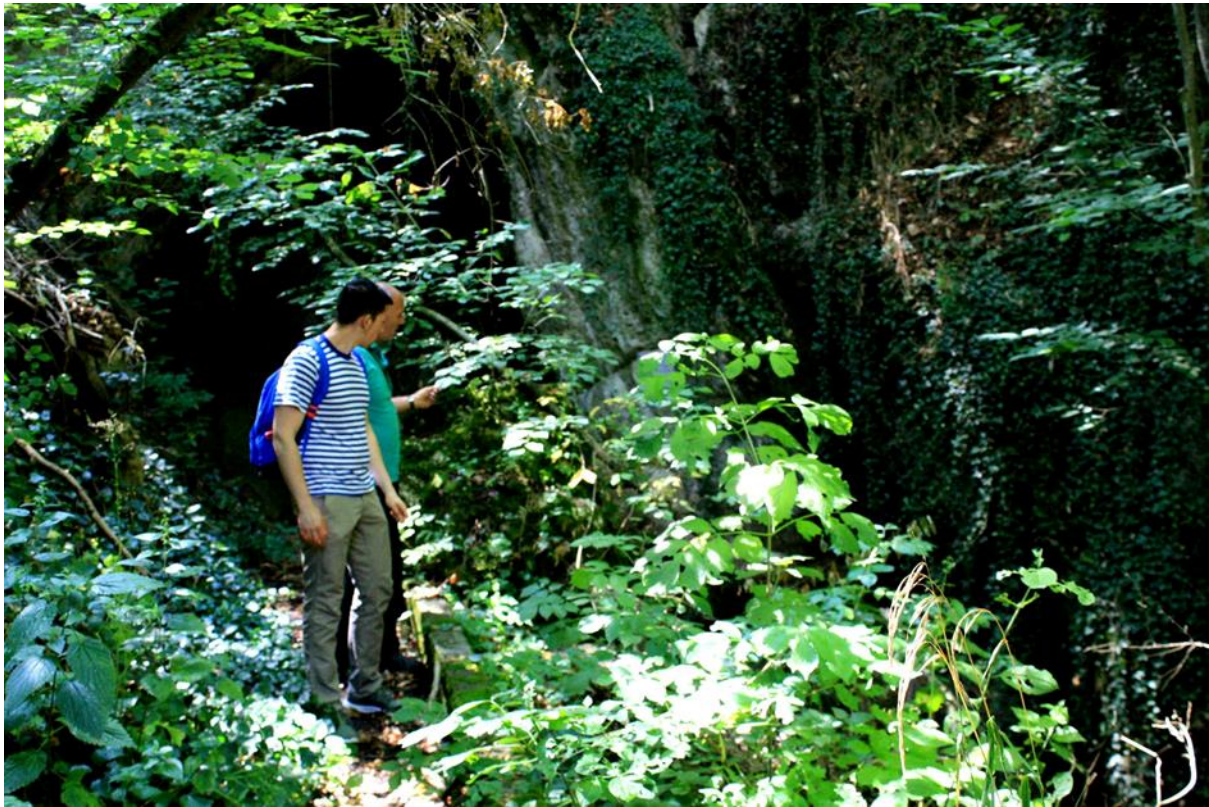


Figure 2: Data collection in Kopaonik (Central Serbia)



Figure 3: Professor Brković and data collection in Rtanj mountain (Central Serbia)



Figure 4: Local healer showing his plants collection in Rtanj region

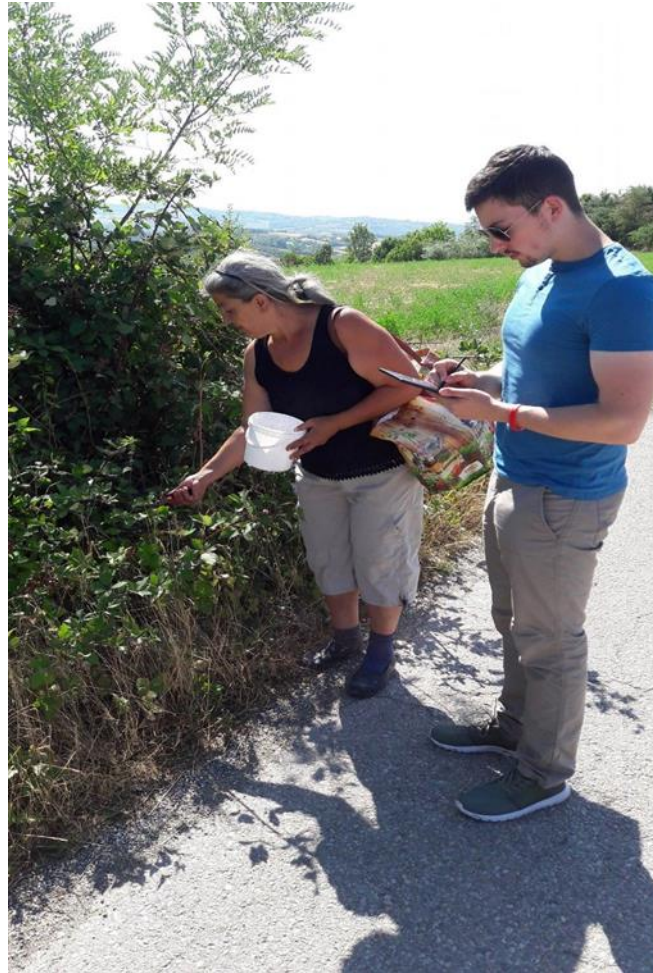


Figure 5: Woman from Rudnik region responds to interview questions

4.3. Data analysis

The obtained data about medicinal plants was analyzed in a table and following five quantitative ethnobotanical indices: UR (Use Report), FC (Frequency of Citation), RFC (Relative Frequency of Citation), MUV (Medicinal Use Value) and FL (Fidelity Level). The use of those indicators has been reflected from their use on the research of (Bibi et al. 2015). The analysed data is presented in Table 1.

4.3.1. Use Report (UR)

The UR refers to the number of different uses a medicinal plant has. It helps to determine which plants have more different uses and diverse applications.

4.3.2. Frequency of Citation (FC) and Relative Frequency of Citation (RFC)

The Frequency of Citation represents the number of informants that mention a specific plant species.

Then, the Relative Frequency of Citation takes the factor of the total number of informants in the survey, so it will let us know the most mentioned species by the informants. The value on the result will be in a range from 0 to 1 following the next formula:

$$\text{RFC} = \text{FC}/\text{N} \quad (0 < \text{RFC} < 1)$$

This calculation was used following the formula that was proposed by (Vitalini et al. 2013).

4.3.3. Medicinal Use Value (MUV)

This formula comes from the index of Use Value (UV) that shows the relative importance of the species known by the informants. The use value does not make distinction of the diversity of uses of specific species (Šavikin et. al. 2013).

When applying to medicinal plants, Medicinal Use Value is obtained, that demonstrate the relative importance of the different species for medicinal purposes.

Following the path used by (Tardío et al. 2008), the Use Value is calculated through the next formula:

$$\text{UV} = \sum \text{U}/\text{N}$$

In this formula, the U means the number of uses a specific informant gives for a specific plant, and N the total number of informants interviewed. So, applied to medicinal uses, it will be obtained the formula for MUV.

$$\text{MUV} = \sum \text{MU}/\text{N}$$

The definitive MUV formula will collect the sum of the total number of medicinal uses per informant per plant species divided between the total of interviewed informants. This will give us a concrete perspective of what species have more relative importance for the informants for medicinal purposes.

4.3.4. Fidelity Level (FL)

The Fidelity Level, following the research of (Bibi et al. 2015), allows us to know which plant species are more used or preferred for the treatment of a specific illness or ailment, as it is very common to use various species for the same treatment, and most of them commonly belongs to the same category due to their botanical similarities and properties.

The formula for the Fidelity Level will shows, in a percentage value, the frequency of use of a specific plant for treating a category of ailment described by the informants. Here is the formula:

$$\text{FL}(\%) = (\text{Ip}/\text{Iu}) * 100$$

Ip indicates the total number of interviewed informants who mentioned the use of a specific specie for the same category of ailment. However, **Iu** is the total number of informants who pointed at the specific plant species for any ailment treatments.

5. Results

5.1. Socio-economic data

The data was collected from 100 informants (63% of them were women and 37% men). When dividing by region: In Rtanj region, a 44.4% were men and 55.6% were women. In Kopaonik, a 73% of them were women and a 27% were men. In Rudnik, a 63.16% were women and a 36.84% were men.

Regarding the ages of the total population, the most part of the interviewed population ranged ages between 41 and 60 years old, a 34% of the interviewed. It is followed very close by the population that is older than 60 years old with a 33% of the total interviewed. The rest of the interviewed, a 22% had ages between 31 and 40 years old and a 11% was under 30 years old. No one was less than 18 years old.

When talking about the local economies of the studied areas, they are divided in the studied regions districts: In the area of Rudnik, and mainly its administrative district, Šumadija, great part of their activity is industrial and focused precisely in the automotive industry, but also it has an important agricultural activity (cereals, fruits, viticulture and vegetable farming) and also livestock (Sumadijski Okrug 2011).

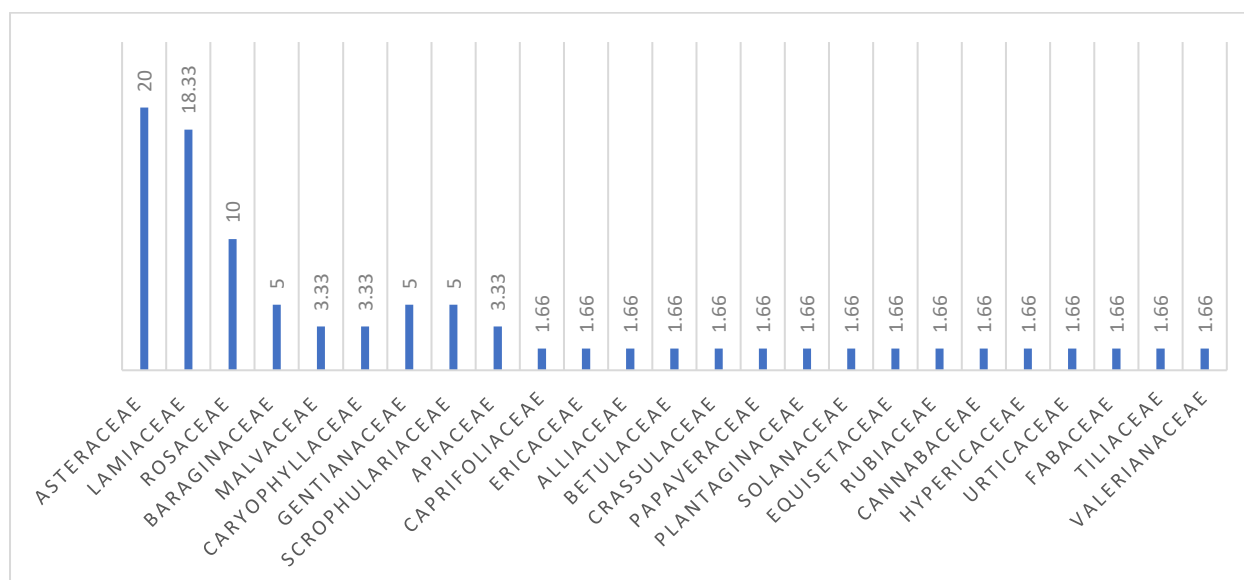
In Kopaonik, and more precisely in the Raška district, the biggest economic activities are mining (extraction of magnesium, asbestos, lead, zinc), tourism, agriculture and livestock (Raski Okrug, 2013; Raska.gov.rs 2011).

In Rtanj and in its administrative district, Zaječar, the biggest economy is agriculture, but also metal processing industry takes an important part (Zajecar.info 2019).

5.2. Diversity of medicinal plants

The study has been taken over 60 different medicinal plant species belonging to 23 families collected in the Central Serbian region, more specifically in Rtanj, Kopaonik and Rudnik. The distribution of the species on the monitored plants families is: Asteraceae (20%), Lamiaceae (18.33%), Rosaceae (10%), Baraginaceae (5%), Gentianaceae (5%), Malvaceae

(3.33%), Caryophyllaceae (3.33%), Scrophulariaceae (5%), Apiaceae (3.33%), Ericaceae (1.66%), Alliaceae (1.66%), Betulaceae (1.66%), Caprifoliaceae (1.66%), Crassulaceae (1.66%), Papaveraceae (1.66%), Plantaginaceae (1.66%), Solanaceae (1.66%), Equisetaceae (1.66%), Rubiaceae (1.66%), Cannabaceae (1.66%), Hypericaceae (1.66%), Urticaceae (1.66%), Fabaceae (1.66%), Tiliaceae (1.66%), Valerianaceae (1.66%) (Graph 1).



Graph 1: Medicinal family plants that are used in Central Serbia (In percentage %)

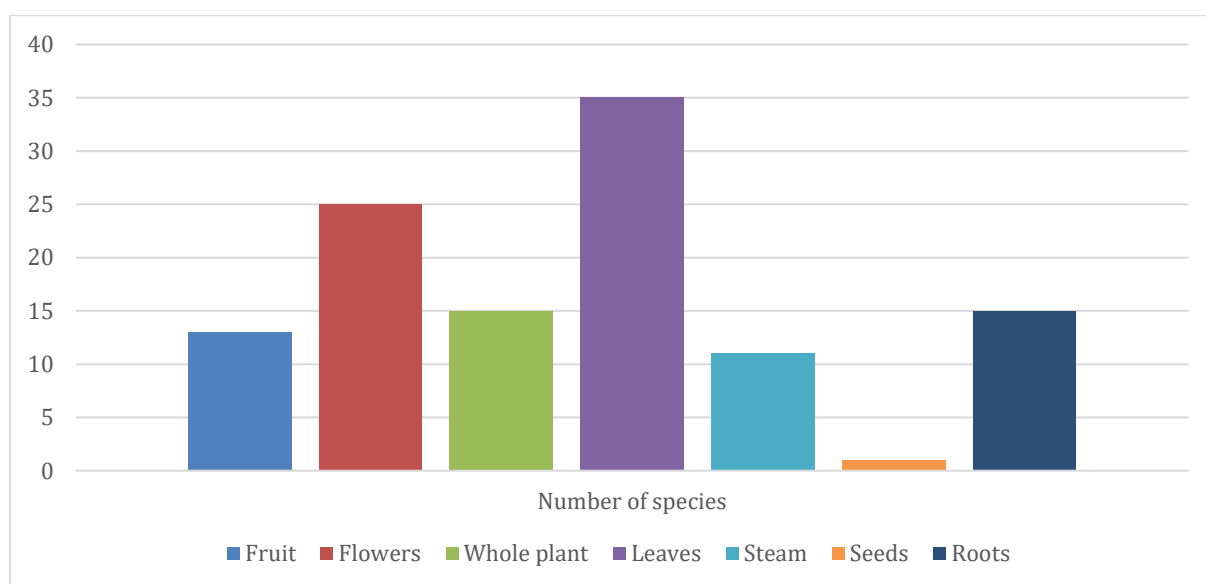
The most predominant plants family is Asteraceae, where a total amount of 12 species were mentioned and collected. The second family is Lamiaceae with 11 species and the third most popular is Rosaceae with 6 species (Graph 1). According to the Use Report (UR) Index, the specie with higher value is *Rubus idaeus*, from Rosaceae category, having a UR= 6. *Achillea clypeolata* and *Achillea millefolium* (Asteraceae) have a value of UR=5. *Verbascum phlomoides* (Solanaceae), *Allium arsinum* (Alliaceae), *Malva sylvestris* (Malvaceae), *Matricaria chamomilla* and *Cichorium intybus* (Asteraceae), *Agrimonia eupatoria* (Rosaceae), *Plantago major* (Plantaginaceae) have all of them a value UR=4.

The specie *Rubus idaeus*, commonly known as raspberry is one of the most common plants with more uses in all Serbia being an important product on Serbian exportations (Kljajić 2017). Serbia is the fourth State in the world on exportation of raspberries with 68.5 thousand tons exported in 2017 (Worldatlas 2017).

In case of "FC" index, the most important plants were *Hypericum perforatum* L. (FC=19), *Allium ursinum* L. (FC=18) and *Satureja montana* L. (FC=18) (Table 1).

5.3. Used parts of plants

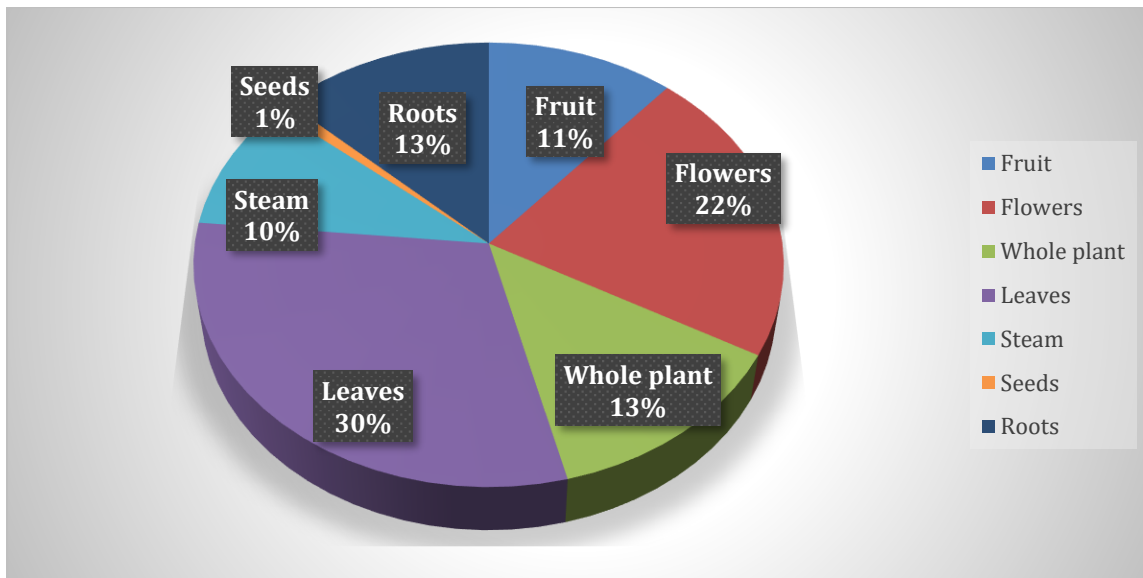
Regarding the different parts of the used medicinal plants, the research tried to verify which parts of the plants were more used between the informants. The results were divided in: Fruit, Flowers, Leaves, Seeds, Roots, the Whole plant and Steam from the plants (Graph 2).



Graph 2: Used parts of the plants

It is important to remark that the same species can have different parts used for medicinal purposes.

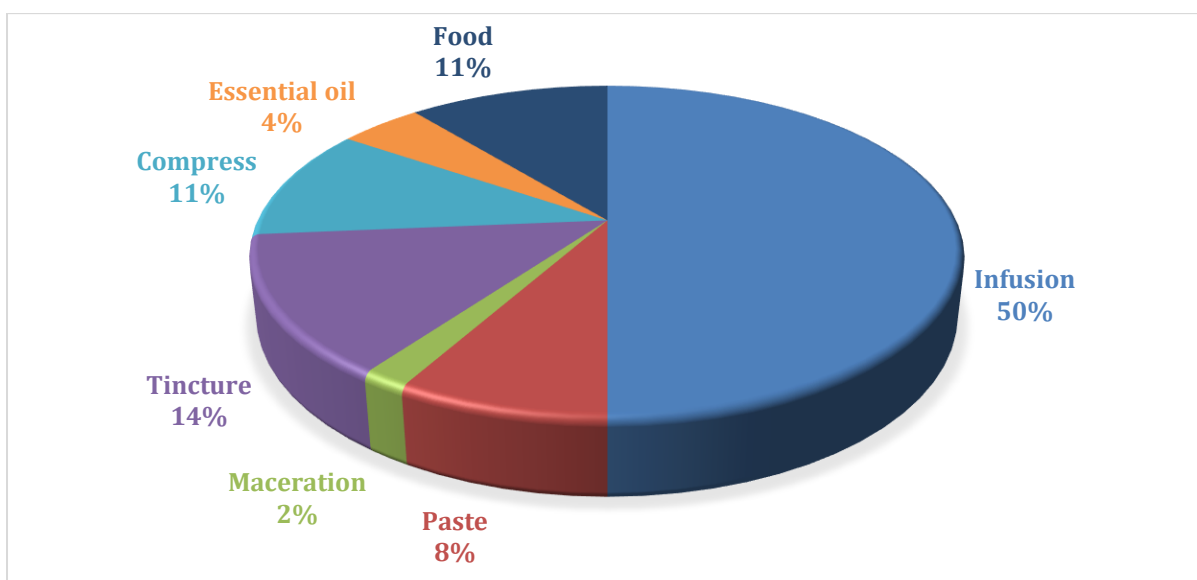
Following the study, the part of the plants with more frequency of citation was the leaves with a 30%, followed by the flowers with a 22% (Graph 3).



Graph 3: Used parts of plants in percentage (%)

5.4. Methods of use of medicinal plants

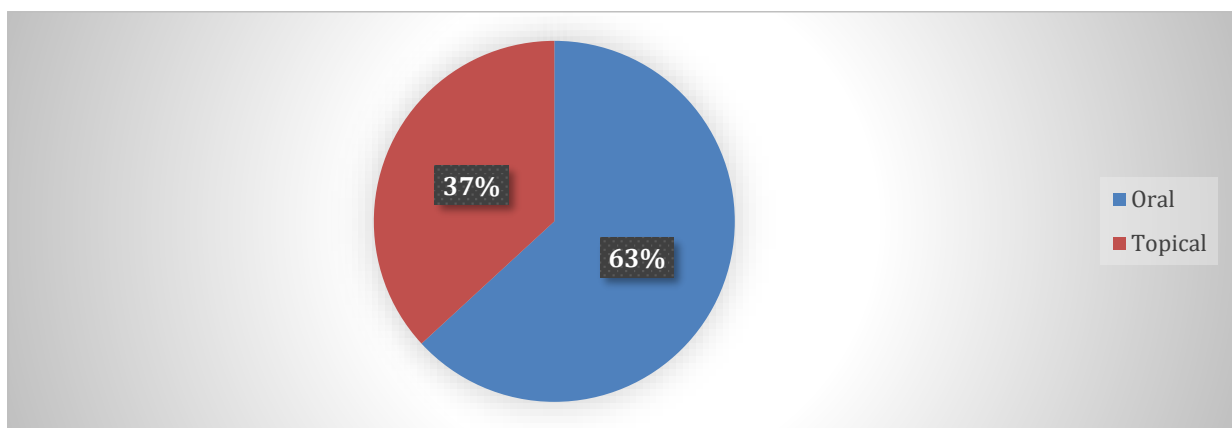
Related to the previous classification, the informants were also asked about the method they use to consume the medicinal plants. This research classified the uses as Infusion, Paste, Maceration, Tincture, Compress, Essential oil and Food. Following the frequency of citation of the interviewees, the results came as in the Graph 4.



Graph 4: Methods of use of the mentioned species in percentage

A half of the informants stated that they prefer to consume the plants on infusion (50%) as it is the most common method followed in general (Graph 4). Also, it is needed to consider that the same species can have various methods of use so one species can have a combination of different methods of being consumed. This collected data is very similar to the study carried in Rtanj Mountain carried by (Zlatković et al. 2014).

Satureja montana L., as it is the plant species with higher level of "FC", is also mostly prepared by infusion (Graph 4). According to the way of use of the mentioned plants, there is also another classification of its consumption: Oral and Topical (Graph 5).



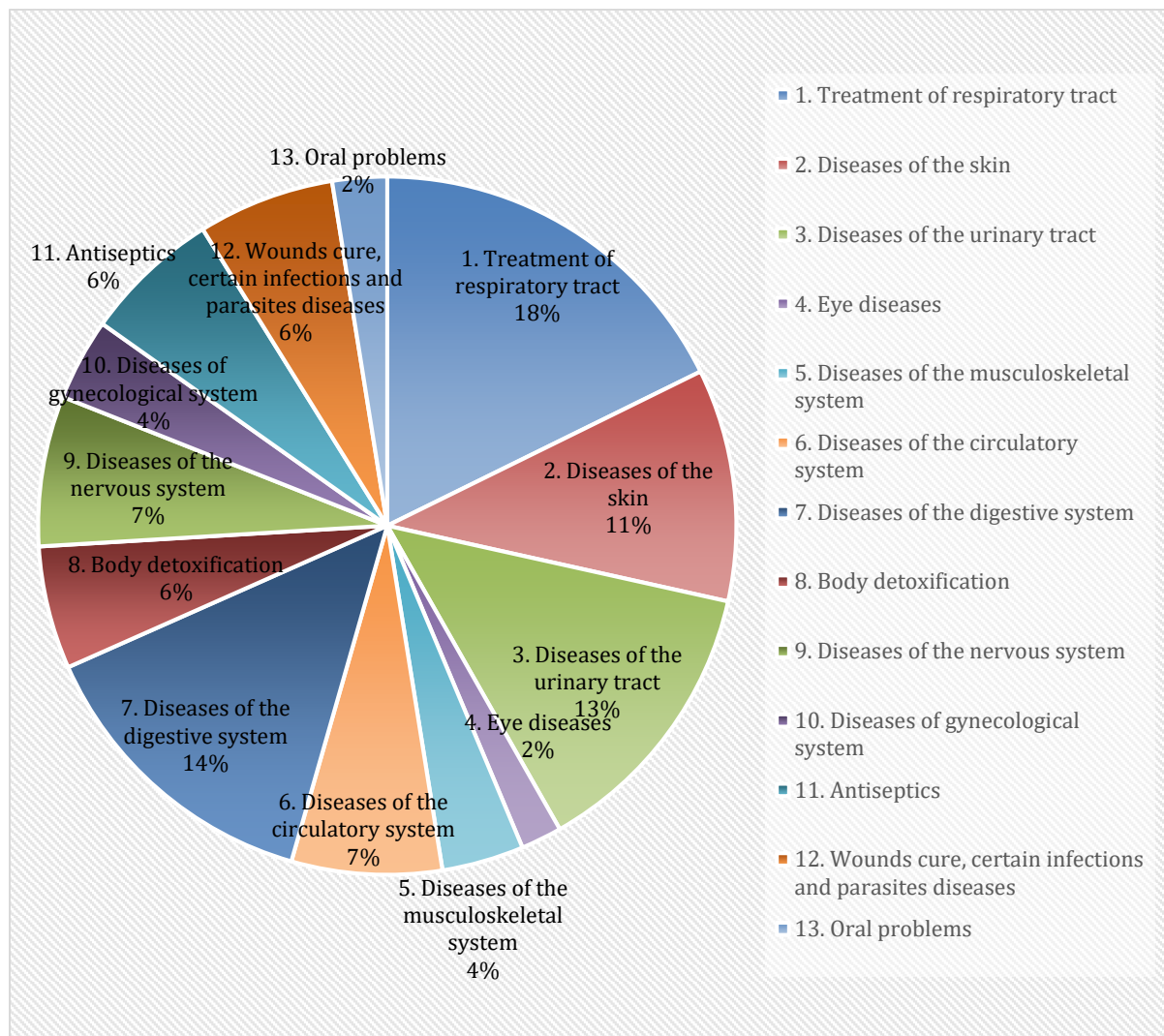
Graph 5: Ways of consumption of the mentioned plants

Following the frequency of citation, most of the plants are orally consumed, a 63% of the mentions. This result is in relation to the previous one where most of the plants could be used in infusion.

5.5. Therapeutic uses of the medicinal plants

Here the study is focused in the frequency of therapeutic uses of each medicinal plant. These therapeutic uses are classified in thirteen different categories: 1. Treatment of respiratory tract, 2. Diseases of the skin, 3. Diseases of the urinary tract, 4. Eye diseases, 5. Diseases of the musculoskeletal system, 6. Diseases of the circulatory system, 7. Diseases of the digestive system, 8. Body detoxification, 9. Diseases of the nervous system, 10. Diseases of gynecological system, 11. Antiseptics, 12. Wounds cure, certain infections and parasites

diseases, 13. Oral problems. These distribution per mentions is reflected in the next graph (Graph 6).



Graph 6: Percentage of mentions per therapeutic uses of the studied medicinal species

There is a wide number of different therapeutic uses of the different species as the informants mentioned. However, the most mentioned therapeutic use is for treatments of the respiratory system with a 18% of the mentions, followed by the diseases of the digestive system with a 14% of the mentions and diseases of the urinary tract with 13% of the mentions. These results are, as well, related to the way of consumption of the medicinal plants as most of the plants are consumed by infusion for respiratory or digestive problems.

Table 1: Table of inventory of medicinal plants in Central Serbia (Rtanj, Kopaonik, Rudnik)

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
Alliaceae	<i>Allium ursinum</i>	Sremuš	Leaves,	Spice,	6, 7, 11, 12	Oral, topical	4	18	0.18	0.04	5.55
	L.		Tuber	essence of plant							
Apiaceae	<i>Daucus carota</i>	Divlja	Roots	Juice	3, 7	Oral	2	4	0.04	0.02	25
	L. subsp. Carota	šargarepa									
	<i>Laserpitium siler</i> L.	Raskovnik	Whole plant	Infusion, powder	3, 7, 8	Oral, topical	3	5	0.05	0.03	20
Asteraceae	<i>Achillea clypeolata</i> Sm.	Žuta hajdučica	Whole plant	Infusion, paste	3, 4, 5, 6, 12	Oral, topical	5	8	0.08	0.05	12.5
	<i>Achillea millefolium</i> L.	Hajdučka trava	Whole plant	Infusion, paste	3, 4, 5, 6, 12	Oral, topical	5	7	0.07	0.05	14.28
	<i>Artemisia absinthium</i> L.	Pelin	Leaves, flowers	Infusion, maceration	7, 8	Oral	2	8	0.08	0.02	12.5
	<i>Calendula officinalis</i> L.	Neven	Flowers, steam, leaves	Infusion, paste, tincture	7, 8, 12	Oral, topical	3	12	0.12	0.03	8.3

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
Asteraceae	<i>Carlina acaulis</i> L.	Vilino Sito	Roots	Infusion	3,12	Oral	2	1	0.01	0.02	100
	<i>Cichorium intybus</i> L.	Cikorija	Roots, flowers, leaves	Infusion, compress	2, 3, 7, 8	Oral, topical	4	3	0.03	0.04	33.33
	<i>Helichrysum arenarium</i> Moench	Smilje	Flowers	Infusion	3, 8	Oral	2	11	0.11	0.02	9.09
	<i>Inula helenium</i> L.	Oman	Roots	Infusion, powder, paste	1, 2, 11	Oral, topical	3	2	0.02	0.03	50
	<i>Matricaria chamomilla</i> L.	Kamilica	Flowers, leaves	Infusion, compress, paste	1, 2, 7, 10	Oral, topical	4	11	0.11	0.04	9.09
	<i>Solidago virgaurea</i> L.	Obična zlatnica	Flowers, leaves	Infusion	1, 3, 8	Oral	3	1	0.01	0.03	100
	<i>Tanacetum vulgare</i> L.	Obični vratič	Leaves	Infusion, spice	2, 5, 10	Oral, topical	3	1	0.01	0.03	100

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
	<i>Tussilago farfara</i> L.	Podbel	Flowers, leaves	Infusion	1	Oral	1	1	0.01	0.01	100
Betulaceae	<i>Betula pendula</i> Roth	Breza	Leaves, bark	Infusion, compress	3, 12	Oral, topical	2	3	0.03	0.02	25
Boraginaceae	<i>Anchusa officinalis</i> L.	Volovski jezik	Leaves, flowers	Infusion	1, 3	Oral	2	1	0.01	0.02	100
	<i>Pulmonaria officinalis</i> L.	Plućnjak	Leaves, roots, flowers, steams	Infusion, compress	1, 12	Oral, topical	2	1	0.01	0.02	100
	<i>Symphytum officinale</i> L.	Gavez	Whole plant	Infusion, compress	1, 2	Oral, topical	2	2	0.02	0.02	50
Cannabaceae	<i>Humulus lupulus</i> L.	Hmelj	Whole plant	Infusion, food, powder	3	Oral	1	5	0.05	0.01	20
Caprifoliaceae	<i>Sambucus nigra</i> L.	Zova	Fruit, flowers	Infusion	1, 2, 11	Oral	3	9	0.09	0.03	11.1
Caryophyllaceae	<i>Herniaria glabra</i> L.	Sitnica	Whole plant	Infusion	1, 3	Oral	2	1	0.01	0.02	100

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
	<i>Saponaria officinalis</i> L.	Sapunjača	Leaves, flowers, fruits	Infusion, tincture	1, 2, 13	Oral, topical	3	2	0.02	0.03	50
Crassulaceae	<i>Sempervivum tectorum</i> L.	Čuvar kuća	Whole plant	Infusion, tincture	1, 2	Oral, topical	2	9	0.09	0.02	11.11
Equisetaceae	<i>Equisetum arvense</i> L.	Poljski rastavić	Stem	Infusion, tincture	1, 3, 7	Oral, topical	3	2	0.02	0.03	50
Ericaceae	<i>Vaccinium myrtillus</i> L.	Borovnica	Fruit, leaves	Infusion	7	Oral	1	2	0.02	0.01	50
Fabaceae	<i>Anthyllis vulneraria</i> L.	Detelina kamenjarka	Overhead parts of the plant	Infusion, compress	2, 3, 7	Oral, topical	3	1	0.01	0.03	100
Gentianaceae	<i>Centaurium erythraea</i> Rafn	Kičica	Fresh tuber, spice	Compress	2, 9	Oral, topical	2	2	0.02	0.02	50

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
	<i>Gentiana cruciata</i> L.	Prostrel	Whole plant, or whole roots	Infusion	7	Oral	1	1	0.01	0.01	100
	<i>Gentiana lutea</i> L.	Lincura	Roots	Infusion, tincture	7, 12	Oral	2	11	0.11	0.02	9.09
Hypericaceae	<i>Hypericum perforatum</i> L.	Kantarion	Steam, leaves, flowers	Infusion, tincture	1, 7, 9	Oral, topical	3	19	0.19	0.03	5.26
Lamiaceae	<i>Clinopodium vulgare</i> L.	Čepić	Leaves, Spices	Infusion	6	Oral	1	1	0.01	0.01	100
	<i>Marrubium vulgare</i> L.	Očajnica	Upper body of the plant	Infusion, compress	1, 6	Oral, topical	2	1	0.01	0.02	100
	<i>Melissa officinalis</i> L.	Matičnjak	Leaves, flowers	Infusion, compress	7, 10, 11	Oral, topical	3	15	0.15	0.03	6.66

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
Lamiaceae	<i>Mentha spicata</i> L.	Nana	Whole plant	Essential oil, infusion, tincture	1, 7, 9	Oral, topical	3	15	0.15	0.03	6.66
	<i>Ocimum basilicum</i> L.	Bosijak	Leaves	Infusion, essential oil, food	1, 11	Oral, topical	2	8	0.08	0.02	12.5
	<i>Origanum vulgare</i> L.	Vranilova trava	Whole plant	Infusion, food	1, 11	Oral	2	4	0.04	0.02	25
	<i>Satureja montana</i> L.	Rtanjski čaj	Flower, leaves	Infusion, compress	1, 2	Oral, topical	2	18	0.18	0.02	5.55
	<i>Stachys officinalis</i> L.	Ranilist	Leaves	Infusion	6, 9	Oral	2	1	0.01	0.02	100
	<i>Teucrium chamaedrys</i> L.	Podubica	Upper body of the plant	Infusion, tincture	1, 2, 5	Oral	3	1	0.01	0.03	100
	<i>Teucrium montanum</i> L.	Trava iva	Upper body of the plant	Infusion, essential oil, food	1, 7, 11	Oral	3	1	0.01	0.03	100

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
	<i>Thymus pulegioides</i> L.	Obična majčina dušica	Upper body of the plant	Infusion, essential oil, food	1, 5, 11	Oral, topical	3	8	0.08	0.03	12.5
Malvaceae	<i>Althaea officinalis</i> L.	Beli Slez	Roots, leaves, flowers	Infusion, maceration	1	Oral	1	8	0.08	0.01	12.5
	<i>Malva sylvestris</i> L.	Crni Slez	Whole plant	Infusion, compress, paste	1, 7, 12, 13	Oral, topical	4	8	0.08	0.04	12.5
Papaveraceae	<i>Chelidonium majus</i> L.	Rusa	Whole plant	Infusion, tincture	2, 7, 8	Oral, topical	3	3	0.03	0.03	33.33
Plantaginaceae	<i>Plantago major</i> L.	Ženska bokvica	Leaves	Infusion, tincture	1, 2, 11, 13	Oral, topical	4	4	0.04	0.04	25
Rosaceae	<i>Agrimonia eupatoria</i> L.	Petrovac	Whole plant	Infusion, paste	2, 7, 10, 13	Oral, topical	4	2	0.02	0.04	50
	<i>Alchemilla vulgaris</i> L.	Vrkuta	Leaves, steam, flowers	Infusion, compress	3, 9, 10	Oral, topical	3	2	0.02	0.03	50

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
Rosaceae	<i>Crataegus monogyna</i> Jacq.	Beli glog	Flowers, leaves, fruits	Infusion, tincture	3, 5, 9	Oral, topical	3	4	0.04	0.03	25
	<i>Rosa canina</i> L.	Divlja ruža	Fruit	Infusion	1, 3, 7	Oral	3	5	0.05	0.03	16.7
	<i>Rubus fruticosus</i> L.	Kupina	Fruit, leaves	Infusion	6, 8	Oral	2	7	0.07	0.02	14.28
	<i>Rubus idaeus</i> L.	Malina	Fruit, leaves	Infusion	2, 3, 6, 7, 8, 10	Oral	6	3	0.03	0.06	33.33
Rubiaceae	<i>Galium verum</i> L. subsp. verum	Ivanjsko cveće	Upper body of the plant	Infusion, paste	3, 7, 9	Oral, topical	3	5	0.05	0.03	20
Scrophulariaceae	<i>Digitalis ferruginea</i> L.	Besnik	Leaves	Infusion	6	Oral	1	2	0.02	0.01	50
	<i>Euphrasia stricta</i> Kunth subsp. Stricta	Vidac	Upper body of the plant	Infusion, essential oil, tincture	4	Oral, topical	1	1	0.01	0.01	100
	<i>Verbascum phlomoides</i> L.	Divizma	Flower, leaves	Infusion, tincture	1, 3, 9, 12	Oral, topical	4	3	0.03	0.04	33.33

Family	Species	Local Name	Part used	Preparation model	Therapeutic use	Oral/Topical	UR	FC	RFC	MUV	FL
Solanaceae	<i>Datura stramonium</i> L.	Tatula	Seeds, leaves	Tinture, paste	1, 2, 9	Oral, topical	3	1	0.01	0.03	100
Tiliaceae	<i>Tilia cordata</i>	Malolisna lipa	Flowers	Infusion	1, 6, 9	Oral	3	1	0.01	0.03	100
Urticaceae	<i>Urtica dioica</i> L.	Kopriva	Leaves, roots	Infusion, tincture	3, 5	Oral, topical	1	11	0.11	0.01	9.09
Valerianaceae	<i>Valeriana officinalis</i> L.	Odoljen, Valerijana	Roots	Infusion	9	Oral	1	4	0.04	0.01	25

Categorization of the collected species in Serbia: 1. Treatment of respiratory tract, 2. Diseases of the skin, 3. Diseases of the urinary tract, 4. Eye diseases, 5. Diseases of the musculoskeletal system, 6. Diseases of the circulatory system, 7. Diseases of the digestive system, 8. Body detoxification, 9. Diseases of the nervous system, 10. Diseases of gynecological system, 11. Antiseptics, 12. Wounds cure, certain infections and parasites diseases, 13. Oral problems

6. Discussion

Despite of the decrease of the use of medicinal plants, Serbia has a vast number of plant species, and they are used for multiple applications. The historical knowledge about the uses of medical plants is very rich as stated in the firsts points of this research, and it has always been linked to the orthodox religion, the monasteries and the rural areas in Serbia. This is the reason for the election of the three localizations: Rtanj, Kopaonik and Rudnik, in the Central Serbia region. These areas are predominantly rural, and they still keep traditional uses of medicinal plants. Also, this relation with medicinal plants is closely linked to the richness of ethnic groups that live in Serbia, that follow their traditions and keep a close contact with the agriculture and natural remedies.

As in the hypothesis, most of the knowledge of medicinal plants among the population is concentrated in the eldest inhabitants of the rural areas, and mainly women. It is important to remark that women were more accessible to the interviews and they were more willing to share their knowledge. Seven from ten informants that accessed to the interview were women. Most of the informants with more knowledge range higher ages than 60 years old.

Generally, most of the population that frequently use medicinal plants do it for health purposes as it is a cheaper remedy than modern drugs and easier to obtain. The main obtention method is the recollection in the countryside or own harvested, but there are also traditional markets where they can buy them.

In comparison with previous very relevant researches in the Balkan region and focusing in the most frequent uses of medicinal plants, Redžić in 2007 reported that the use of medicinal plants in his research in Bosnia and Herzegovina is mainly for respiratory tract diseases, followed by digestive and urinary tract problems.

Also, Ivancheva and Stancheva in 2000 already published their research of traditional medicine plants used in Bulgaria and reported that the most frequent uses were focused on digestive and respiratory diseases.

A third study by Šavikin in 2013 reported the most popular uses of plants in the Western Serbian area of Zlatibor, where the most common pathologies involving their use were digestive, dermal and respiratory diseases.

These statements allowed us to prove that there is a common traditional knowledge in the region linked to the use of the most common medicinal plants, concentrated in the most rural areas and sharing the same pathologic healing remedies.

By contrast, there is a lack of knowledge from the younger generations that are much more familiar with the modern medicine and more connected with the global trends. Most of the younger population in Serbia lives in urban areas, where there is a big loss of these traditions because of the lack of contact with medicinal plants. As stated by the World Bank, a 56% of Serbian population lives in urban areas (World Bank, 2018) and they make more use of modern medicines.

In any case, there was still an interest on traditional uses of plants by some young informants. One example was one young male informant of 28 years old in Boljevac, Rtanj who carried on a small traditional business harvesting *Calendula officinalis* L. and producing cosmetics and creams with this autochthone species from the South of Europe. Although it is reduced, it keeps a hope that young generations will keep this knowledge for the future, and it can be compatible with the modern medicine.

7. Conclusion

This research documents information about the uses of medicinal plants by the population of Central Serbia, more exactly the regions of Rtanj, Kopaonik and Rudnik. There have been registered 60 medicinal plant species for treating 13 diseases categories. Most of the referenced uses of these species are related to the treatments for the respiratory tract, as well as gastrointestinal problems, as those are the most common symptoms that do not require of serious medical treatment but can be treated with medicinal plants.

The knowledge about Ethnobotany in Central Serbia still lives in the old generations who use medicinal plants for the most immediate and cheapest remedies. They have a big role to transmit it to the younger generations who are losing their interest on it. However, thanks to all the local and international Ethnobotany researchers, there is a hope that this precious knowledge will be kept, reach international aware and be preserved in order to contribute to the conservation of the rich amount of medicinal species that characterizes this region of Europe, as well as the cultures that have enriched this discipline with their own traditions, customs and uses of their local plants in their daily life.

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9. Attachments

Attachment 1: Questionnaire

The questionnaire was used in the research in Central Serbia (Rtanj, Kopaonik, Rudnik)

АНКЕТА ВЕЗАНА ЗА ФРЕКВЕНЦИЈУ КОРИШЋЕЊА ЛЕКОВИТОГ БИЉА У ДЕЛОВИМА ЦЕНТРАЛНЕ И ЈУГОИСТОЧНЕ СРБИЈЕ.

1.Локација:

2.Зона:

- a) Градска
- b) Село

3.Годиште испитаника:

- До 18 година
- 18-30 година
- 31-40 година
- 40-50 година
- 60+ година

4.Да ли користите лековито биље у својству побољшања здравственог стања

- a) Да
- b) Не

5.Коју врсту користите највише:

Навести назив домаћи или латински:

6.Навести због које болести се користи највише дата биљка.

(резултати ће бити распоређени по категоријама)*

7.Начин припреме:

- a) Чај
- b) Тинктура
- c) Зачинско биље

8.Начин на који се користи биљка:

- a) Локално (Облога)
- b) Орално (Чај,сок)

9.Колико често користите лековито биље:

- a) Користим,али веома ретко
- b) Користим неколико пута у току године
- c) Користим неколико пута у току месеца
- d) Користим неколико пута у току недеље
- e) Користим свакодневно

10.Да ли биљке сами сакупљате или их купујете на пијаци /апотекама

- a) Да
- b) Не