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RESEARCH ARTICLE

Traditional uses of plants in human and ethnoveterinary medicine on Mt. Rujan (southeastern Serbia)

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Abstract The population from 25 villages in two municipalities on Rujan Mt. in southeastern Serbia (130 informants) was surveyed about human and ethnoveterinary medicine by completing a questionnaire containing general information about respondents and specific issues related to their applications. There were 2254 reports on the use of plants in human ethnopharmacology and 793 for ethnoveterinary medicine. The Informant Consensus Factor and comparison of ethnicity and gender for the most frequently reported plant taxa in human and ethnoveterinary medicine were calculated. Multivariate correspondence analysis was performed. A total of 101 medicinal plant taxa used in human ethnopharmacology and belonging to 42 families were recorded during the ethnobotanical research, of which 29 taxa are included in European Pharmacopoeia 10.2. The most frequently mentioned families were Asteraceae (502 reports) and Lamiaceae (404 reports). *Hypericum perforatum* L. (197 reports) and *Matricaria chamomilla* L. (164 reports) were the most used plant taxa. Among 17 categories, digestive (513 URs) and skin (331 URs) diseases were the most frequently reported. The research recorded 43 plant species used in ethnoveterinary medicine from 25 families. The most frequently mentioned families were Lamiaceae (6 reports) and Rosaceae (6 reports). The most used plant taxa were *Fraxinus ornus* L. (108 reports) and *Helleborus odorus* Waldst. & Kit. (80 reports). Among the six categories, the most reported diseases were digestive (267 reports), infectious (240 reports), and skin (159 reports). The present study contributes significantly to diversifying strategies in traditional human and ethnoveterinary medicine.

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Abbreviations
ICF Informant consensus factor
URs Use reports

Introduction

People have used wild plants since ancient times for various purposes: as food (Güneş et al. 2018), medicine, in veterinary practice, for construction, equipment, musical instruments, handicrafts, dyes, fuel, ornaments, and toys (Yerebasan et al. 2021). Plants are often used for the treatment of human and animal diseases. Traditional knowledge about plants used in human and ethnoveterinary medicine has accumulated over centuries is at risk of being lost forever because of rapid cultural changes (Güler et al. 2021), the development of modern chemistry, modern food preparation techniques, and conventional pharmacology. Therefore, there is a need to document ancestral knowledge in databases that will enable its preservation. In recent years, there has been an increasing tendency to use herbal preparations alongside conventional drug therapy in which ethnobotanical knowledge has practical application (Džamić and Matejić 2017; Živković et al. 2020). Serbia is on the Balkan Peninsula and has exceptional floristic diversity (Zlatković et al. 2014; Jarić et al. 2015). Rural areas in Serbia are rich in medicinal plants and traditional ethnobotanical knowledge (Dajić Stevanović et al. 2014). The level of poverty in these areas is high, and the first choice of people for health care is the use of medicinal plants in natural herbal preparations (Matejić et al. 2020; Živković et al. 2020; Jarić et al. 2015). Ethnobotanical field research conducted in Serbia in the last two decades covered only some areas of Serbia and mainly focused on the use of plants in medicine, while ethnoveterinary data are scarce (Zlatković et al. 2014; Matejić et al. 2020; Živković et al. 2020).

The present study aimed to record the profile of all medical uses for humans and domestic animals per herbal drug in rural areas of Rujan Mt. (southeastern Serbia), an area that is yet to be studied. Rujan Mountain is a hilly mountainous area with an underdeveloped infrastructure, inhabited mainly by older people, so seeing a doctor or veterinarian are rare events. During the summer, the inhabitants collect plants that are dried and use them for various ailments until the following year. According to the people interviewed, plants have been used to treat common diseases such as human tuberculosis and scarlet fever in pigs. The selected research area is also attractive because it is a region inhabited by Serbs and Albanians. Nowadays, Serbs from other mountains live in an area previously inhabited mainly by Albanians who moved to the cities. The settlers brought much new knowledge in addition to the traditional knowledge of the locals. Considering the current population in this area, we endeavored to record and preserve the knowledge about plant use in this area for both ethnic groups.

To obtain information on the ethnopharmacological characteristics of the population from this multicultural area, the following questions are presented in the paper:

Which are the most traditionally used medicinal plants in the study area in human and ethnoveterinary medicine?

What are the folk names of used plants, organs used, forms of preparation and administration, and which indications are usually treated?

Are there any differences in medicinal plant use in human and ethnoveterinary medicine between the Serbian and Albanian populations?

Which plants are used for both humans and animals and are the preparation recipes the same?

Materials and methods

Research area

The investigated area of Rujan Mt. is in southeastern Serbia (42.262406° N−42.450750° N and 21.710398° E−21.888848° E). The research included two municipalities, Bujanovac and Preševo. The study area covers 166.34 km2 (according to Google Maps) at elevations from 398 to 968 m. It is a rural area, with 10 villages in the municipality of Preševo and 15 villages in the municipality of Bujanovac. The villages Slavujevac, Ljanik, Svinjište, Sebrat, and Lukarce are south of the Rujan Mt. peak; Ašane, Mamince, Strezovac,

Aliđerce, Reljan, Golemi Dol, Buštranje, Bratoselce, Biljača, and Samoljica are west of the peak; Žbevac, Krševica, Klinovac, Žuželjica, Ljiljance, and Kuštica are north of the peak, and Spančevac, Pretina, Klenike, and Sv. Petka east of the peak (Fig. 1).

The site is rich in plant species. So far, 592 species of vascular flora have been recorded. This area is the only habitat for some species, in particular *Crocus rujanensis* Randjel. & D.A.Hill (endemic species), which is currently known only from this mountain (Simić and Zlatković 2022).

Population

The municipalities of Preševo and Bujanovac are in the fifth stage of demographic age (Anđelković Stoilković 2019). The number of inhabitants is far higher than those currently living in the research area.

According to the 2022 census, the total number of inhabitants living in Preševo is 35,097, and in Bujanovac, 42,634 (https://publikacije.stat.gov.rs/G2022/HtmlL/G20221350.html). A comparative study of Albanians and Serbs was done, but according to census data, there are almost no Albanians in the study

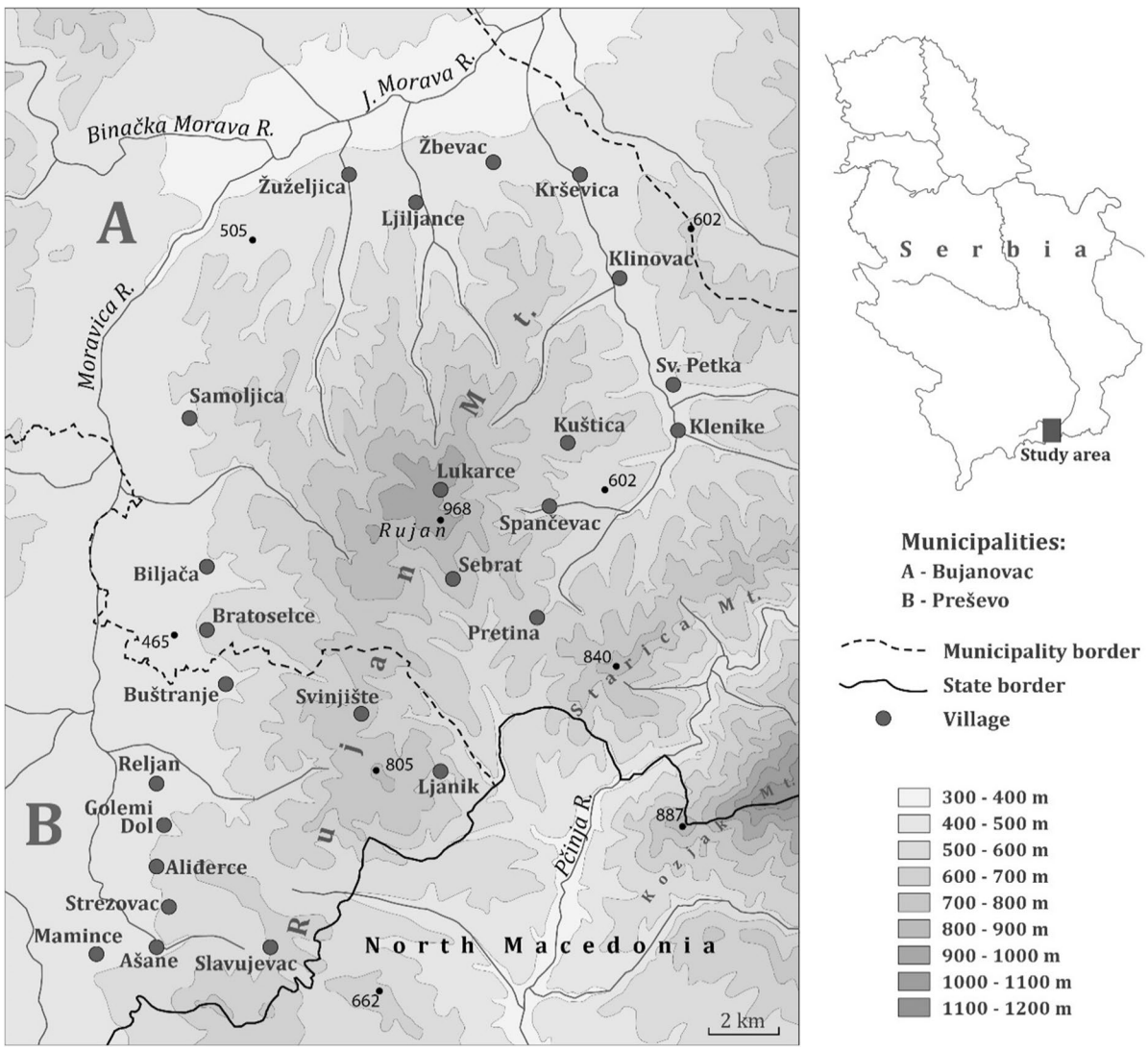

Fig. 1 A map of Rujan Mt. with waterbodies highlighted, including villages (black dots) visited for ethnobotanical interviews in two municipalities

area. The data on Albanians are unrealistic because they boycott the censuses for political reasons.

About 90% of the Albanian population live along the edge of the western side of the Rujan Mt. (although they do not officially exist according to the censuses), and about 25% in the entire study area. In the researched area, there are ethnic (Serbs and Albanians) and religious (Orthodox and Muslims) differences, though the cultural difference has disappeared over time. Although the Albanian population makes up a large percentage of the population, many of them are abroad. The Serbian population is older, the younger population having left for better conditions in larger cities. Traditional medical treatment with plants is very present since the area is inhabited by a population that, due to age and insufficient resources, only periodically applies the modern treatment method with the help of medicines.

The territory of the municipality Bujanovac has favorable natural conditions for the intensification of livestock production, with over 17,992 ha of arable agricultural land, over 8521 ha of pastures, and 1699 ha of meadows, and this could represent the backbone of the development of the municipality. There is significant potential in organic livestock production, i.e., cattle and goat breeding (Municipal Council of Bujanovac Municipality 2021). The climatic conditions, with summer droughts and early frosts, are ideal for cattle breeding. However, there are no livestock farms, and despite the development of livestock culture, most households do not keep livestock in large numbers. In Bujanovac, most households are engaged in livestock production (cattle breeding—Simmental and domestic colored beef, sheep and goats, pigs, beekeeping, and poultry). Animal husbandry in the municipality of Preševo is on the rise. On the slope of the catchment area, the population is mainly engaged in animal husbandry, namely sheep, cattle, and goat breeding (ex-post analysis of the municipalities of Bujanovac, Medveđa, and Preševo, 2005).

Ethnopharmacological survey

The village population in two municipalities at Rujan Mt. was interviewed in 2022. A semi-structured questionnaire was answered by 130 informants from 25 villages (15 villages in the municipality of Bujanovac and 10 villages in the Preševo municipality). A study area map with the distribution of villages visited within the scope of interviews is given in Fig. 1.

Sixty-eight men and 62 women living in the study area, aged 41–91, were interviewed. Data collected from the informants were the names of plants used, the form in which they are used, how they are prepared and applied, and internal or external administration modes.

If the application of plants in human and ethnoveterinary medicine was discussed, informants were asked which plant parts were used and to provide the samples in their dry state if they had them or fresh from natural habitats of plants in the vicinity around their houses.

The residents of some villages (Samoljica, Žbevac, Krševica, Klinovac, Žuželjica, Ljiljance, Kuštica) in the municipality of Bujanovac were not willing to participate in the survey, which is why the number of respondents in these places is small compared to the total number of inhabitants. By chance, we came to the respondents in the field. Along with whether they would like to participate in the survey and explanations of what kind of research it is, we received recommendations about other people who could be interviewed. At the beginning of the interview, interviewees gave cursory answers. As the interview progressed, they became more relaxed, and we received more complete responses. Each respondent's answer was recorded in the survey questionnaire. Respondents voluntarily stated their ethnicity, with a prior explanation of the type of research.

The plant species reported and collected during the interviews were identified according to Josifović (1970–1986) and Tutin et al. (1964–1980, 1993). Taxonomic nomenclature was according to the checklist from the WFO database (https://wfoplantlist.org/plant-list). The species collected during the research were deposited in the "Herbarium Moesiacum Niš" (HMN) collection of the Faculty of Sciences and Mathematics, University of Niš., and inventory voucher numbers are given in Tables 1 and 2.

Data analysis

The results were summarized in a table and arranged in alphabetical order of the plant taxa's Latin name with other data: family, local folk names, voucher specimen in HMN herbarium, the plant part used (with the number of use reports (URs) in brackets),

Table 1 Plant species most used in human ethnopharmacology for indications in each therapeutic category in two municipalities on Rujan Mt.

Group	Municipality	URs	Reports ratio [%]	No. of taxa	ICF[a]	Taxa most used (Number of URs)	Taxa ratio [%]
Di	Bujanovac	288	12.7	39	0.9	*Matricaria chamomilla* L. (45), *Thymus glabrescens* Willd. (39), *Hypericum perforatum* L. (35)	41.3%
	Preševo	225	10	30	0.9	*Matricaria chamomilla* L. (52), *Hypericum perforatum* L. (29)	36%
	Rujan Mt	513	22.8	44	0.9	***Matricaria chamomilla*** **L. (97)**, ***Thymus glabrescens*** Willd. **(66)**, ***Hypericum perforatum*** **L. (64)**	44.2%
Sk	Bujanovac	164	7.3	22	0.9	*Hypericum perforatum* L. (71)	43.3%
	Preševo	167	7.4	25	0.8	*Hypericum perforatum* L. (48), *Plantago major* L. (43)	54.5%
	Rujan Mt	331	14.7	32	0.9	***Hypericum perforatum*** **L. (119)**, ***Plantago major*** **L. (74)**	58.3%
Gu	Bujanovac	147	6.4	24	0.8	*Ocimum basilicum* L. (21), *Thymus glabrescens* Willd. (21), *Mentha x piperita* L. (18)	40.8%
	Preševo	167	5.6	20	0.8	*Tilia platyphyllos* Scop. (26), *Thymus glabrescens* Willd. (17), *Mentha x piperita* L. (16)	35.3%
	Rujan Mt	273	12.1	31	0.9	***Tilia platyphyllos*** **Scop. (39)**, ***Thymus glabrescens*** Willd. **(38)**, ***Mentha x piperita*** L. **(34)**	40.6%
Rs	Bujanovac	157	7	32	0.8	*Ocimum basilicum* L. (21), *Sambucus nigra* L. (20), *Tilia platyphyllos* Scop. (18)	37.6%
	Preševo	103	4.6	26	0.7	*Tilia platyphyllos* Scop. (27), *Sambucus nigra* L. (14)	39.8%
	Rujan Mt	260	11.5	40	0.8	***Tilia platyphyllos*** **Scop. (45)**, ***Sambucus nigra*** **L. (34)**, ***Rubus caesius*** **L. (27)**	40.8%
Em	Bujanovac	109	4.8	27	0.8	*Taraxacum officinale* F.H. Wigg. (22), *Urtica dioica* L. (11), *Origanum vulgare* L. (10)	39.4%
	Preševo	100	4.4	22	0.8	*Urtica dioica* L. (25), *Taraxacum officinale* F.H. Wigg. (21)	46%
	Rujan Mt	209	9.3	36	0.8	***Taraxacum officinale*** **F.H. Wigg. (43)**, ***Urtica dioica*** **L. (36)**, ***Origanum vulgare*** **L. (27)**	50.7%
Ci	Bujanovac	91	4.0	15	0.8	*Crataegus monogyna* Jacq. (36)	39.6%
	Preševo	73	3.2	18	0.8	*Crataegus monogyna* Jacq. (38)	52.0%
	Rujan Mt	164	7.3	23	0.9	***Crataegus monogyna*** **Jacq. (74)**, ***Urtica dioica*** **L. (28)**	62.2%
Ur	Bujanovac	69	3.1	17	0.8	*Equisetum arvense* L. (14), *Silene vulgaris* (Moench) Garcke (12)	37.7%
	Preševo	43	1.9	13	0.7	*Equisetum arvense* L. (14)	32.6%
	Rujan Mt	112	5.0	23	0.8	***Equisetum arvense*** **L. (28)**, ***Silene vulgaris*** **(Moench) Garcke (14)**, ***Zea mays*** **L. (12)**	48.2%
Bl	Bujanovac	59	2.6	7	0.9	*Urtica dioica* L. (29)	49.1%
	Preševo	46	2.0	8	0.8	*Urtica dioica* L. (20)	43.5%
	Rujan Mt	105	4.7	10	0.9	***Urtica dioica*** **L. (49)**, ***Malus sylvestris*** **L. (29)**	74.3%
Fg	Bujanovac	47	2.1	14	0.7	*Achillea millefolium* L. (16)	34.0%
	Preševo	30	1.3	12	0.6	*Achillea millefolium* L. (6), *Thymus glabrescens* Willd. (6)	40%
	Rujan Mt	77	3.4	18	0.8	***Achillea millefolium*** **L. (22)**, ***Galium verum*** **L. (9)**	40.3%
Ps	Bujanovac	17	0.7	3	1	*Melissa officinalis* L. (15)	88.2%
	Preševo	30	1.3	5	0.9	*Melissa officinalis* L. (18)	60%
	Rujan Mt	47	2.1	7	0.9	***Melissa officinalis*** **L. (33)**	70.2%

Table 1 (continued)

Group	Municipality	URs	Reports ratio [%]	No. of taxa	ICF[a]	Taxa most used (Number of URs)	Taxa ratio [%]
Ms	Bujanovac	12	0.5	7	0.4	*Bellis perennis* L. (2), *Mentha longifolia* (L.) Hudson (2)	33.3%
	Preševo	23	1.0	13	0.4	*Urtica dioica* L. (6), *Althaea cannabina* L. (5)	47.8%
	Rujan Mt	35	1.5	16	0.6	***Urtica dioica* L. (8)**, ***Althaea cannabina* L. (5)**	37.1%
Ea	Bujanovac	12	0.5	2	0.9	*Sempervivum tectorum* L. (10)	83.3%
	Preševo	22	1	2	0.9	*Sempervivum tectorum* L. (21)	95.4%
	Rujan Mt	34	1.5	3	0.9	***Sempervivum tectorum* L. (31)**	91.2%
Ca	Bujanovac	9	0.4	3	0.7	*Cichorium intybus* L. (5)	55.5%
	Preševo	24	1.1	12	0.5	*Chelidonium majus* L. (5)	37.5%
	Rujan Mt	33	1.5	12	0.6	***Cichorium intybus* L. (6)**, ***Chelidonium majus* L. (5)**, ***Taraxacum officinale* F.H. Wigg. (5)**	48.5%
Ey	Bujanovac	15	0.7	2	0.9	*Matricaria chamomilla* L. (12)	80%
	Preševo	15	0.7	2	0.9	*Matricaria chamomilla* L. (14)	93.3%
	Rujan Mt	30	1.3	3	0.9	***Matricaria chamomilla* L. (26)**	86.7%
Mg	Bujanovac	12	0.5	2	0.9	*Herniaria glabra* L. (8)	66.6%
	Preševo	2	0.1	2	0	*Herniaria glabra* L. (1), *Prunus spinosa* L. (1)	100%
	Rujan Mt	14	0.6	2	0.9	***Herniaria glabra* L. (9)**	64.3%
Ne	Bujanovac	2	0.1	2	0	*Salix purpurea* L. (2)	100%
	Preševo	7	0.3	4	0.5	*Tanacetum vulgare* L. (4)	57.1%
	Rujan Mt	9	0.4	4	0.6	***Tanacetum vulgare* L. (4)**, ***Salix purpurea* L. (3)**	77.8%
Pa	Bujanovac	4	0.2	2	0.6	*Lysimachia nummularia* L. (3)	75%
	Preševo	4	0.2	3	0.3	*Dryopteris filix-mas* (L.) Schott (2), *Lysimachia nummularia* L. (1)	75%
	Rujan Mt	8	0.3	3	0.7	***Lysimachia nummularia* L. (4)**, ***Dryopteris filix-mas* (L.) Schott (3)**	87.5%

[a]ICF—Informant consensus factor

Groups of diseases: Di—digestive, Sk—skin, Gu—general and unspecified, Rs—respiratory, Em—endocrinological, metabolic and nutritional, Ci—circulatory, Ur—urological, Bl—blood, Fg—female genital, Ps—psychological, Ms—musculoskeletal, Ea—ear, Ca—carcinomas, Ey—eye, Mg—male genital, Ne—neurological, Pa—parasites

form, and mode of administration (Supplement 1, 2, Tables 1 and 2). A precise definition for the use reports (including plant species, category of use and mode of administration) was followed according to earlier research (Stucki et al. 2019; Dassou et al. 2020; Schlittenlacher et al. 2022). All URs were organized into one of the 17 categories used in human ethnopharmacology and six categories used in ethnoveterinary medicine. According to Weckerle et al. (2018), the variance was calculated for used plants considering the number of informants and URs per species.

The Informant Consensus Factor (ICF) for the most frequently reported taxa was calculated to analyze the collected data from Rujan Mt. in general and from both municipalities. According to Trotter and Logan (1986), it was calculated as the quotient between the number of URs minus the number of used plant taxa and the number of URs minus one. A high value, near 1, indicated many URs of a species in the research area. The taxa ratio is the percentage of URs reported for the most frequently used plants.

The plant use by ethnicity and gender was compared using ICF analysis. The overlap of plant taxa reported by the two ethnic groups (Serbian and Albanian) on Rujan Mt. is graphically represented. The overlap of URs for comparing the two ethnic groups is also graphically represented.

Table 2 Plant species most commonly used in ethnoveterinary medicine for indications in each therapeutic category in two municipalities on Rujan Mt.

Group	Municipality	URs	Reports ratio [%]	No of taxa	ICF[a]	Taxa most used (Number of URs)	Taxa ratio [%]
Di	Bujanovac	145	18.3	19	0.9	*Cydonia oblonga* Mill. (35), *Rumex patientia* L. (32)	46.2
	Preševo	122	15.4	15	0.9	*Cydonia oblonga* Mill. (31), *Rumex patientia* L. (22)	43.4
	Rujan Mt	267	33.7	20	0.9	***Cydonia oblonga*Mill. (66)**, ***Rumex patientia*L. (54)**, ***Clinopodium vulgare*L. (22)**	53.2
In	Bujanovac	132	16.6	6	1	*Fraxinus ornus* L. (62)	47
	Preševo	108	13.6	7	1.0	*Fraxinus ornus* L. (46)	42.6
	Rujan Mt	240	30.1	8	0.9	***Fraxinus ornus*L. (108)**, ***Helleborus odorus*** Waldst. & Kit. **(54)**	67.5
Sk	Bujanovac	85	10.7	8	0.9	*Hypericum perforatum* L. (32)	37.6
	Preševo	74	9.3	10	0.9	*Plantago major* L. (28)	37.8
	Rujan Mt	159	20.0	11	0.9	***Plantago major*L. (56)**, ***Hypericum perforatum*L. (54)**	69.2
Rs	Bujanovac	24	3.0	7	0.7	*Avena sativa* L. (7), *Ocimum basilicum* L. (5)	50
	Preševo	41	5.2	6	0.9	*Capsicum annuum* L. (16)	39.0
	Rujan Mt	65	8.2	6	0.9	***Capsicum annuum*L. (20)**, ***Thymus glabrescens*Willd. (11)**	47.7
Re	Bujanovac	14	1.8	3	0.8	*Lolium temulentum* L. (6)	42.9
	Preševo	29	3.6	3	0.9	*Lolium temulentum* L. (11)	37.9
	Rujan Mt	43	5.4	3	0.9	***Lolium temulentum*L. (17)**, ***Sambucus ebulus*L. (13)**	69.8
Ci	Bujanovac	11	1.4	4	0.7	*Achillea millefolium* L. (3), *Calendula officinalis* (3)	54.5
	Preševo	8	1.0	4	0.6	*Crataegus monogyna* Jacq. (3)	37.5
	Rujan Mt	19	2.4	4	0.8	***Achillea millefolium*L. (5)**, ***Calendula officinalis*L. (5)**	52.6

[a]ICF—Informant consensus factor

Groups of diseases: Di—digestive, In—infectious, Sk—skin diseases, Rs—respiratory, Re—reproductive, Ci—circulatory

Statistical analysis

Chi-square test

The Chi-square ($\chi 2$) test was applied to compare plant use distribution between different informant groups. Statistical analyses were done using Minitab 17 at a significance level of $p < 0.05$.

Multivariate correspondence analysis

Multivariate correspondence techniques (Rohlf, 1988) were applied to indicate potential connections among variables by observing their grouping in a graph. The output of this multivariate analysis shows the coordinates of the row (respondents) and column (character states) on correspondence axes displayed on the scatter plot.

Results

Quantitative analyses

Human ethnopharmacology

The study results showed that 101 plant taxa are used to treat various ailments and diseases in the ethnopharmacology of the population (2254 URs). The results are systematized in Supplement 1 (Table 1), with information about each plant species noted during the research. The species were classified into 42 families. High numbers of plant species were from the families Asteraceae (15), Lamiaceae (10), Rosaceae (11), Hypericaceae (1) and Urticaceae (1). Families such as Asteraceae (502 URs, 22.2%), Lamiaceae (404 URs, 17.9%), Rosaceae (280 URs, 12.4%), Hypericaceae (197 URs, 8.7%), and Urticaceae (126 URs, 5.6%) were the most

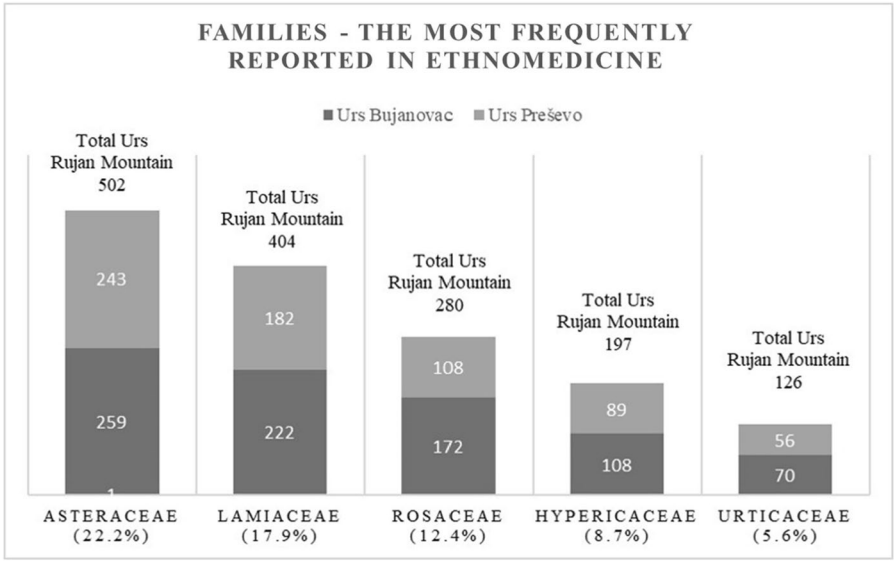

Fig. 2 The most frequently reported families of medicinal plants used in human ethnopharmacology on Rujan Mt. and in two municipalities

widely reported (Fig. 2). Of the 101 plant taxa used to treat various ailments and diseases in humans on Rujan Mt, 29 species are included in the European Pharmacopoeia (European Pharmacopoeia 10.2 2020).

The majority of plant taxa are herbaceous plants (75%), followed by trees (4%) and shrubs (21%). The most frequently used plant parts were the aerial part (1264 URs, 56.1%), leaves (228 URs, 10.1%), floral structures (458 URs, 20.3%), fruit and seeds (176 URs, 7.8%), and underground parts (128 URs, 5.7%).

Plants used to treat diverse ailments are prepared and administered in different forms. Tea or water extractions, infusions (1455 URs, 64.6%), poultices-compresses (183 URs, 8.1%), decoctions (181 URs, 8%), and oil extracts (132 URs, 5.9%) were standard modes of preparation (Fig. 3). Most plants were used for internal oral application (1790 URs, 79.4%), while fewer plants were used for external application (464 URs, 20.6%).

During our study, it was noted that inhabitants of Rujan Mt. usually used the following plant species:

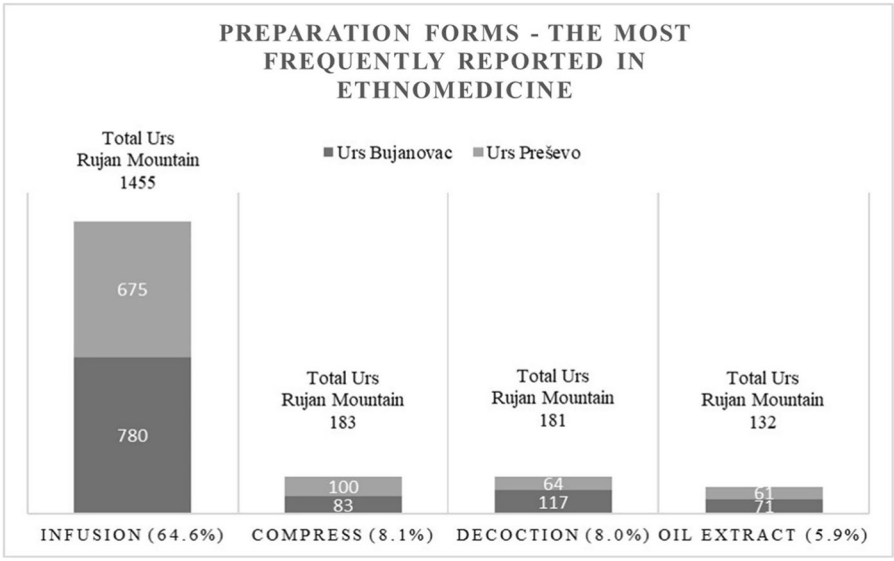

Fig. 3 The most frequently reported preparation forms of medicinal plants used in human ethnopharmacology on Rujan Mt. and in two municipalities

Hypericum perforatum L. (197 URs, 8.7%), *Matricaria chamomilla* L. (164 URs, 7.3%), *Urtica dioica* L. (126 URs, 5.6%), *Thymus glabrescens* Willd. (123 URs, 5.5%), and *Achillea millefolium* L. (104 URs, 4.6%).

Plant taxa most employed in each municipality and a group of ailments are presented in Table 1. The primary reported ailment groups were digestive (DG) diseases (513 URs, 22.8%) and the skin system (Sk) (331 URs, 14.7%).

Ethnoveterinary medicine

According to the URs of the Serbian interviewees, livestock consists primarily of cows, goats, pigs, and poultry, i.e., chickens. A few Albanian respondents are engaged in animal husbandry, with most of them keeping cows, goats, and chickens, while one household has buffaloes.

The research showed that 43 plant taxa are used to treat various ailments and diseases in ethnoveterinary medicine (793 URs). The results are systematized in Supplement 2 (Table 2), with data for each plant species mentioned during the research. The species are classified into 25 families. The most significant number of plant species was in the families Lamiaceae (6), Rosaceae (6), Asteraceae (4) and Poaceae (3). Families such as Oleaceae (108 URs, 13.6%), Rosaceae (101 URs, 12.7%), Polygonaceae (63 URs, 7.9%), Urticaceae (61URs, 7.7%), and Plantaginaceae (60 URs, 7.6%) were the most widely reported (Fig. 4). The most significant plant taxa were herbaceous plants (74.4%) and trees (25.6%). The most frequently used plant parts were leaf (238 URs, 30.1%), aerial part (182 URs, 22.9%), fruit (166 URs, 20.9%), bark (66 URs, 8.3%), flower (64 URs, 8.1%), underground parts (64 URs, 8.1%) and thorn (13 URs, 1.6%).

Plants used to treat various diseases are prepared and administered in different forms, such as tea or water extractions, infusions (180 URs, 22.7%), macerates (153 URs, 19.3%), poultices-compresses (86 URs, 10.8%), and decoctions (81 URs, 10.2%) (Fig. 5). Most URs mentioned oral application (533 URs, 69.7%), while fewer mentioned external application (240 URs, 30.3%).

Out of a total of 43 plant species that the respondents use in ethnoveterinary medicine, 31 are wild, and 12 are cultivated: *Allium cepa* L., *Allium sativum* L., *Avena sativa* L., *Calendula officinalis* L., *Capsicum annuum* L., *Cydonia oblonga* Mill., *Ficus carica* L., *Mentha x piperita* L., *Ocimum basilicum* L., *Solanum lycopersicum* L., *Tilia platyphyllos* Scop., and *Zea mays* L.

It was observed that the inhabitants of Rujan Mt. most often used the following plant species for treating animals: *Fraxinus ornus* (108 URs, 13.6%), *Helleborus odorus* (80 URs, 10.1%), *Cydonia oblonga* Mill. (66 URs, 8.3%), *Rumex patientia* L. (63 URs, 7.9%), *Urtica dioica* L. (61 URs, 7.7%), *Plantago major* L. (60 URs, 7.6%), and *Hypericum perforatum* L. (54 URs, 6.8%).

The primary reported groups of diseases were Di—diseases of the digestive tract (267 URs, 33.7%), Infectious (240 URs, 30.2%), Sk—skin (159 URs,

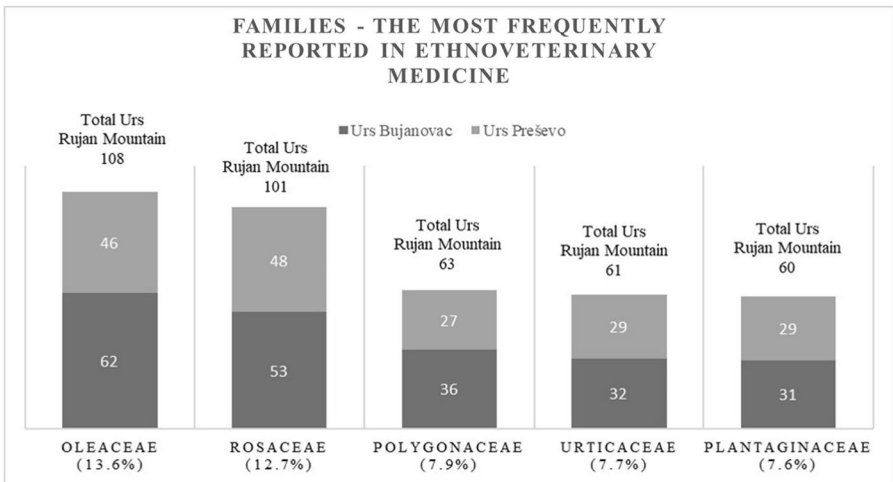

Fig. 4 The most frequently reported families of medicinal plants used in veterinary ethnopharmacology on Rujan Mt. and in two municipalities

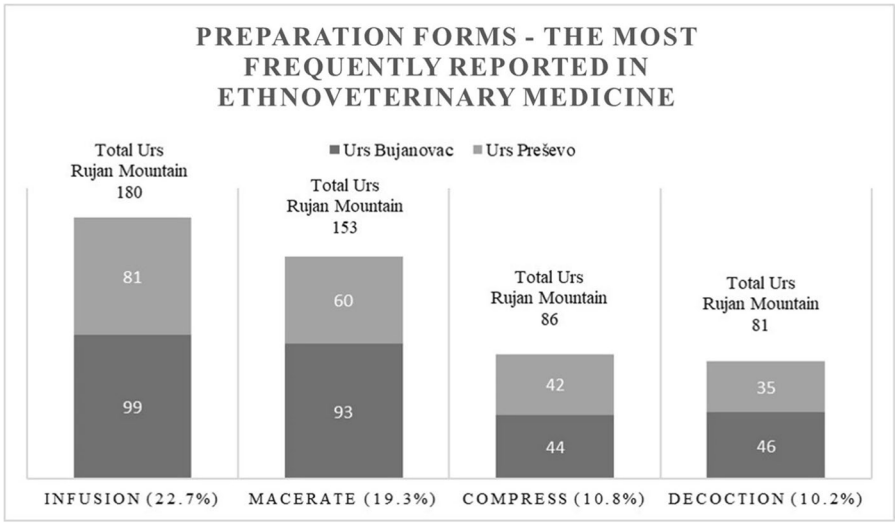

Fig. 5 The most frequently reported preparation forms of medicinal plants used in ethnoveterinary medicine on Rujan Mt. and in two municipalities

20.0%), Rs—respiratory system (65 URs, 8.2%) and Ci—circulatory (19 URs, 2.4%). The plant taxa most represented in each municipality and disease group are shown in Table 2.

Data on the use of plants by serbs and albanians

Of 101 total plant taxa used in human ethnopharmacology reported in the study, 75 (74.2%) were reported only by Serbs, 1 (1%) only by Albanians, and 25 (24.8%) were used by both Serbs and Albanians (Fig. 6A). Of 2254 URs in human ethnopharmacology, Serbs provided 775 URs, Albanians one, and 1478 URs were from Serbs and Albanians (Fig. 6B). Of 43 plant taxa used in ethnoveterinary medicine, 27 (62.8%) were reported only by Serbs, 3 (7%) were used only by Albanians, and 13 (30.2%) were used by both Serbs and Albanians (Fig. 7A). Out of 793 URs in ethnoveterinary medicine, Serbs gave 243 URs, and Albanians 27, while Serbs and Albanians gave totaling 523 URs (Fig. 7B). Although more Albanians live in the villages on Rujan Mt, the results show more use of plants by Serbs. The reason is the unwillingness of Albanians in certain villages to participate in the survey questionnaire.

Informant consensus factor for groups of ailments by ethnicity and gender

A comparison of the number of plant taxa, the number of reports on use, and the ICF between the municipalities on the Rujan Mt. is shown in

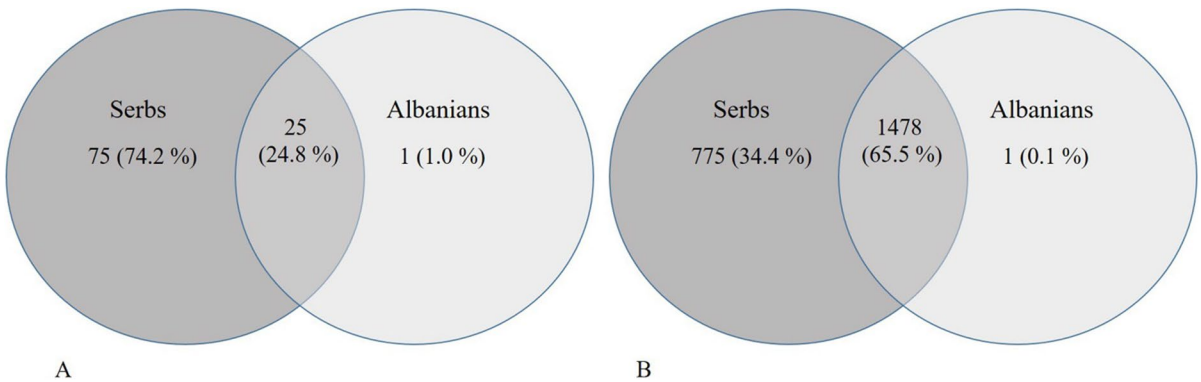

Fig. 6 The overlap of plant taxa (A) and URs (B) recorded by two ethnic groups in human ethnopharmacology on Rujan Mt.

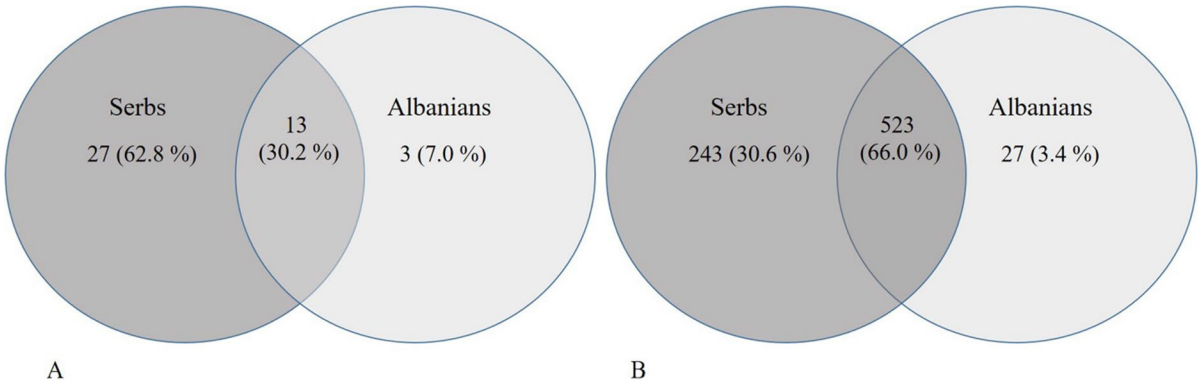

Fig. 7 The overlap of plant taxa (A) and URs (B) recorded by two ethnic groups in ethnoveterinary medicine on Rujan Mt.

Table 3 Comparison of gender and ethnicity for groups of diseases in ethnoveterinary medicine by analysis of informant consensus factors

Group of ailments	Sex	Number of used plant taxa				Number of URs				ICF*		
		SER[b]	ALB	Test and Sig	No. of different taxa	SER	ALB	Test and Sig	Σ	SER	ALB	Σ
Di	Male	17	6	Chi-square = 0.034 p = 0.853	20	109	35	Chi-square = 0.034 p = 0.853	144	0.9	0.9	0.9
	Female	15	6		17	91	32		123	0.8	0.8	0.9
	Σ	18	7		20	200	67		267	0.9	0.9	0.9
In	Male	6	3	Chi-square = 0.090 p = 0.764	7	126	14	Chi-square = 0.103 p = 0.748	140	1	0.9	1
	Female	6	4		8	90	10		100	0.9	0.7	0.9
	Σ	6	4		8	216	24		240	1	0.9	1
Sk	Male	10	1	Chi-square = 0.509 p = 0.476	10	81	2	Chi-square = 1.639 p = 0.201	83	0.9	1	0.9
	Female	8	2		8	71	5		76	0.9	0.8	0.9
	Σ	11	2		11	152	7		159	0.9	0.8	0.9
Rs	Male	5	2	Chi-square = 0.024 p = 0.876	6	37	4	Chi-square = 5.590 p = 0.018	41	0.9	0.7	0.9
	Female	6	2		7	16	8		24	0.7	0.6	0.7
	Σ	6	2		7	53	12		65	0.9	0.9	0.9
Re	Male	2	1	Chi-square = 1.000 p = 1.000	3	14	4	Chi-square = 0.942 p = 0.332	18	0.9	1	0.9
	Female	2	1		3	16	9		25	0.9	1	0.9
	Σ	2	1		3	30	13		43	1	1	1
Ci	Male	4	0	N/A	4	13	0	N/A	13	0.8	0	0.8
	Female	3	0		3	6	0		6	0.6	0	0.6
	Σ	4	0		4	19	0		19	0.8	0	0.8

[b] Ethnicity codes, SER—Serbian, ALB—Albanian, *ICF—Informant Consensus Factor, NA—statistical testing not applicable

Groups of diseases: Di—digestive, In—infectious, Sk—skin diseases, Rs—respiratory, Re—reproductive, Ci—circulatory

Tables 3 and 5. The highest consensus (ICF ˃0.90) in human ethnopharmacology in the municipalities of Bujanovac and Preševo was for digestive, skin, general and unspecified, blood, psychological, eye, and ear diseases. In veterinary ethnoveterinary medicine, the highest consensus (ICF ˃0.90) in these municipalities is for digestive, infectious, skin, and reproductive diseases.

ICF for human ethnopharmacology

Greater consensus in human ethnopharmacology in the municipality of Bujanovac is for skin (Sk), respiratory (Rs), urological (Ur), blood (Bl), female genital (Fg), psychological (Ps), carcinoma (Ca), small genital (Mg) and parasite (Pa) groups of diseases. In ethnoveterinary medicine, there is a greater consensus only for the circulatory (Ci) group of diseases; the same consensus for both areas is for digestive (Di), infectious (In) and skin (Sk) groups of diseases, while respiratory (Rs) and reproductive (Re) groups are more prominent in the municipality of Preševo. The greater consensus in Bujanovac is due to the higher number of settlements that participated in the survey.

The same plant was used in human ethnopharmacology in both municipalities for circulatory, blood, and psychological diseases, ear and eye diseases, and in ethnoveterinary medicine for digestive, infectious, and reproductive diseases.

The consensus factor of informants for groups of diseases according to ethnicity and gender in human ethnopharmacology is shown in Table 4. According to respondents' URs, 17 categories of diseases were formed. The highest consensus value (ICF $^{>}$0.90 or ICF = 0.90) was among Serbs for the digestive (Di) and skin (Sk) disease groups.

ICF for ethnoveterinary medicine

In ethnoveterinary medicine, the use of medicinal plants according to gender and ethnicity is shown in Table 3, with statistical analysis of the ICF. According to the respondents' URs for using plants to treat animals, six categories of diseases were formed. The results showed that the value of the informant consensus factor (ICF $^{>}$ 0.90 or ICF = 0.90) was higher for the digestive (Di), skin (Sk), and reproductive (Re) disease groups. The consensus factor of male informants of both nationalities is higher compared to females for infectious (In), respiratory (Rs), and circulatory (Ci) disease groups.

Statistical analysis

Results of the Chi-square test

The chi-square test ($\chi 2$) was performed to compare gender differences concerning ethnicity for several plant taxa used in human and ethnoveterinary medicine. The results showed that males and females in both cases (human and ethnoveterinary medicine) did not differ in the number of used taxa as regards ethnicity. In eight instances, Albanian males or females did not use plants in human ethnopharmacology for Bl, Fg, Ps, Ea, Ca, Mg, Ne, and Pa. In one case for Ci in ethnoveterinary medicine, it was not possible to perform statistical analysis.

Considering the number of URs concerning ethnicity, results showed gender differences in treating Sk for humans and Rs for ethnoveterinary medicine. As mentioned above, in a few cases, Albanian of both genderdid not use plants for the following groups of diseases: Fg, Ps, Ca, Mg, Ne, and Pa in human ethnopharmacology and Ci group of diseases in ethnoveterinary medicine.

Results of multivariate qualitative analyses

The leaves of species from the Amaryllidaceae, Moraceae, Plantaginaceae, and Salicaceae families, and aerial parts of Euphorbiaceae, Papaveraceae, Violaceae, and Vitaceae families, as well as the oil extracts of Hypericaceae, are used for the treatment of skin diseases in human ethnopharmacology. Fresh leaves of the family Crassulaceae are used to treat ear diseases (Fig. 8).

For animal skin diseases, the internal use of Oleaceae and the external use of Ranunculaceae and Apiaceae are common. The external use of species from the families Pinaceae, Amaryllidaceae, Moraceae, and Plantaginaceae in the form of fresh bark, macerate or fresh bulb or poultice, as well as the use of flowers from the family Hypericaceae in the form of oil extract, is common for the treatment of animal skin diseases (Fig. 9).

Results of correspondence analysis for human ethnopharmacology Results of correspondence analysis for human ethnopharmacology (Fig. 8) indicate a statistical connection among the two groups of analyzed elements regardless of the position of settlement on the mountain, age cohort, or gender of respondents:

- for the treatment of skin diseases: the use of a) leaf–folium (Fol) of families Amaryllidaceae (Ama), Salicaceae (Sal), Plantaginaceae (Pla) and

Table 4 Comparison of gender and ethnicity for groups of ailments in human ethnopharmacology by informant consensus factor analysis

Group of ailments	Sex	Number of used plant taxa				Number of URs				ICF*		
		SER[b]	ALB	Test and Sig.	No of different taxa	SER	ALB	Test and Sig.	Σ	SER	ALB	Σ
Di	Male	37	7	Chi-square = 0.009 p = 0.924	37	215	42	Chi-square = 0.514 p = 0.473	257	0.8	0.9	0.9
	Female	35	7		35	208	48		256	0.8	0.9	0.9
	Σ	44	8		44	423	90		513	0.9	0.9	0.9
Sk	Male	25	5	Chi-square = 0.075 p = 0.785	25	131	23	Chi-square = 4.035 p = 0.045	154	0.8	0.8	0.8
	Female	25	6		25	135	42		177	0.8	0.9	0.9
	Σ	32	6		32	266	65		331	0.9	0.9	0.9
Gu	Male	26	7	Chi-square = 0.108 p = 0.743	26	93	32	Chi-square = 0.139 p = 0.709	125	0.7	0.8	0.8
	Female	23	5		23	113	35		148	0.8	0.9	0.8
	Σ	31	7		31	206	67		273	0.9	0.9	0.9
Rs	Male	32	2	Chi-square = 0.250 p = 0.617	32	127	12	Chi-square = 0.985 p = 0.321	139	0.7	0.9	0.7
	Female	30	3		31	106	15		121	0.7	0.9	0.8
	Σ	39	3		40	233	27		260	0.8	0.9	0.9
Em	Male	25	5	Chi-square = 0.046 p = 0.830	25	88	25	Chi-square = 0.051 p = 0.821	113	0.7	0.8	0.8
	Female	26	6		28	76	20		96	0.7	0.7	0.7
	Σ	36	6		36	164	45		209	0.8	0.9	0.8
Ci	Male	15	4	Chi-square = 0.007 p = 0.931	17	94	4	Chi-square = 0.333 p = 0.564	98	0.9	0	0.8
	Female	14	4		16	62	4		66	0.8	0	0.8
	Σ	20	6		23	156	8		164	0.9	0.3	0.9
Ur	Male	14	1	Chi-square = 0.070 p = 0.791	14	48	1	Chi-square = 3.419 p = 0.064	49	0.7	0	0.7
	Female	20	2		20	56	7		63	0.7	0.8	0.7
	Σ	23	2		23	104	8		112	0.8	0.9	0.8
Bl	Male	7	0	NA	7	61	0	Chi-square = 0.108 p = 0.743	61	0.9	0	0.9
	Female	8	1		8	42	2		44	0.8	1	0.8
	Σ	10	1		10	103	2		105	0.9	1	0.9
Fg	Male	11	0	NA	11	30	0	N/A	30	0.7	0	0.7
	Female	13	1		14	46	1		47	0.7	0	0.7
	Σ	11	1		18	30	1		77	0.7	0	0.7
Ps	Male	4	0	NA	4	21	0	N/A	21	0.9	0	0.9
	Female	5	0		5	26	0		26	0.8	0	0.8
	Σ	7	0		7	47	0		47	0.9	0	0.9
Ms	Male	10	2	Chi-square = 0.889 p = 0.346	11	17	2	Chi-square = 3.584 p = 0.058	19	0.4	0	0.4
	Female	8	4		11	10	6		16	0.2	0.4	0.3
	Σ	14	4		16	27	8		35	0.8	0.6	0.6
Ea	Male	3	1	NA	3	11	7	Chi-square = 0.083 p = 0.774	18	0.8	1	0.9
	Female	2	1		2	9	7		16	0.9	1	0.9
	Σ	3	1		3	20	14		34	0.9	1	0.9
Ca	Male	9	0	NA	9	13	0	N/A	13	0.3	0	0.3
	Female	6	4		8	14	6		20	0.6	0.4	0.6
	Σ	10	4		12	27	6		33	0.7	0.4	0.7
Ey	Male	1	1	Chi-square = 0.000 p = 1.000	1	13	1	Chi-square = 0.871 p = 0.351	14	1	0	1
	Female	2	2		3	13	3		16	0.9	1	0.9
	Σ	2	2		3	26	4		30	1	0.7	0.9

Table 4 (continued)

Group of ailments	Sex	Number of used plant taxa				Number of URs				ICF*		
		SER[b]	ALB	Test and Sig.	No of different taxa	SER	ALB	Test and Sig.	Σ	SER	ALB	Σ
Mg	Male	2	0	NA	2	7	0	N/A	7	0.8	0	0.8
	Female	2	0		2	7	0		7	0.8	0	0.8
	Σ	2	0		2	14	0		14	0.9	0	0.9
Ne	Male	2	1	NA	3	2	2	N/A	4	0	1	0.3
	Female	3	0		3	5	0		5	0.5	0	0.5
	Σ	4	1		4	7	2		9	0.5	1	0.6
Pa	Male	2	0	NA	2	3	0	N/A	3	1	0	1
	Female	3	0		3	5	0		5	0.5	0	0.5
	Σ	3	0		3	8	0		8	0.7	0	0.7

[b] Ethnicity codes, SER - Serbian, ALB - Albanian, *ICF—Informant Consensus Factor, NA-statistical testing not applicable

Groups of diseases: Di—digestive, Sk—skin, Gu—general and unspecified, Rs—respiratory, Em—endocrinological, metabolic and nutritional, Ci—circulatory, Ur—urological, Bl—blood, Fg—female genital, Ps—psychological, Ms—musculoskeletal, Ea—ear, Ca—carcinomas, Ey—eye, Mg—male genital, Ne—neurological, In—parasites

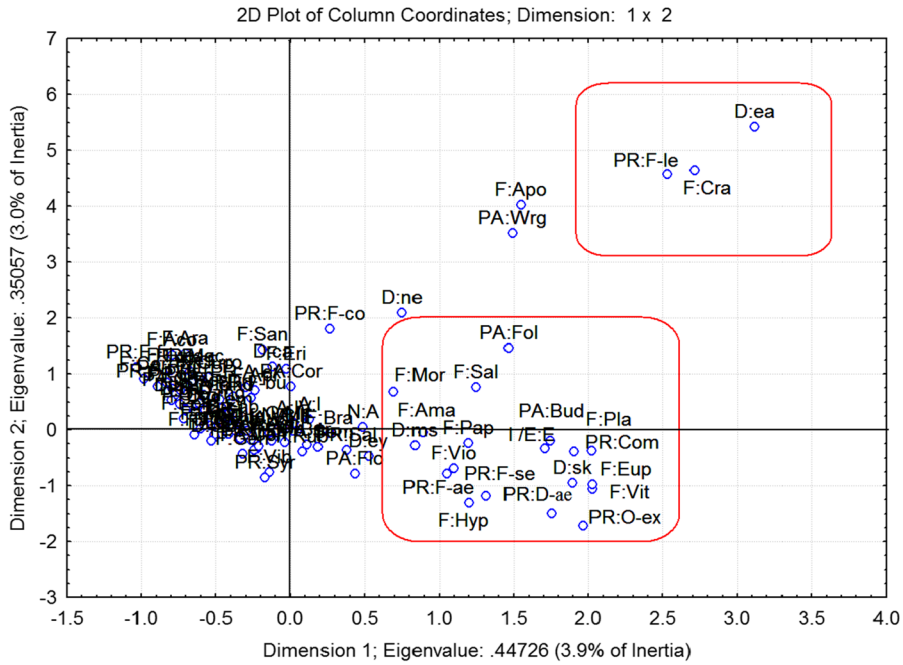

Fig. 8 Results of correspondent analysis—human ethnopharmacology on Rujan Mt.

Moraceae (Mor) in the form of poultices-compresses (Com).

a. b) the use of aerial part, also in the form of poultice (Com) of families Euphorbiaceae (Eup), Papaveraceae (Pap), Violaceae (Vio), and Vitaceae (Vit), c) the use of aerial part in the form of oil extract (O-ex) of family Hypericaceae (Hyp);

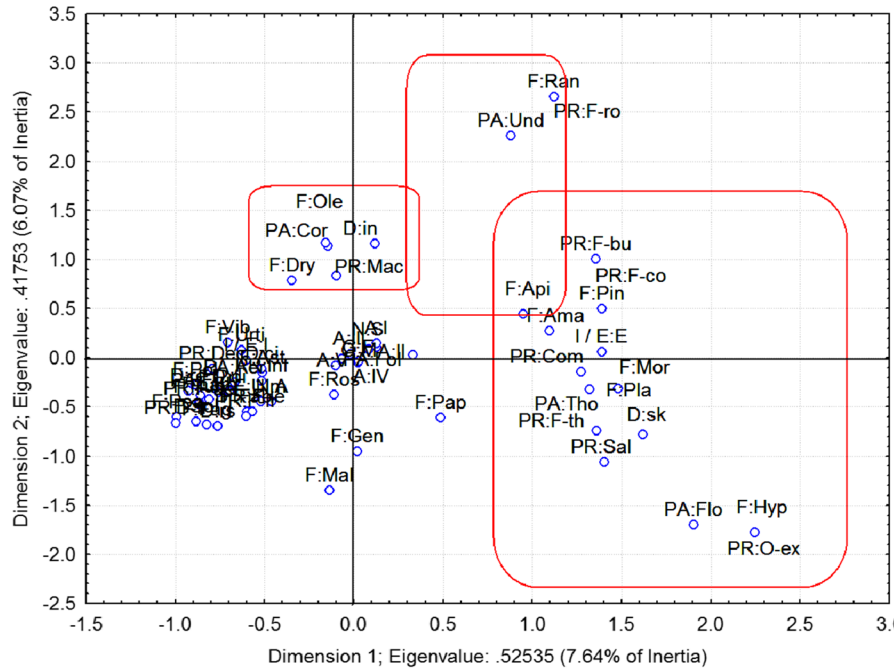

Fig. 9 Results of correspondent analysis—ethnoveterinary medicine on Rujan Mt.

- for treating the diseases of the ear: the use of fresh leaves (F-le) of the family Crassulaceae (Cra).

Results of correspondence analysis for ethnoveterinary medicine Based on the statements of respondents in the survey, the use of species from the families Pinaceae (Pin), Amaryllidaceae (Ama), Moraceae (Mor), and Plantaginaceae (Pla) is notable. Fresh leaves (F-le), fresh bulbs (F-bu), fresh bark (*cortex*) (F-co), or fresh ends (F-en) of shoots (thorns) are used, mainly as poultices or in ointments for external use in treating animal skin diseases. The use of oil extracted from the flowers of plants from the Hypericaceae (Hyp) family is also frequent. On the other hand, the internal use of Oleaceae species (*Fraxinus ornus* L.) in the form of macerate and external use of Apiaceae, and Ranunculaceae species (*Heracleum sphondylium* L. and *Helleborus odorus* Waldst. & Kit., respectively), as fresh-root poultices for the treatment of infectious diseases, is common. There is no association between the use of medicinal species, their preparation, and mode of administration with the ethnicity, age, or gender of respondents in the survey (Fig. 9).

Discussion

Small areas with unique historical and cultural backgrounds can be a source of new ethnobotanical knowledge, providing an essential basis for further pharmacological research. In this regard, the chosen region of Rujan Mountain, where two culturally distinct peoples, Albanians and Serb, have coexisted for centuries, is a unique environment that may have relevance for ethnobotany. Considering this area is unexplored from an ethnobotanical point of view, we tried to obtain data from the inhabitants about the use of plants for medicinal and veterinary purposes.

According to the respondents in the study, *Hypericum perforatum* L. (197 URs), *Matricaria chamomilla* L. (164 URs), *Urtica dioica* L. (126 URs), *Thymus glabrescens* Willd. (123 URs), and *Achillea millefolium* L. (104 URs) are the most widely utilized plant species in human ethnopharmacology on Rujan Mt.

Ethnobotanical research dealing with other Balkan regions also reported using these plant species for various remedies. The most often used plant species in ethnomedicine on the mountains Kopaonik (Jarić et al. 2007) and Rtanj (Zlatković et al. 2014) is *Hypericum perforatum* L. It is used differently

in southern and western Bosnia and Herzegovina than in our study, mostly in combination with other herbal species (for liver diseases, pulmonary gas, blood purification, and internal ulcers) (Supplement 1, Table 1, last column). *Matricaria chamomilla* L. was the most frequently mentioned plant species in the Negotin region (Janaćković et al. 2019), while *Achillea millefolium* L. was the most utilized in Delibatska Peščara (Popović et al. 2012), on Mt. Kopaonik (Mustafa et al. 2015), Mt. Suva Planina (Jarić et al. 2015), and in Kosovo (Mullalija et al., 2021). *Urtica dioica* L. and *Thymus glabrescens* Willd. are also used all over the Balkans for various remedies (Supplement 1, Table 1, last column).

Although the use of these plants in Serbia and the Balkans is widespread, there are various ways to prepare and administer them for treating the same condition, and some plant species can be used to treat very different diseases, depending on the region. In our study, *Achillea millefolium* L. was mentioned for the treatment of the following groups of diseases: circulatory and blood diseases, cancer, digestive diseases, endocrinological, metabolic and nutritional, female genital, musculoskeletal, general and unspecified, neurological, parasitic, respiratory, skin, and urological diseases (Supplement 1, Table 1). Other ethnobotanical research from the Balkans mentioned that *A. millefolium* L. is used for several purposes (Marković 2019; Mullalija et al. 2021). *A. millefolium* L. is applied on Mt. Rujan in compresses from fresh leaves, oil extracts with olive oil, and ointments with pork fat or infusions. At the same time, among the Albanians from Štrpce, it is mixed with milk fat to treat acne, and among respondents from Kosovo and Metohija as a tincture in combination with *A. absinthium* L. to treat gastritis (Mustafa et al. 2020; Mullalija et al. 2021). Corn silk (*Zea mays* L.) is usually used to treat gout and rheumatic pain. As a well-known diuretic, corn silk stimulates the elimination of toxins and uric acid from the body, which could be a possible explanation for why it is used for gout, edema, and arthritis (Šarić Kundalić et al., 2016; Mustafa et al. 2015; Matejić et al. 2020). Our research mentions corn silk for treating arthritis, kidney pain, and urinary infections.

Achillea millefolium L. is used against hemorrhoids in our study and in the study conducted in Turkey (Çakılcıoğlu and Türkoğlu 2009).

Selvi et al. (2022) determined that plants from the family Lamiaceae have traditional medicinal uses in Turkey. The following five plants were reported with some similar uses in our study: *Ocimum basilicum* L. against abdominal pain (stomachache) and cough; *Mentha* x *piperita* L., *Origanum vulgare* L., and *Teucrium chamaedrys* L. for the treatment of stomach diseases, and *Salvia verticillata* L. as a laxative. *Origanum vulgare* L. was used for toothache in Turkey, and in our study, *Salvia officinalis* L. was used. *Rosmarinus officinalis* L. was applied internally in Turkey, and in our study only externally. *Thymus glabrescens* Willd. is mentioned in our study but not reported in Turkey (Selvi et al. 2022).

The novelty of our data in comparison to the previously conducted ethnobotanical research in neighboring regions of Serbia and the Balkan Peninsula can be seen in the last columns of Tables 1 and 2 (Supplement 1, Table 1, last column, and Supplement 2, Table 2, last column).

The following 10 plant species that feature in our study and which are not mentioned in other ethnobotanical research from the Balkans on the traditional medicinal uses of plants for treating humans were investigated: *Althaea cannabina* L., *Citrullus lanatus* (Thunb.) Matsum. & Nakai, *Cruciata laevipes* Opiz, *Cyanus tuberosus* (Vis.) Soják, *Cyclamen hederifolium* Aiton, *Dryopteris filix-mas* (L.) Schott, *Lolium temulentum* L., *Nerium oleander* L., *Onopordum acanthium* L., and *Sorbus torminalis* (L.) Crantz (Supplement 1, Table 1, last column). Traditional uses of these plant species in the treatment of humans were not mentioned in previously conducted ethnobotanical research in neighboring regions of Serbia and the Balkan Peninsula, so their preparation recipes can be considered novelties of our study. The recipes for preparing remedies from mentioned plants for medicinal purposes in humans are given in the supplementary material (Supplement 3). In our work, we recorded 212 new uses of plants in ethnomedicine and 39 in ethnoveterinary medicine, which are listed with in Tables 1 and 2 (Supplement 1, 2).

In our work, the most common species mentioned in ethnoveterinary medicine were *Fraxinus ornus* L. (108 URs), *Helleborus odorus* Waldst. & Kit. (80 URs), *Cydonia oblonga* Mill. (66 URs), *Rumex patientia* L. (63 URs), and *Urtica dioica* L. (61 URs). These species are commonly used in the Balkans to treat various animal diseases (Supplement 2,

Table 2, last column). In ethnoveterinary medicine, as well as human ethnopharmacology, plant species often have several different purposes. For example, *Allium sativum* L. is used in our study to treat infections and swelling in domestic animals. Pieroni et al. (2011, 2014) and Marković et al. (2021) reported different uses of this species. *Urtica dioica* L. was mentioned by respondents in our study for treating diarrhea, improving appetite, strengthening the organism, and improving egg laying. The uses of *U. dioica* L. were also mentioned by Šubarević et al. (2015) and Mustafa et al. (2020).

By comparing the use of plants in our study (Supplement 2, Table 2, last column) with other Balkan research that investigated the traditional uses of plants for the treatment of animals, a list of 14 plant species specific of this study was obtained: *Cirsium ligulare* Boiss, *Clinopodium vulgare* L., *Cruciata levies* Opiz, *Heracleum sphondylium* L., *Lolium temulentum* L., *Malus sylvestris* L., *Mentha aquatica* L., *Ocimum basilicum* L., *Pinus nigra* J.F. Arnold, *Potentilla neglecta* Baumg., *Potentilla recta* L., *Quercus pubescens* Willd., *Robinia pseudoacacia* L., and *Solanum lycopersicum* L. Traditional uses of these plant species in treating domestic animals were not mentioned in ethnobotanical research from neighboring regions of Serbia and the Balkan Peninsula, so their preparation recipes can be considered novelties of our study. The recipes for medicinal use in domestic animals are given in the supplementary material (Supplement 4).

Plant species that have the same uses in humans and domestic animals on Rujan Mt. are most often used for diarrhea (*Centaurium erythraea* Rafn., *Potentilla recta* L., *Rumex patientia* L.), to expel parasites (*Dryopteris filix-mas* (L.) Schott, *Lysimachia nummularia* L.), and for improving food digestion (*Teucrium chamaedrys* L.) (Supplement 1, 2, Tables 1 and 2). Considering the Balkan Peninsula, *C. erythraea* Rafn. was mentioned against diarrhea in humans by Pieroni (2011) and Mustafa et al. (2020) and for the same use in domestic animals by Marković et al. (2021). *P. recta* L. was not mentioned for diarrhea in the other considered ethnobotanical papers from the Balkans for use in human and ethnoveterinary medicine. Herbal preparations that have the same application in humans and domestic animals are given in the supplementary material (Supplement 5).

We found that a significant number of URs in humans (1478 URs) and ethnoveterinary medicine (523 URs) are typical among Albanians and Serbs. This information indicates that the traditional use of medicinal plants has been preserved. The highest number of matching URs between the two groups of respondents is because they had lived in the studied areas for a long time, so the traditional knowledge about plant use was shared between the two ethnic groups. However, in the case of Serbs for each disease category, there is a more significant consensus value than for Albanians, pointing to a more homogeneous knowledge about the use of medicinal plants among Serbs compared to Albanians. However, there needs to be uniformity in the number of respondents by ethnicity, which is a shortcoming of the study. Pieroni et al. (2011) determined that the use of plants by respondents of different ethnicity is related to their cultural adaptation. A significant number of plant taxa are attributed to both Serbs and Albanians, and only a tiny percentage indicates diversity, which is probably due to religious and cultural influences.

There are some noteworthy differences between our findings and those of earlier research that compared the ethnobotanical practice of Serbs and Albanians in various regions of the Balkans.

Wild oregano (*Origanum vulgare* L.) is the most quoted and used medicinal herb in northern Albania and was cited by every Albanian interviewee on the Pešter plateau. In contrast, its use is more sporadic among Serbs (Pieroni et al. 2011). In our study, *O. vulgare* L. was mentioned only by Serbs.

The plant species used by Albanians and Serbs for skin problems mentioned in our study and also mentioned by the Albanian population from Peshkopi are *Allium cepa* L., *Hypericum perforatum* L., and *Sambucus nigra* L. The use of *A. cepa* and *H. perforatum* for treating skin problems in our study and Peshkopi is different. *Sambucus nigra* L. is used for the treatment of skin wounds by the Albanian population from Peshkopi and by Serbs on Rujan Mt. There is no similarity in reports about the use of plants for the treatment of skin problems between Albanians living in Peshkopi and on Rujan Mt. The plants that were most used for humans by Rujan Mt. Albanians were *Matricaria chamomilla* L. and *Tilia platyphyllos* Scop.

Species whose uses were common in Kosovo and Metohija mostly did not have the same use as in our study. According to the study of Mustafa et al. (2020), *Achillea millefolium* L. tea was used to treat

hypertension and earache, while in our study, these uses are not mentioned; *Arctostaphylos uva-ursi* (L.) Spreng. tea was used as a panacea, but in our work for kidney pain, *Hypericum perforatum* L. tea was used for treating heart disease, warts, and earache, while there was no report of these uses in our work.

In our research, there is more information about ethnoveterinary medicine among Serbs than among Albanians. *Allium sativum* L. was the plant species mentioned in ethnoveterinary medicine by old Albanians in our study and the study conducted on the Pešter plateau (Pieroni et al. 2011). *Achillea millefolium* L., *Allium cepa* L., and *Helleborus* sp. were the plant taxa mentioned by Serbs in the study of Pieroni et al. (2011) and our study (Supplement 2, Table 2, last column). The uses of *A. sativum* L. by Albanian respondents from Rujan Mt. and the Pešter plateau differed. On the Pešter plateau, Albanians used this species for massaging swollen udders. In our study, Albanians used it for eye infections in animals, while among Serbs, it had application in treating swelling. *Achillea millefolium* L., *Allium cepa* L., and *Helleborus* sp. are mentioned only by Serbian respondents on the Pešter plateau and in our study, and their applications are different (Supplement 2, Table 2, last column).

Correspondence analysis reflects the common ethnopharmacological practice in the study area, indicating connections among plant species and their use in traditional medicine. The results of the correspondence analysis for human ethnopharmacology indicate a statistical connection between two groups of analyzed elements, the first group around skin diseases (D: sk) and the second group around ear diseases (D: ea) (Fig. 8). The application of a few plant species identified as distinctive for our study based on correspondence analysis has yet to be mentioned in other ethnobotany research from the Balkans. Among the new uses of plants in human ethnomedicine are the use of the fresh leaves of *S. purpurea* L. for treating wounds, fresh leaves of *A. sativum* L. against swelling and bruises, aerial parts of *E. cyparissias* L. for external treatment of burns, and exudates of *V. vinifera* L. for the removal of warts. Also, internal treatment of psoriasis with the aerial part of *Ch. majus* L. as syrup can be considered a novelty of our research.

Numerous investigations from the Balkans have already described the applications of other plants that were singled out as distinctive in our investigation. The use of *H. perforatum* L. oil extract against skin diseases, particularly wounds and burns, the administration of fresh *S. tectorum* L. leaves for the treatment of earache, *Ch. majus* L. against skin wounds, and the external application of *P. major* L. leaves for the treatment of skin wounds as a poultice are all common practices in various Balkan regions (Supplement 1, Table 1, last column). However, the use of skin poultices from the aerial part of *V. odorata* L. for the treatment of eczema, and psoriasis has been documented only in the Svrljig region (Matejić et al. 2020), while the treatment of skin swelling with *A. cepa* L. leaves has already been mentioned by Jarić et al. (2015) and Matejić et al. (2020).

Also of interest to our work is the administration of another plant, *F. carica* L., which is used to treat warts throughout the Balkans in various forms. On Mt. Rujan, the plant's leaves or fruits are pulled off, and the leaking 'milk' is applied to the warts as a poultice. Similarly, Mateji et al. (2020) discuss using *F. carica* L. leaves. This plant can also be utilized in the form of juice (Šarić Kundalić et al. 2010 or latex (Mustafa et al. 2020; Mulalija (2021).

The correspondence analysis results for ethnoveterinary knowledge on Rujan Mt. indicate no statistical connection between the two analyzed elements, the first group being skin diseases and the second group infectious diseases (Fig. 9).

Some applications of plants in ethnoveterinary medicine, singled out by corresponding analysis, are mentioned for the first time on Mt. Rujan. Thus, the *Allium cepa* L. bulb and *Allium sativum* L. leaves are used to treat swelling in domestic animals. The bulb is cut in half and placed on the swelling, while the dry leaves of *Allium sativum* L. are covered with boiling water and left to stand for 5 min. The leaves are then placed on a piece of cloth and applied to swelling on the udder of a cow, goat, or after farrowing in pigs. Based on the study by Pieroni et al. (2011), it is known that these species can be used to treat skin conditions. A novel use of *Ficus carica* L. in ethnoveterinary medicine is the compression of the leaves to cure animal skin diseases, such as warts on the udder. The use of *F. carica* L. in animal healing has been mentioned in research by Marković et al. (2021).

Additionally, new to ethnoveterinary medicine is the use of *Pinus nigra* J.F. Arnold bark to treat wounds or thickening on animal skin. Fresh bark

from the plant is peeled off and burned, resulting in a black tar that is used to lubricate the thickened skin. None of the analyzed papers mentioned the use of *Pinus nigra* J.F. Arnold for ethnoveterinary purposes. On the other hand, it was documented that *Plantago major* L. leaves can be used to treat animal skin wounds in the form of poultices (Šubarević et al. 2015; Mustafa et al. 2020; Marković et al. 2021). The uses of plants identified by corresponding analysis as specific for the infectious group of diseases in animals, such as *Fraxinus ornus* L. against infections in chickens and the root of the *Helleborus odorus* Waldst. & Kit., have previously been reported in ethnobotanical research from the Balkans (Supplement 2, Table 2, last column).

Conclusion

Our study identified 144 plant taxa used for human medicine and veterinary purposes by the Serbian and Albanian population on Rujan Mt. The results show a greater diversity of plants used to treat human ailments; 101 plant taxa were reported for this purpose, while 43 taxa were used for treating animal conditions. Several plant applications specific of this area have not yet been published in other ethnobotanical research from the Balkans, which signifies the contribution of this study to the expansion of ethnobotanical knowledge in this region. In addition, the comparative presentation of plant uses for treating humans and animals enabled a comparison of remedies in human and animal ethnomedicine. The knowledge of local people about the use of traditional herbal medicines in the study area could serve as a foundation for further scientific research to demonstrate the efficacy of local herbal remedies.

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Declarations

Competing interests The authors declare no competing interests.

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