Traditional knowledge of medicinal and aromatic plants after the demographic changes in Bosnia and Herzegovina

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Abstract. Regardless of migration of the population from rural to urban areas, traditional knowledge of medicinal and aromatic plants still exists in Bosnia and Herzegovina. An ethnobotanical interview has been conducted in 48 rural settlements. For every cited species, the form of use, useful parts, common name, and application were recorded. At the population level, frequency citation, relative frequency of citation and use value have been studied, in order to determine the significant plants for the local community. The participants use actively 91 plant species from 44 families. The highest number of medicinal plants belongs to the families *Lamiaceae* and *Rosaceae*. The respondents use mostly the leaves, followed by inflorescences, roots, fruits, and herbage. Plants are usually applied in the form of infusions, cordials, food supplements, and tonics. Even though the settlements have been affected by mass migration of the population, traditional knowledge related to the use of medicinal and aromatic plants still persists. Respondents over 45 years of age have reported that they know how to use 11 species of useful plants on the average. That average number goes much lower with young respondents up to 25 years of age. A marked decline has been noted in the intergenerational knowledge transfer and 17.53% of the younger respondents have never used any traditional medicine, irrespective of the fact that they can list up to five different plants. The presented results of this research should provide a basis for further investigations and management activities in the ethnobotany of Bosnia and Herzegovina.

Key words: demographics, ethnobotanical interview, loss of traditional knowledge, useful plants

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Introduction

It has been estimated that over 70 000 plant species on Planet Earth are used in folk medicine (Farnsworth & Soejarto 1991; Lange 2004; Mittermeier & al. 2004). In Europe, about 2000 medicinal and aromatic plants are utilized for commercial purposes (Lange 1998). India, where over 7500 me-

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dicinal plants are used, is believed to have the longest history of traditional use of medicinal plants (Shankar & Majumdar 1997). In China, the number of medicinal plants ranges from about 6000 to 10 000 (Xiao 1991; He & Sheng 1997). Of that number, 1000 species of medicinal plants are used daily in the Chinese medicine, and half of them are considered to be of major medical importance (He & Sheng 1997). In Africa, there are fewer known medicinal plants and their number ranges somewhere up to 5000 species (Iwu 2014). There are about 1500 medicinal plants in Germany, and about 800 medicinal and aromatic plants in Spain, 450 of which are used for commercial purposes (Blanco & Breaux 1997, unpubl.; Lange 1998, 2004).

Of the 2000 medicinal and aromatic species used for commercial purposes (Lange 2004), about 1200-1300 are indigenous to the territory of Europe. Most medicinal plants originate from natural ecosystems, and the rest are cultivated. However, selling of medicinal plants on the market varies by country: for example, in Hungary, the medicinal plants sold on the market claim about 30-50%, while in Albania and Turkey, their percentage is almost 100% (Vojniković & al. 2013). The World Health Organization has published a list of 21 000 medicinal plant species. More than half of the medicines in the world are made from plants or represent synthetic copies of the plant substances (Groombridge 1992). It is believed that every fourth plant finds some form of use in human therapy (Groombridge 1992; Lange 1998, 2004).

Bosnia and Herzegovina belong to a group of countries with extremely high levels of biodiversity. About 5000 vascular plants are estimated to grow in Bosnia and Herzegovina, including varieties, species and subspecies (Redžić 2007) . They include about 3000 species of blue-green and other algae, and 3000-5000 fungi and lichen species. According to the official data, only 40 species of vascular plants are used for medial purposes, though the latest ethnobotanical research reports a much higher number, ranging on 747 plant species (Macanović & Barudanović 2021).

According to Redžić (2007), medicinal plant species from the area of Bosnia and Herzegovina inhabit 53 different types of ecosystems, which indicates significant ecological and floristic diversity. The use of medicinal and aromatic plant species has been crucial for sustaining life during the recent war in Bosnia and Herzegovina, especially in the besieged cities (Redžić 2006). During the war (1992-1995) in Bosnia and Herzegovina, in the area of Podrinje and Žepa alone, the inhabitants have used a great number of wild medicinal and edible plants and over 40 types of mushrooms and lichens (Redžić & al. 2010). It has been established that many plant species with distant habitats from the populated areas, regardless of their nutritional value, do not find use in human nutrition (Redžić 2006). A similar phenomenon has been noted in the use of medicinal plants (Lakušić & al. 1980, 1991; Redžić & al. 1989, 1990).

The economic value of natural resources in Bosnia and Herzegovina is estimated as extremely high. The latter has been confirmed by the official data on exports of non-timber forest products from 2010 year onwards. An estimated number of over 100 000 families collect medicinal plants in their traditional livelihood practices (Vejzagić-Ramhorst & Miskin 2010; Vojniković & al. 2013).

Under the Convention on Biological Diversity, traditional knowledge is defined as knowledge, innovations or practices of local communities around the world. It has been accumulated over the centuries, and has evolved and been adapted to the needs of local communities. It is preserved by passing from generation to generation in the form of folk narration or customs (Molnar & al. 2008). Unfortunately, with abandonment of rural areas, most traditional knowledge is gradually forgotten and the available ecosystem services remain unused.

This paper explores the state of traditional knowledge in the abandoned areas and rural settlements of Bosnia and Herzegovina, recognized for their numerous natural resources and tradition. The main objective of the research has been to record knowledge about the traditional use of medicinal plants in Bosnia and Herzegovina in selected rural settlements.

Material and methods

Reserch area

The surveyed area extends at an altitude of 400 m to 800 m, and includes the basin area of river Neretva in Bosnia and Herzegovina, with its numerous tributaries. The climate is mostly sub-Mediterranean to moderately continental. The area is heavily affected by the warm air waves that travel through the Neretva Canyon and reach the borderlines of Herzegovina region. The surveyed area includes 48 settlements from the areas of Central and North Herzegovina and Central Bosnia. For each settlement, the following data have been collected: name, GPS coordinates, altitude, and number of inhabitants (Table 1).

Table 1. List of settlements with the number of inhabitants.

Settlements	Coordinates	No of inhabitants per settlement	
		1991	2013*
Argud	43°31'8.98"N 18°17'1.92"E	74	34
Banjdol	43°17'29.06"N 17°55'52.38"E	317	77
Bare	43°49'11.16"N 17°50'15.35"E	172	29
Blagaj	43°15'27.05"N 17°53'46.24"E	1804	2684
Boždarevići	43°43'58.70"N 17°52'37.48"E	168	58
Brđani	43°42'28.09"N 18° 0'48.11"E	436	195
Bukovlje	43°47'46.28"N 17°52'10.74"E	183	64
Čelina	43°46'6.60"N 17°45'53.14"E	132	73
Čuhovići	43°38'17.61"N 18° 8'29.31"E	162	58
Dobrč	43°21'10.72"N 17°52'31.56"E	196	45
Doljani	43°29'44.53"N 18°14'30.66"E	85	29
Donji Gradac	43°43'32.91"N 17°51'44.45"E	224	88
Dračevice	43°16'50.01"N 17°52'44.11"E	809	1338
Džanići	43°48'3.02"N 17°50'51.99"E	51	13
Džepi	43°40'9.65"N 18° 1'30.08"E	721	303
Glavatičevo	43°29'53.25"N 18° 6'44.20"E	547	194
Gobelovina	43°46'23.41"N 17°55'13.26"E	147	45
Gorani	43°44'54.40"N 17°48'13.36"E	366	75
Gornje Gnojnice	43°19'33.68"N 17°53'35.11"E	526	109
Gornje Višnjevice	43°44'47.61"N 17°52'14.70"E	228	88
Gornji Nevizdraci	43°42'56.87"N 17°52'7.66"E	217	155
Grabovci	43°42'54.20"N 17°54'54.16"E	265	157
Jasenica	43°17'10.71"N 17°47'51.47"E	2071	1696
Jasenik	43°49'59.57"N 17°50'37.86"E	410	204
Kruščica	43°48'37.81"N 17°48'9.04"E	314	143
Kružanj	43°17'4.09"N 17°56'41.75"E	840	284
Luka	43°32'30.70"N 18°13'51.91"E	170	≤10
Lukomir	43°38'12.52"N 18°10'53.43"E	156	41
Ljesovina	43°45'23.06"N 17°50'14.90"E	80	≤10
Milišići	43°40'7.60"N 18°15'9.73"E	73	28
Obri	43°43'4.13"N 17°50'52.98"E	286	57
Odžaci	43°31'7.42"N 18°13'38.98"E	105	80
Oteležani	43°45'54.04"N 17°47'59.75"E	205	162
Podhum	43°45'4.99"N 17°49'6.30"E	194	82
Podvelež	43°18'33.08"N 17°54'47.01"E	692	181

Settlements	Coordinates	No of inhabitants per settlement	
		1991	2013*
Požetva	43°50'48.10"N 17°51'29.30"E	60	≤10
Raotići	43°46'16.32"N 17°52'32.27"E	104	53
Raštani	43°22'25.07"N 17°49'37.97"E	1451	1523
Repovci	43°45'20.04"N 17°58'8.20"E	193	141
Seonica	43°44'24.18"N 17°50'32.16"E	252	100
Solakova Kula	43°47'57.67"N 17°47'55.04"E	186	42
Stojkovići	43°46'15.02"N 17°56'33.43"E	110	28
Šabići	43°39'27.31"N 18°15'53.31"E	37	17
Tušila	43°36'53.60"N 18°15'40.67"E	180	74
Umoljani	43°40'4.65"N 18°13'37.89"E	92	43
Vojno	43°24'50.70"N 17°52'9.00"E	622	546
Vrdolj	43°39'21.11"N 18° 2'53.56"E	197	73
Zabrđani	43°29'17.57"N 18°12'37.62"E	72	23

The last official census of the population in Bosnia and Herzegovina in 2013 (source: http://www.statistika.ba/).

Research topic

Intensive field research has yielded varied traditional knowledge and practices. The method of direct ethnobotanical interview (semi-directive interview) (Huntington 2000; Redžić 2006, 2007, 2010; Šarić-Kundalić & al. 2010, 2016; Rai & al. 2011; Jacobs & al. 2014) was used. The aim of applying that survey model was to collect as much data as possible about the medicinal plants, their effect, common names, preparation recipes, etc.

Data collection and processing

The survey was conducted on the territory of Bosnia and Herzegovina, in the period from 2015 to 2023. A total of 717 respondents were interviewed. The population from rural areas, known for their traditional products in the market, was included. Subjects were selected at random and individual settlements were not favoured. The cited plants were collected, herbarized and identified and then stored in the Herbarium of the Faculty of Sciences at the University of Sarajevo. Nomenclature of the species and families was given in accordance with the Euro-Med checklist (Euro+Med 2006).

Quantitative ethnobotanical analysis

Data from the field survey were organized in an Excel sheet for quantitative analysis. The usage reports were prepared following Tardío & Pardo-de-Santayana (2008) and further applied for the calculation of quantitative ethnobotanical indices: frequency of citation (FC), relative frequency of citation (RFC) and use value (UV). Frequency of citation (FC) was calculated as sum of informants citing the use of a particular species.

Relative frequency of citation (RFC) was used to show the importance of each species in the study area (Phillips & al. 1994). That index showed the local importance of each species and was provided after the frequency of citation (FC, the number of informants mentioning the use of the species) was divided by the total number of informants participating in the survey (N), without consideration of the use categories. RFC values were calculated according to the following formula:

$$RFC = \frac{FCs}{N},$$

where FC_s was frequency of citation and N was the total number of informants in the survey. A high RFC value for a species indicated that the species was used both frequently and by a high proportion of informants in the study area.

Use value (UV) was applied to measure the relative importance of a locally used species (Phillips & al. 1994). UV was calculated according to the following formula:

$$UV = \frac{\sum Ui}{n},$$

where U_i was the number of UR_s cited by each informant for a given species and *n* refered to the total number of informants.

Use values are high, when there come many use reports for a plant, implying that the plant is important, and low (approaching 0), when there are few reports related to its use. The use value, however, does not manifest whether a plant is used for single or multiple purposes (Tardio & al. 2008; Abe & Ohtani 2013; Zhang & al. 2020).

Pearson correlation coefficient

With the help of descriptive statistics the frequency and percentage representation of the results was determined using a Microsoft Excel software package, and the most important results have been presented in tables and charts. Pearson product-moment correlation coefficient has been useful for quantifying numerically the nature of the linear relationship between two variables. Pearson correlation coefficient is the ratio of covariance between two variables (Bano & al. 2014). The ethnobotanical interview data have been analyzed in order to determine a positive correlation (significance level p=0.05) between the number of plants/taxa and age of respondents, in order to determine the trend of loss of traditional knowledge across generations.

Results and discussion

The ethnobotanical interview was completed with the help of 717 respondents from 48 villages (Table 1) on the territory of Bosnia and Herzegovina. The interview included men (66.53%) and women (32.64%); 4.60% of the respondents did not declare their gender. In the conducted study, respondents were divided into four age groups: young (I group: 18 to 25 years), mature (II group: 26 to 45 years), adult (III group: 46 to 65 years), and elderly (IV group: over 66 years). The youngest respondents were 18 years and the oldest 92 years old (Table 2). The average age of respondents was 37 years. The cited plant species by the respondents were presented alphabetically in Table 3, along with the professional name, common name, family, frequency of citation (FC), relative frequency of citation (RFC), cultivation, and use values (UV).

According to the ethnobotanical interview, respondents use 90 plants species and one lichen species In terms of their systematic affiliation, the plant species belong to a total of 44 families, with prevalence of: *Lamiaceae* (13.33%), *Rosaceae* (13.33%), *Asteraceae* (11.56%), *Amaryllidaceae* (5.60%), and *Ericaceae* (4.44%). The results of the studies coincide with those from some earlier studies by Rexhepi & al. (2014); Miskoska-Milevska & al. (2020) and Redžić (2006). Most plant species are cited only once (Fig. 1). They are divided into three groups: wild, cultivated and semicultivated. Respondents have mostly cited the use of wild species: 67 (74%), followed by cultivated (13%) and semicultivated (13%), 24 species altogether (Fig. 2).

Table 2. Participation of respondents by gender and age.

Age (category)	Male	Female	Total number	Percentage
18-25 (I)	123	182	308	42.96%
26-45 (II)	49	188	240	33.47%
46-65 (III)	51	55	136	18.98%
66-85 (IV)	11	22	33	4.60%
Total	**234**	**477**	**711**	**100%**

Undeclared: 6

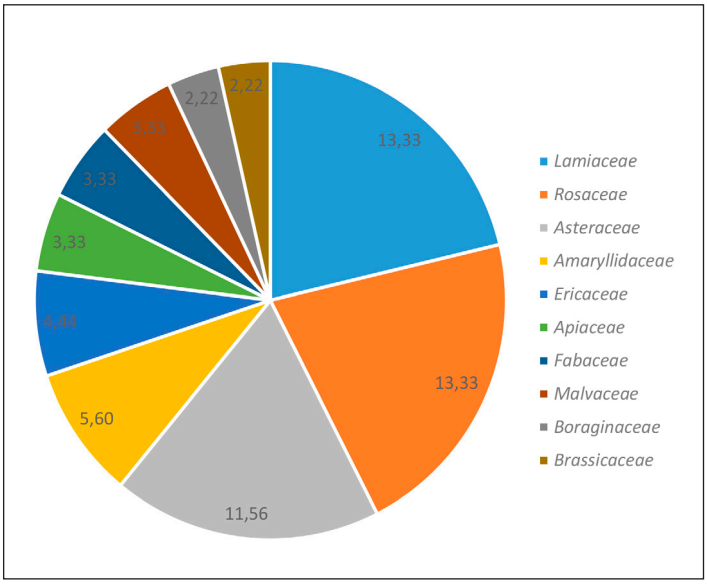

Fig. 1. Frequency of useful species, according to the best represented families (%).

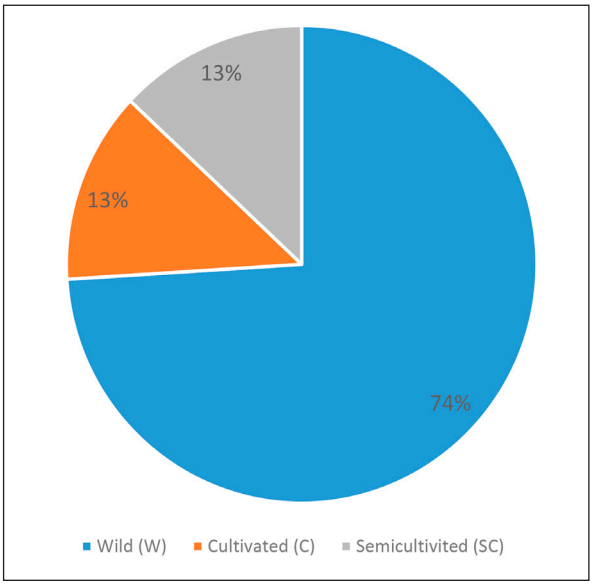

Fig. 2. Representation of useful plants (%) by groups: wild (W), cultivated (C) and semicultivated (SC).

The best known and widest consumed medicinal species are: *Mentha* sp. (RFC 0.238; *Mentha arvensis, M. aquatica*, *M. longifolia*, *M. pulegium*), followed by *Matricaria chamomilla* (RFC 0.160), *Achillea millefolium* (RFC 0.149), *Salvia officinalis* (RFC 0.130), *Sambucus nigra* (RFC 0.130), *Hypericum perforatum* (RFC 0.127), ect. (Table 3). Regarding the collection of medicinal plants, most respondents collected them by picking (58.29%).

Research has confirmed that the respondents mostly collect medicinal plants by regular harvesting (58.29%). Some of the respondents buy (44.35%) but also grow (23.71%) medicinal plants regularly. Research has shown that respondents over the age of 65 have been the ones who mostly harvest (72.73%) and grow medicinal plants (27.27%).

Those who collect medicinal plants in the lowest numbers (42.73%) and mostly buy them (59.58%) are respondents younger than 45 years.

The practice of collecting medicinal plants is less used today, although it has been recorded by ethnobotanical interviews. With regard to the use of plant parts, certain plants are used entirely, and others with only some of their parts (e.g. root) (Fig. 3). In terms of usable parts, respondents mostly cited leaves (54), followed by inflorescences (44), roots (28), fruits (24), entire plant (21), stem (13), seed (6), bark (3), and pedicel (2). Medicinal plants with the greatest number of usable parts are: *Achillea millefolium*, *Salvia officinalis*, *Hypericum perforatum*, *Taraxacum campylodes*, *Urtica dioica*, *Rosa canina*, and *Cichorium intybus*. Up to four useful parts have the species: *Sambucus nigra*, *Vaccinium myrtillus*, *V. vitis-idaea*, *Althaea officinalis*, *Alchemilla xanthochlora*, and *Calluna vulgaris*. Up to three usable parts have the following plants: *Mentha* sp., *Crataegus monogyna*, *Rubus* sp., *Primula vulgaris*, *Equisetum arvense*, *Allium sativum*, *Artemisia* sp., *Petroselinum crispum*, etc. In the greatest number of the cited plant species, only one part is used. Some of such species are: *Cucurbita* sp., *Cydonia oblonga*, *Ficus carica*, *Hedera helix*, *Prunus armeniaca*, *P. avium, P. domestica*, *Salix* sp., *Sesamum* sp., *Valeriana officinalis*, *Verbascum* sp., *Vitis* sp., *Zea mays*, etc.

The modes of plants use differ and are presented in Fig. 4. A great number of plants have multiple forms of preparation and use. The plant species with the highest number of citation also have several forms and ways of use, which is in agreement with the conclusions of Redžić (2006). Dandelion has the greatest number of utilization techniques, as many as seven (7), followed by species with five (5) techniques each: *H. perforatum*, *U. dioica*, *Beta vulgaris*, *Aronia* sp., *Vi-*

Table 3. Wild and cultivated taxa used in Bosnia and Herzegovina, with data on frequency citation (**FC**), relative frequency of citation (**RFC**) and use value (**UV**).

Family	Species (*Latin name*)	Local name	W/SC/C	FC	RFC - ICF	UV
Asteracae	*Achillea millefolium* L.	kunica	W	107	0.149	0.250
Sapindaceae	*Aesculus hippocastanum* L.	kesten divlji	W	2	0.003	0.005
Rosaceae	*Alchemilla xanthochlora* Rothm.	vrkuta	W	12	0.017	0.028
Amaryllidaceae	*Allium cepa* L.	luk crveni kapula	C	1	0.001	0.002
Amaryllidaceae	*Allium sativum* L.	bijeli luk	C	10	0.014	0.023
Amaryllidaceae	*Allium ursinum* L.	medvjeđ luk	W	2	0.003	0.005
Xanthorrhoeaceae	*Aloe vera* (L.) Burm.f.	aloe vera	SC	1	0.001	0.002
Malvaceae	*Althaea officinalis* L.	šljez	W	16	0.022	0.037
Rosaceae	*Amelanchier* sp.	aronija	C	1	0.001	0.002
Fabaceae	*Anthyllis vulneraria* L.	ranjenik	W	2	0.003	0.005
Asteraceae	*Arctium lappa* L.	čičak	W	1	0.001	0.002
Ericaceae	*Arctostaphylos uva-ursi* (L.) Spreng.	medvjeđe uho	W	6	0.008	0.014
Asteraceae	*Artemisia* sp.	pelin	W	7	0.010	0.016
Chenopodiaceae	*Beta vulgaris* subsp. *maritima* (L.) Arcang.	cvekla	C	6	0.008	0.014
Betulaceae	*Betula pendula* Roth	breza	W	1	0.001	0.002
Brassicaceae	*Brassica oleracea* L.	kupus	C	1	0.001	0.002
Asteraceae	*Calendula officinalis* L.	neven	SC	17	0.024	0.040
Ericaceae	*Calluna vulgaris* (L.) Hull	vrijesak	W	5	0.007	0.012
Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	rusomača	W	1	0.001	0.002
Apiaceae	*Carum carvi* L.	kim	SC	5	0.007	0.012
Parmeliaceae	*Cetraria islandica* (L.) Ach.	islandski lišaj	W	4	0.006	0.009
Asteraceae	*Cichorium intybus* L.	konjogriz	W	16	0.022	0.037
Lauraceae	*Cinnamomum verum* J. Presl	cimet	C	4	0.006	0.009
Cornaceae	*Cornus mas* L.	drijen	W	7	0.010	0.016
Rosaceae	*Crataegus monogyna* Jacq.	glog	W	19	0.026	0.044
Cucurbitaceae	*Cucurbita* sp.	tikva	C	1	0.001	0.002
Zingiberaceae	*Curcuma longa* L.	kukurma	C	1	0.001	0.002
Rosaceae	*Cydonia oblonga* Mill.	dunja	W	1	0.001	0.002
Equisetaceae	*Equisetum arvense* L.	preslica	W	13	0.018	0.030
Orobanchaceae	*Euphrasia* sp.	vidac	W	2	0.003	0.005
Moraceae	*Ficus carica* L.	smokva	W	1	0.001	0.002
Apiaceae	*Foeniculum vulgare* Mill.	komorač	SC	5	0.007	0.012
Rosaceae	*Fragaria vesca* L.	jagoda	W	2	0.003	0.005
Gentianaceae	*Gentiana lutea* subsp. *symphyandra* (Murb.) Hayek	lincura	W	3	0.004	0.007
Araliaceae	*Hedera helix* L.	bršljan	W	1	0.001	0.002
Asteraceae	*Helichrysum italicum* (Roth) G. Don	smilje	SC	6	0.008	0.014

Family	Species (*Latin name*)	Local name	W/SC/C	FC	RFC - ICF	UV
Cannabaceae	*Humulus lupulus* L.	hmelj	W	10	0.014	0.023
Hypericacee	*Hypericum perforatum* L.	kantarion	W	91	0.127	0.213
Juglandaceae	*Juglans regia* L.	orah	W	2	0.003	0.005
Cupressaceae	*Juniperus communis* L.	smreka	W	4	0.006	0.009
Lamiaceae	*Lavandula angustifolia* Mill. subsp. *angustifolia*	lavanda	SC	1	0.001	0.002
Linaceae	*Linum* sp.	lan	W	1	0.001	0.002
Rosaceae	*Malus* sp.	jabuka kisela	W	2	0.003	0.005
Malvaceae	*Malva* sp.	crni sljez	W	1	0.001	0.002
Lamiaceae	*Marrubium vulgare* L.	macina trava	W	4	0.006	0.009
Asteraceae	*Matricaria chamomilla* L.	kamilica	W	115	0.160	0.269
Lamiaceae	*Melissa officinalis* L.	matičnjak	SC	13	0.018	0.030
Lamiaceae	*Mentha pulegium* L.	verem	W	2	0.003	0.005
Lamiaceae	*Mentha* sp.	nana	W	171	0.238	0.400
Rosaceae	*Morus alba* L.	dud	W	2	0.003	0.005
Ranunculaceae	*Nigella* sp.	ćurokot	W	1	0.001	0.002
Lamiaceae	*Ocimum basilicum* L.	bosiljak	SC	3	0.004	0.007
Fabaceae	*Onobrychis viciifolia* Scop.	grahorika	W	3	0.004	0.007
Lamiaceae	*Origanum vulgare* subsp. *viridulum* (Martrin-Donos) Nyman.	vranilova trava	W	4	0.006	0.009
Apiaceae	*Petroselinum crispum* (Mill.) Fuss	peršun	C	7	0.010	0.016
Pinaceae	*Pinus* sp.	bor	W	13	0.030	0.030
Plantaginaceae	*Plantago* sp.	bokvica	W	38	0.053	0.089
Primulaceae	*Primula vulgaris* Huds.	jagorčevina	W	15	0.021	0.035
Rosaceae	*Prunus armeniaca* L.	marelica	W	1	0.001	0.002
Rosaceae	*Prunus avium* (L.) L.	trešnja	W	1	0.001	0.002
Rosaceae	*Prunus domestica* L.	šljive	W	1	0.001	0.002
Boraginaceae	*Pulmonaria officinalis* L.	plućnjak	W	2	0.003	0.005
Lythraceae	*Punica granatum* L.	nar	W	1	0.001	0.002
Rosaceae	*Rosa canina* L.	šipak	W	40	0.056	0.093
Lamiaceae	*Rosmarinus officinalis* L.	ruzmarin	SC	3	0.004	0.007
Rosaceae	*Rubus idaeus* L.	malina	W	4	0.006	0.009
Rosaceae	*Rubus* sp.	kupina	W	16	0.022	0.037
Salicaceae	*Salix* sp.	vrba	W	1	0.001	0.002
Lamiaceae	*Salvia officinalis* L.	kadulja	W	93	0.130	0.217
Viburnaceae	*Sambucus nigra* L.	zova	W	93	0.130	0.217
Lamiaceae	*Satureja* sp.	čubra	W	2	0.003	0.005
Crassulaceae	*Sempervivum tectorum* L.	čuvarkuća	W	7	0.010	0.016
Pedaliaceae	*Sesamum* sp.	susam	C	1	0.001	0.002
Caryophyllaceae	*Silene* sp.	pušina	W	3	0.004	0.007
Asteraceae	*Silybum* sp.	sikavica	W	1	0.001	0.002
Boraginaceae	*Symphytum officinale* L.	gavez	W	8	0.011	0.019
Asteraceae	*Taraxacum* sect. *Taraxacum*	maslačak	W	56	0.078	0.131

Family	Species (*Latin name*)	Local name	W/SC/C	FC	RFC - ICF	UV
Lamiaceae	*Teucrium chamaedrys* L.	dubčac	W	2	0.003	0.005
Lamiaceae	*Teucrium montanum* L.	iva	W	2	0.003	0.005
Lamiaceae	*Thymus serpyllum* L.	majčina dušica	W	53	0.074	0.124
Malvaceae	*Tilia* sp.	lipa	W	13	0.018	0.030
Fabaceae	*Trigonella foenum-graecum* L.	piskavica	W	3	0.004	0.007
Asteraceae	*Tussilago farfara* L.	podbjel	W	2	0.003	0.005
Urticaceae	*Urtica dioica* L.	kopriva	SC	53	0.074	0.124
Ericaceae	*Vaccinium myrtillus* L.	borovnica	W	57	0.079	0.133
Ericaceae	*Vaccinium vitis-idaea* L.	brusnica	SC	30	0.042	0.070
Valerianaceae	*Valeriana officinalis* L.	valerijana	W	1	0.001	0.002
Scrophulariaceae	*Verbascum* sp.	divizma	W	1	0.001	0.002
Vitaceae	*Vitis* sp.	grožđe	SC	1	0.001	0.002
Poaceae	*Zea mays* L.	kukuruz	C	1	0.001	0.002
Zingiberaceae	*Zingiber officinale* Roscoe	đumbir	C	16	0.022	0.037

W, wild species; **SC**, semicultivated species; **C**, cultivated species.

tis sp., *A. millefolium* then four (4), *S. officinalis*, *Plantago* sp., *Calendula officinalis*, *Sempervivum tectorum*, *Rubus idaeus*, *Ocimum basilicum*, *Fragaria vesca*, etc.

Based on the data from the ethnobotanical interview, use values (UV) for all cited plant species were determined. Use values were high, when there have been many use reports for a plant, implying that the plant was important, and low (approaching 0), when there have been few reports related to its use. The most intensively used plants with the highest utilization values were: *Mentha sp.* (0.40), *M. chamomilla* (0.269), *A. millefolium* (0.250), *S. officinalis* (0.217), *Sambucus nigra* (0.217), *H. perforatum* (0.213), *V. myrtillus* (0.133), *Leontodon taraxacum* (0.131), *Thymus serpyllum* (0.124), *U. dioica* (0.124), *R. canina* (0.093), *Plantago* sp. (0.089), *V. vitis-idaea* (0.07), *Crataegus monogyna* (0.044), etc.

On the basis of the available literature data, the explored area of Bosnia and Herzegovina has always been recognized for its ample natural resources (Lakušić & al. 1980, 1991; Redžić & al. 1989;1990; Redžić 2006, 2007, 2010; Šarić-Kundalić & al. 2010 2016). According to many studies conducted in different parts of Bosnia and Herzegovina (Redžić 2006, 2007), it can be concluded that the population still uses many useful plants. In that area, vegetation research has shown the presence of 301 useful plant species from 70 families and 203 genera (Macanović 2019, unpubl.).

However, the surveyed area in the post-war period is facing mass migration of population from the rural settlements. For the purposes of the study, an analysis of the demographic picture was carried out. The demographic picture has changed significantly in the last 30 years, especially after the war developments in the 1990s. Demographic data from the population censuses in 1991 and 2013 were used (http://www.statistika.ba/). A comparison was drawn of the number of inhabitants of rural areas, in which the survey was conducted, in order to determine the degree of population loss. A great number of residents have left the rural settlements and went to urban areas, while a lesser number have left Bosnia and Herzegovina altogether. The latter finding was also confirmed by the comparison of results from the 1991 and 2013 population censuses. In the last 30 years, the number of inhabitants in the surveyed area (urban and rural) has decreased by 43 000. The total number of inhabitants in the 48 rural settlements was lower by 5428 people, which testified to a significant population outflow to other regions. Young-generation residents, who have left the rural settlements, did not visit them anymore and thus have lost contact with the traditional lifestyle.

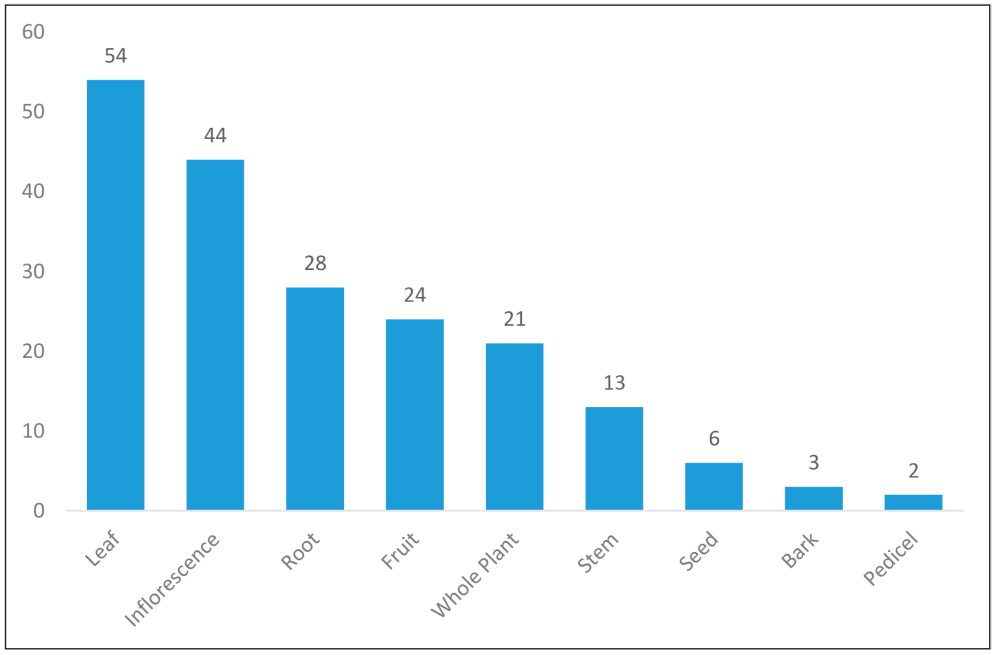

Fig. 3. Parts of useful medicinal and aromatic plants in the researched area.

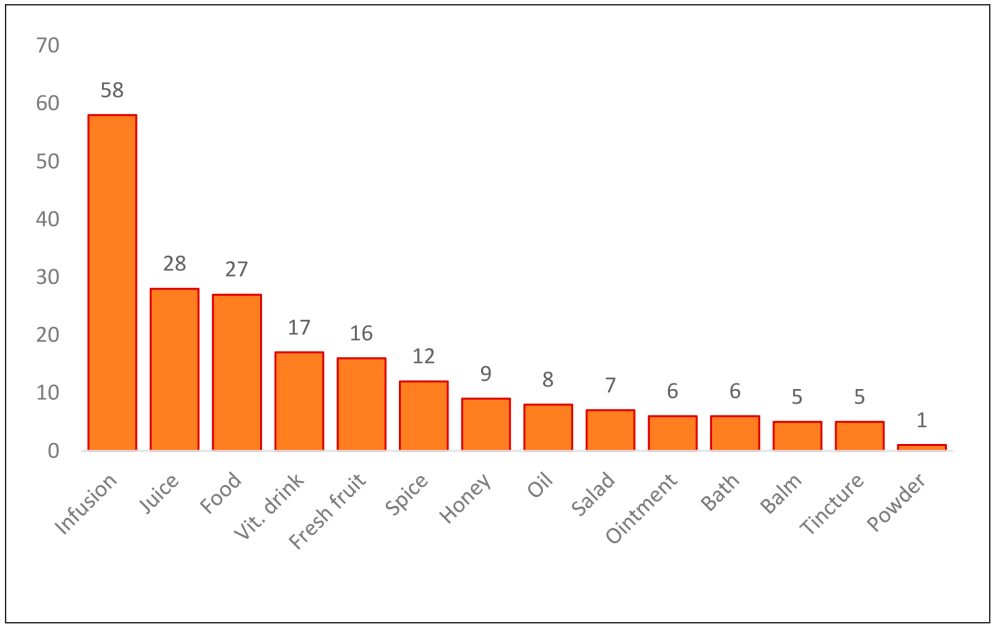

Fig. 4. Modesways of using plants use in the researched area.

Respondents participated in the study in the following percentage: young people up to 25 years of age accounted for 42.96%, mature participants for 33.47%, middle-aged people for 19.98%, and 4.60% of the respondents were 66 years and older. The research has shown that women possess greater traditional knowledge, which coincided with other investigations by Sansanelli & al. (2017) and Miskoska-Milevska & al. (2020).

Although there are 301 medicinal plant species growing in this area (Macanović 2019, unpubl.), the number of species used by the local population is far lower. Respondents have been found to use 91 plant species of medicinal and aromatic plants, mostly for nutrition and treatment. Some 16.04% of the respondents provided traditional recipes for the use of medicinal plants for medical treatment, food, cordials, or food supplements. Of those, the greatest number of prescriptions, or 63.75%, was listed by respondents older than 45 years. Knowledge of the different types of traditional recipes depended greatly on the age of

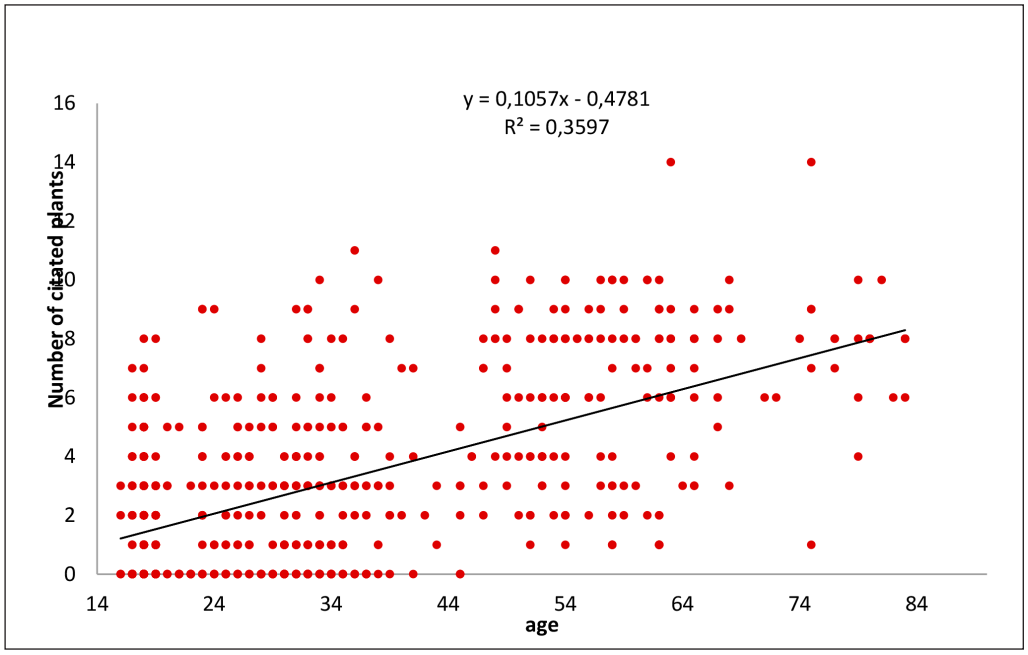

Fig. 5. Correlation analysis of the respondents age and their knowledge of the use of plants.

respondents. In addition to a decline in listing recipes across the generations, the respondents of I and II age groups listed only recipes for cordials and drinks. They listed a total of 37 recipes (35.23%). Respondents over the age of 60 reported use of a variety of recipes and plant parts. Most often for medical treatment, cooking, preparation of balms, tonics, ointments, and oils. In order to monitor the degree of correlation of traditional knowledge across the generations (age groups), a comparative analysis has shown a correlative relationship between the respondents age and their knowledge of the use of plants (*r=0.60*) (Fig. 5). Apparently, older respondents knew more about the use of plants, as compared to the younger generations, who visited the rural areas less fequently.

Through the ethnobotanical interview, the respondents cited a small number of plants that they use for medicinal purposes. Of the 717 respondents, 59.55% indicated that they use certain plant species for treatment. The youngest respondents have cited the lowest number of species. In addition to the recognition of medicinal plants, there has been a decline in knowledge of the use of traditional recipes.

By analyzing the results of the interview according to the respondents age, it was found that medicinal plants have been used by respondents of all ages. However, the knowledge of traditional recipes for cooking, medicines, ect. depended strongly on the age of respondents. A steady trend has been noticed in the decline of knowledge about the useful plants across the generations. Namely, respondents up to 25 years of age used up to 5 plants in some traditional recipes, while those over 46 years of age used up to 11 plants on the average. The highest number of prescriptions (63.75%) has been reported by respondents over 46 years of age. The recipes differ in composition and relate to cooking, preparation of cordials, syrups and medicines. The recipes for balms (4), tonics (2), ointments (1) and oils (4) have been also listed. Respondents under the age of 40 have provided 37 recipes (35.23%). Most recipes refer to the preparation of cordials, namely from elderflower, nettle or mint, or of food supplements. The recipes mentioned in the questionnaire were mostly repeated or the identical.

Traditional knowledge has been mostly transferred across generations (87.30%) and the results have shown that it was better preserved by women. This is in agreement with the conclusions of Rexhepi & al. (2017) and Miskoska-Milevska & al. (2020). The trend of the above-mentioned transfer is still retained across the study area and dominates with respondents over 46 years of age. The youngest respondents (25 years),

besides from their parents, acquire their knowledge partly from the Internet, but it is mostly general there and unrelated to the local community. They mostly live in the urban areas and nearly 40.91% of them go to the countryside only once a month, while 19.17% go there once in five years. The greatest number of respondents, who have stated that they live in the countryside, belongs to the population above 46 (87.87%) and 66 years of age (63.97%).

The greatest number of respondents who have stated that they collect medicinal and aromatic plants regularly (36.36%) were older than 65 years. The highest percentage of respondents under the age of 25 have never collected or harvested plant species, because they did not know how to do it (84%), or have never done it because they are not interested (11%).

Based on the above results, a decline of traditional knowledge across the generations is evident and will become ever stronger over the years, because of man's losing his connection with the environment and nature, especially in rural areas. All that greatly affects utilization of the natural resources and awareness of their value. Survival of many indigenous and local communities depends on traditional knowledge. It is indispensable for the survival, economic profit and long-term sustainable use of the resources.

Although traditional knowledge is based on sustainable management, the use of biodiversity is presently based on a small proportion of easily accessible and quickly exploited services. Modern use of provisioning services can lead to their degradation and permanent loss. This obviously indicates a clear-cut need in urgent documenting of the traditional knowledge and its application in the process of effective ecosystem protection and management.

Conclusion

The present research has shown that the local communities in Bosnia and Herzegovina still use medicinal plants for treatment. Notably, the most often cited plant species occur in the wild and are mostly collected by the middle-aged inhabitants. The research shows a need in urgent amassing of ethnobotanical and traditional knowledge, because of it is disappearing. This is corroborated by a survey, where greater knowledge is possessed by residents over 46 years of age who come from rural areas. This topic has not been studied earlier with calculation of RFC and UV values, especially in Bosnia and Herzegovina. Mass migration from rural communities distrupts the transfer of traditional knowledge to younger generations. Young people today live in cities and visit the rural areas less and less. The present results suggest that a more frequent investigation of the traditional knowledge and ethnobotanical studies are advisable, in order to preserve as much knowledge as possible about utilization of natural resources and useful plants. The obtained knowledge provides an opportunity for new pharmacological research into the healing properties of plants, production of new medicines, as well as for the preservation of biodiversity by the mechanisms of sustainable management and protection.

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