

DOI: 10.5586/asbp.3622

Publication history

Received: 2019-02-06

Accepted: 2019-05-22

Published: 2019-06-28

Handling editor

Beata Zagórska-Marek, Faculty of Biological Sciences, University of Wrocław, Poland

Authors' contributions

IŠ, MJD, and MG: research idea; IŠ and MJD: field study; FV: further analysis of results; all authors: writing the manuscript

Funding

The research was partially self-financed by the authors and partially with the funds of the University of Zagreb, Faculty of Agriculture, Department of Seed Science and Technology.

Competing interestsŁŁ serves as an associate editor of *Acta Societatis Botanicorum Poloniae*; other authors: no competing interests have been declared**Copyright notice**© The Author(s) 2019. This is an Open Access article distributed under the terms of the [Creative Commons Attribution License](#), which permits redistribution, commercial and noncommercial, provided that the article is properly cited.**Citation**Varga F, Šolić I, Jug Dujaković M, Łuczaj Ł, Grdiša M. The first contribution to the ethnobotany of inland Dalmatia: medicinal and wild food plants of the Knin area, Croatia. *Acta Soc Bot Pol.* 2019;88(2):3622. <https://doi.org/10.5586/asbp.3622>

ORIGINAL RESEARCH PAPER

The first contribution to the ethnobotany of inland Dalmatia: medicinal and wild food plants of the Knin area, Croatia

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An ethnobotanical survey was carried out in the Knin area (northern Dalmatia, Croatia) with the aim of recording traditional plant use by the local (native) people and contributing to the knowledge of plant biodiversity in the investigated area. Ethnobotanical data were collected by interviewing 40 local people at 17 locations. Data on 123 plant taxa (on average 21 taxa per interview) and 122 unique medicinal and 18 food uses in the local community were recorded. Prevalent medicinal uses of the recorded taxa were the treatment of digestive, respiratory, cardiovascular disorders, and injuries. The most commonly used plant parts gathered were leaves (35%) and flowers (20%). The most commonly collected plants in the investigated area were: *Urtica dioica*, *Thymus longicaulis*, *Sambucus nigra*, and *Hypericum perforatum*.

Keywords

ethnobotany; wild edible plants; medicinal plants; aromatic plants

Introduction

Although the term “ethnobotany” was coined in 1895 by Harshberger, knowledge of the use of wild plants found in our environment as food or medicine has existed for thousands of years. Some of the oldest records of wild plant use date back to ancient civilizations such as the Greek, Egyptian, and Chinese [1]. In modern times, with advances in agriculture, chemistry, and pharmacology, synthetic drugs have prevailed as the main approach to treat diseases, and the gathering of wild edible plants has been delegated to second place, after growing crops [2]. Still, the tradition of wild plant use is present to this day in small rural communities throughout the world as a part of their cultural heritage. Over the last few decades, there has been a concerted effort to preserve the last scraps of plant use traditions in Europe, especially in Mediterranean countries like Spain [3,4] and Italy [5,6] but also in the Balkan region [7,8], where old archived data on plant use are scarce [9]. Due to its natural geographic, climatic, and soil conditions, Croatia exhibits richness in plant diversity. With approximately 5,000 species and subspecies of vascular flora belonging to 1,090 genera and 189 families recorded so far, Croatia has one of the richest vascular floras in Europe [10]. Due to this great plant biodiversity and the need for its conservation, most botanical studies conducted in Croatia are focused on exploring floristic composition, vegetation, and

threatened and endemic species [11]. To this day, only a few ethnobotanical surveys have been carried out, and most of them focused on exploring the coastal or pericoastal areas of the country [12–14]. To our knowledge, the area of Knin, located further from the sea and at a higher elevation, has never been the subject of any ethnobotanical research. The areas of Croatia further from the coast are a completely blank spot on the ethnobotanical map of Europe. The Knin area was damaged in the Homeland War (1991–1995), and population stagnation has been recorded since. The local population declined from 23,025 inhabitants before the war (1991 census) to 15,190 inhabitants after the war (2001 census) and to 15,407 most recently (2011 census) [15,16]. This presents a certain risk of loss of valuable traditional knowledge, usually passed on from one generation to another, especially in small, closed communities. Before the Homeland War, the area had a thriving rural culture and people who were shepherds and farmers had very close connections to the mountain ecosystem they lived in. The aim of this study was to document medicinal and food wild plant uses in the city of Knin and its surrounding area as well as to contribute to the knowledge of plant biodiversity in the area.

Material and methods

Study area

The study area is located in northern Dalmatia, on the slopes of Spas hill, in Šibenik-Knin County, covering 257 km². The research was conducted at 17 locations (Fig. 1): Biskupija – population 406, Golubić – 1,029, Kijevo – 417, Knin – 10,633, Kovačić – 900, Očestovo – 144, Pađene – 175, Plavno – 253, Polača – 210, Potkonje – 110, Ramljane – 118, Riđane – 67, Uzdoľje – 226, Vrbnik – 447, Vrpolje – 213, Zvjerinac – 70, and Žagrović – 637 [16].

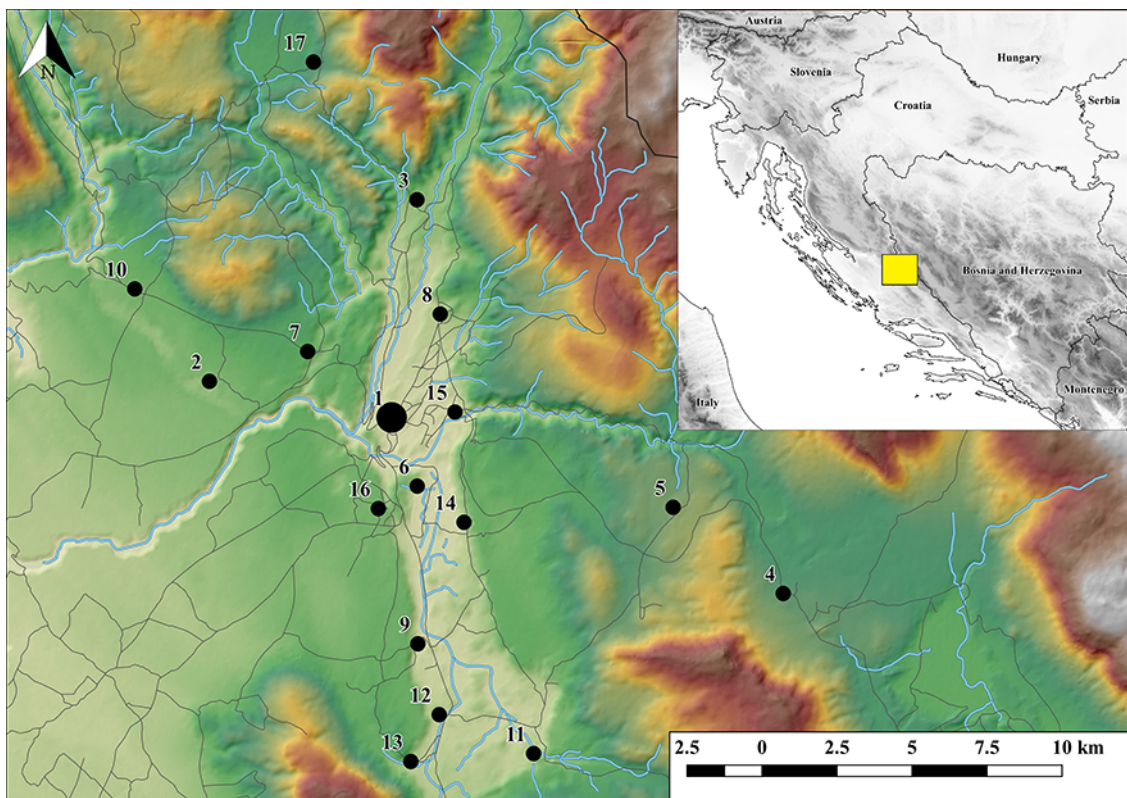


Fig. 1 Location of the study area. Numbers represent studied locations: 1 – Knin; 2 – Očestovo; 3 – Golubić; 4 – Kijevo; 5 – Polača; 6 – Potkonje; 7 – Žagrović; 8 – Vrpolje; 9 – Ramljane; 10 – Pađene; 11 – Riđane; 12 – Zvjerinac; 13 – Uzdoľje; 14 – Biskupija; 15 – Kovačić; 16 – Vrbnik; 17 – Plavno.

The area is surrounded by mountain massifs: Plješivica to the north, Dinara to the east, and Kozjak to the south. Mountain areas intersect with fertile valleys such as the Knin valley. The valley area is framed by a limestone plateau carved by the Krka River and its tributaries Orašnica, Kosovčica, and Butižnica, forming deep canyons [17].

The climate on the research site is mostly sub-Mediterranean [18]. The average annual air temperature in Knin is 12.8°C, with cold and windy winters and very hot and dry summers. The average annual rainfall is 1,073.2 mm [19]. Vegetation is characterized by thermophilus broad-leaved deciduous forests as zonal vegetation [*Ostryo-Carpinion orientalis* Horvat (1954) 1958 alliance], which has mainly degraded into shrublands and rocky pastures (*Satureion subspicatae* Horvat 1962 alliance). Nowadays, there is succession due to abandonment of the pastures. The area has a long history of agricultural production, including viticulture, fruit-growing, and sheep and goat herding, due to favorable hydrological and soil conditions [17].

Data collection

Interviews were conducted from April 2016 to June 2017. The first author is originally from the investigated area and helped with the selection of the interviewees. Informants were also encountered in front of their houses or chosen using the snow-ball method [20]. Only native inhabitants or those who had lived there most of their lives were interviewed. This study was carried out following the guidelines of the International Society of Ethnobiology Code of Ethics [21] and the American Anthropological Association Code of Ethics [22]. All interviews were conducted in the Croatian language. The interviews were semistructured, allowing the interviewers to gather as much data as possible on plant use from the participants [23].

In total, 40 interviews were conducted with 49 people (eight men and 41 women, 31 with single respondents and nine with two people). The age of the interviewees ranged from 21 to 88 (average age = 68, median = 71). They were questioned about their age and place of residence. Questions addressed to the informants were focused on determining the plants used for medicinal and nutritive purposes, plant parts used, specific ailments that the plants were used for, and manner of preparation. Participants also showed us the plants they collected, either already collected or in their natural habitat by joining us on a walk through the area when it was possible (Fig. 2). When describing the plants, participants used vernacular names; therefore, plant identification was conducted on site. If that was not possible, specimens were collected, and the species were determined in the lab using standard identification keys and iconographies [24–27]. Plant names used follow The Plant List [28] and *Flora d'Italia* [26]. The material collected is stored



Fig. 2 One of the authors (top left) gathering information about plant use from interviewees.

in the Herbarium Croaticum (ZA) at the University of Zagreb, Faculty of Science. Regarding the use of medicinal plants, we recorded both wild and cultivated plants. For food use, we recorded only wild plants, but some taxa occurred both in the wild and domesticated state, therefore, we included them when we observed wild or feral populations of these species in the study area.

Data analysis

The data obtained were analyzed to determine the number of useful plant taxa mentioned, number of plant families, species that were attributed with most uses, number of different uses, most reported medicinal uses, and plant parts most frequently used. The following indices were also calculated: *(i)* pharmacological ethnobotanical index, a modified ethnobotanical index [29] representing the ratio between useful medicinal plants and total flora of the area [10]; *(ii)* ethnobotanical richness, expressed as the number of utilized species per square kilometer [30]; *(iii)* relative frequency of citation, the number of informants mentioning a species divided by the number of participants in the research [31]; *(iv)* fidelity level, number of participants claiming the use of certain species for a particular medicinal purpose divided by the total number of participants citing the species (calculated for a species mentioned three or more times) [32]. Plant species used as food were compared to recent ethnobotanical studies conducted at sites with the nearest proximity to the study area.

Results

During this research, we collected data on 123 plant taxa (four genera, 118 species, and one subspecies) belonging to 46 plant families, used by local residents (Tab. 1). Participants used 41 plant taxa exclusively for treating a variety of ailments, 43 exclusively as food, and 42 for both medicinal and nutritive purposes. On average 20.6 species (median = 18.5) per interview were recorded (minimum seven, maximum 56). On average, 7.6 medicinal plants and 15.8 food plants per interview were listed. In total, the following plant families were best represented: Asteraceae (17 species cited 128 times), Lamiaceae (13 taxa cited 139 times), and Rosaceae (18 taxa cited 117 times). We recorded some families that were represented by only one or two species, but those species were highly cited by local residents such as the families Clusiaceae (*Hypericum perforatum* cited 29 times), Caprifoliaceae (*Sambucus nigra* cited 29 times), and Cornaceae (*Cornus mas* cited 26 times). The most cited species (highest relative frequency of citation) were *Urtica dioica* (0.85), *Thymus longicaulis* (0.78), *S. nigra* (0.73), and *H. perforatum* (0.73).

The participants used 269 vernacular names describing 123 useful plant taxa. We recorded 13 cases of homonymy (the same local name for different species), mostly for closely related species (e.g., “bokvica” for *Plantago lanceolata* and *P. major*, “murva” for *Morus alba* and *M. nigra*, and “kopriva” for *U. dioica* and *U. urens*). For some taxa, a great diversity of local names (synonymy) was recorded, e.g., *Melissa officinalis* was described by nine distinct local names.

The main plant parts used were leaves (34.9% of total mentioned plant parts) and flowers (20.1% of total plant parts mentioned). Plant parts such as fruits and leaves were used to a greater extent as food, whereas flowers and roots were used more often for medicinal purposes (Fig. 3).

The most common use of plant species for food was in the form of infusions (35%), boiled wild vegetable mix (28%), and syrup (12.1%) (Fig. 4). In the Knin area, 79 plant species were used as food, whereas, on the sites Vrana and Poljica, the number was lower [33,34]. Overlap between these areas is illustrated using a Venn diagram (Fig. 5).

We recorded 122 uses categorized based on Cook's classification [35]. Most reported medicinal uses were for treating digestive (59), respiratory (45), cardiovascular disorders (43), and injuries (43). The greatest variety of species was used for treating digestive (24), respiratory (22), and cardiovascular (19) disorders (Tab. 2). The most reported unique medicinal uses were for treating wounds (24 use reports), diarrhea (20 use reports), and stomach ailments (19 use reports).

Tab. 1 Wild food plant species and medicinal species used in the Knin area.

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Achillea millefolium</i> L. (48013, 48014)	Asteraceae	Tinturuša, tintorova trava	Yarrow	l, fl	For headache	Infusion	0.050
<i>Achillea cf. pratensis</i> Saukel & Länger	Asteraceae	Hajdučica, stolisnik, kunica, hajdučka trava, rmanac, stolisnjak, ajdučica	-	ap, fl	Gynecological problems, lungs (infusion), common cold (infusion with thyme and nettle), wounds, lipids, heartburn, stomach (infusion with St John's wort and wormwood), internal organs, urination	Infusion, herbal grappa, syrup	0.575
<i>Aesculus hippocastanum</i> L. (48015, 48016)	Hippocastanaceae	Divlji kesten	Horse chestnut	f	Rheumatism (herbal grappa)	-	0.025
<i>Agrimonia eupatoria</i> L. (48015, 48016)	Rosaceae	Petrovac	Common agrimony	ap	Bones	-	0.025
<i>Allium cepa</i> L.	Amaryllidaceae	Kapula	Onion	b	Cough, ulcers	-	0.075
<i>Allium sativum</i> L.	Amaryllidaceae	Bijeli luk	Garlic	b	Cleansing of blood vessels (with lemon juice)	-	0.025
<i>Allium</i> sp.	Amaryllidaceae	Divlji luk	.	wh	-	Boiled wild veg mix	0.025
<i>Althaea</i> sp. / <i>Lavatera</i> sp. (48150)	Malvaceae	Pitomi sljez, bijeli sljez, šljez, bijeli šljez	Marshmallow / tree mallow	r, l, fl	Respiratory tract (infusion), common cold for children (infusion), expectoration	-	0.100
<i>Amaranthus retroflexus</i> L. (48120)	Amaranthaceae	Štir	Redroot pigweed	l	-	Boiled wild veg mix, boiled, salad	0.450
<i>Arctium lappa</i> L. (48018)	Asteraceae	Repuh, lepuh	Great burdock	l	Swelling, to relieve pain, lungs, knee	-	0.075
<i>Armoracia rusticana</i> P. Gaertn., B. Mey. et Scherb. (49198, 49199)	Brassicaceae	Ren	Horseradish	r	Rheumatism (grated in alcohol)	-	0.025
<i>Artemisia absinthium</i> L. (48047)	Asteraceae	Pelin, pelim	Absinthe	ap	Hearth, intestines cleansing, parasites, asthma (infusion with immortelle), stomach (infusion with rosemary, sage and mountain germander), cough, common cold (infusion), appetite (infusion and herbal grappa with cork of mahaleb and cherry), stomach (infusion with St John's wort and yarrow), lungs, for blood cleansing, stomach (herbal grappa)	Herbal grappa, infusion	0.375
<i>Asparagus acutifolius</i> L. (48050)	Asparagaceae	Šparoga	Wild asparagus	sh	-	Boiled, raw, fried with eggs	0.150

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Avena sativa</i> L.	Poaceae	Zob	Oat	f	Sciatica	-	0.025
<i>Bellis perennis</i> L.	Asteraceae	Tratinčica	English daisy	ap	Stomach (infusion)	-	0.025
<i>Beta vulgaris</i> L. (mangold) (49202)	Chenopodiaceae	Blitva	Mangold	l	Wounds	-	0.025
<i>Beta vulgaris</i> L. (red beet) (49197)	Chenopodiaceae	Cikla	Beetroot	r	Immunity (with carrots and apples)	-	0.025
<i>Brassica oleracea</i> L. (49201)	Brassicaceae	Kupus	Cabbage	l	Pain relief	-	0.025
<i>Calendula officinalis</i> L. (48019)	Asteraceae	Neven	Common marigold	fl	Wounds (macerate, ointment), stomach, sunbathing (macerate), joints (grappa), wounds, burns, and hemorrhoids (ointment with chamomile), corns, warts, and face cleansing (macerate)	-	0.200
<i>Capsella bursa-pastoris</i> (L.) Medik. (48020)	Brassicaceae	Šurljen, šrljen, šurjen	Shepherd's purse	l	-	Boiled wild veg mix, infusion	0.125
<i>Celtis australis</i> L. (48048, 48049)	Ulmaceae	Kostjelić, koštela	European nettle tree	f	-	Raw, herbal grappa, syrup	0.100
<i>Ceterach officinarum</i> Willd. (49200)	Aspleniaceae	Zlatica	Rustyback	l	Liver improvement	-	0.025
<i>Chelidonium majus</i> L. (48046)	Papaveraceae	Rosopas, rusa	Greater celandine	sp, ap	Warts; skin infections, eczema, and freckles (macerate)	-	0.075
<i>Chenopodium album</i> L. (48021)	Chenopodiaceae	Loboda, laboda, laboda, laboda, divlja	Goosefoot	l	-	Boiled wild veg mix, boiled, salad	0.450
<i>Chondrilla juncea</i> L. (48045)	Asteraceae	Divlja salata, salatuša, divlja salatuša, divlja salata, divlja salatača, radić	Rush skeleton-weed	l	-	Boiled wild veg mix, salad,	0.400
<i>Cichorium intybus</i> L. (48044)	Asteraceae	Cikorija, radić, grka, divlja salata, divlja salata	Common chicory	l	Bladder (infusion)	Boiled wild veg mix, salad, boiled	0.300
<i>Cirsium arvense</i> (L.) Scop. (48012)	Asteraceae	Palamuda, palamina, mačja muda	Creeping thistle	l	-	Boiled wild veg mix	0.175
<i>Cornus mas</i> L. (48011, 48022, 48023)	Cornaceae	Drenjina, drijen, drijenina, drenići, drenjine	Cornelian cherry	f	Improving blood count (with blackberry), diarrhea (syrup)	Syrup, jam, liqueur, boiled, raw, infusion	0.650

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Corylus avellana</i> L. (48042)	Corylaceae	Divji ljeshnjak	Common hazel	f	-	Raw	0.025
<i>Crataegus monogyna</i> Jacq. (48024)	Rosaceae	Glog, glob bijeli, glog-inja, glogić	Common hawthorn	l, fl, f	Heart (infusion), blood pressure regulation (infusion), high blood pressure (liqueur)	Infusion, raw	0.450
<i>Cydonia oblonga</i> Mill. (48025)	Rosaceae	Dunja	Quince	l	Diarrhea (infusion)	-	0.075
<i>Daucus carota</i> L. (48027)	Apiaceae	Divlja mrkva, divlja mrkvića, mrkva divja, divja mrkva	Wild carrot	l, r	-	Boiled, boiled wild veg mix	0.225
<i>Daucus carota</i> subsp. <i>sativus</i> (Hoffm.) Arcang.	Apiaceae	Mrkva	-	r	Immunity (with red beets and apples)	-	0.025
<i>Dioscorea communis</i> (L.) Caddick & Wilkin (48116, 48117)	Dioscoreaceae	Kukača, vija, kuke	Black bindweed	r, sh	Back pain, rheumatism (herbal grappa), heel spur	Boiled, boiled wild veg mix, raw, with eggs	0.175
<i>Diplotaxis tenuifolia</i> (L.) DC. (48028)	Brassicaceae	Riga	Perennial wall-rocket	l	-	Salad	0.075
<i>Equisetum arvense</i> L. (48030)	Equisetaceae	Borić, borak, preslica	Common horsetail	ap	Urinary tract (infusion), kidneys, kidney stones (infusion)	-	0.150
<i>Eryngium amethystinum</i> L. (48031)	Apiaceae	Brmbeč, brmbeći	Field eryngo	l, r	-	Boiled	0.050
<i>Ficus carica</i> L. (48035)	Moraceae	Smokva	Common fig	s, f	Warts (s), digestion (jam)	-	0.050
<i>Foeniculum vulgare</i> Mill. (48036)	Apiaceae	Komorač	Fennel	f, l	-	Spice, infusion, boiled wild veg mix	0.075
<i>Fragaria vesca</i> L. (48038)	Rosaceae	Divlja jagoda	Wild strawberry	l, f	Common cold (infusion)	Boiled wild veg mix, raw	0.025
<i>Galium aparine</i> L. (48039)	Rubiaceae	Prilipača, bročika što se lijepi	Goosegrass	l	-	Boiled wild veg mix	0.050
<i>Galium lucidum</i> All. (48052, 48053)	Rubiaceae	Bijela bročika	Hedge bedstraw	l	-	Boiled wild veg mix	0.025
<i>Galium verum</i> L. (49193, 49194, 49195)	Rubiaceae	Žuta bročika	Lady's bedstraw	ap	Kidneys (infusion)	-	0.025
<i>Gentiana lutea</i> L.	Gentianaceae	Srčenič	Great yellow gentian	r	Lungs	-	0.025

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Geranium molle</i> L. (48054)	Geraniaceae	Kozja stopica, kozja nožica, krvavac	Dove's foot Crane's bill	l	-	Boiled wild veg mix	0.075
<i>Helichrysum italicum</i> (Roth.) G. Don (48055)	Asteraceae	Smilje	Curry plant	fl, ap	Skin, face, freckle removal (macerate), hands, rejuvenation of skin (ointment), asthma (infusion with wormwood)	Infusion	0.075
<i>Hypericum perforatum</i> L. (48058)	Clusiaceae	Kantarion, gospina trava	Common Saint John's wort	fl	Wounds, burns (macerate), wounds (balm), skin (macerate), stomach (infusion with wormwood and yarrow), injuries, insect bites, massage, sunbathing (macerate), gynecological diseases (infusion), menopause (infusion), colon inflammation (macerate)	Infusion	0.725
<i>Juglans regia</i> L. (49204, 49205)	Juglandaceae	Orah	Persian walnut	yf, l	Sunbathing (macerate), thyroid (syrup, herbal grappa), hair loss (with common kno'grass, nettle and elder)	-	0.150
<i>Juniperus oxycedrus</i> L. (48060, 48061)	Cupressaceae	Smreka, smrika	Prickly juniper	f, sh	Kidneys, <i>E. coli</i> , lungs (infusion), cough, bronchitis	Herbal grappa, children's snack, infusion, raw	0.225
<i>Lactuca serriola</i> L. (48063)	Asteraceae	Mličika, kozja brada	Prickly lettuce	l	-	Boiled wild veg mix, salad	0.050
<i>Lamium maculatum</i> (L.) L. (48075)	Lamiaceae	Pčelinka, pčelinjak, čelija ljubica, čelinka, čelinjak, čela, mrtva kopriva	Spotted dead-nettle	l	-	Boiled wild veg mix, children's snack (fl)	0.150
<i>Laurus nobilis</i> L. (49192)	Laureaceae	Lovor	Bay laurel	l	Cough (syrup and infusion)	-	0.050
<i>Lavandula × intermedia</i> Emeric ex Loisel. (48026)	Lamiaceae	Lavanda	Lavender	fl	For massage, for insect bites, for mosquito bites, burns, varicose veins (tincture), for surface veins, sore back, muscle pain (ointment)	-	0.075
<i>Malus domestica</i> Borkh. (49191)	Rosaceae	Jabuka	Apple	f	With red beets and carrots for immunity	-	0.025
<i>Malus sylvestris</i> (L.) Mill. (48064, 48065)	Rosaceae	Divljakuša jabuka, divja jabučica, divlja jabuka	Crab apple	f	For diabetes (boiled), soporific effect	Raw, vinegar	0.100

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Malva sylvestris</i> L. (48059, 48062)	Malvaceae	Sliz, sljez, obični sljez, sljez, crni sljez	Common mallow	l	Vein thrombosis, cough	Boiled wild veg mix, infusion	0.225
<i>Matricaria chamomilla</i> L. (48057)	Asteraceae	Kamilica, pitoma kamilica	German chamomile	fl	Sedative (infusion), wounds, burns, hemorrhoids (ointment with marigold)	Infusion	0.375
<i>Melissa officinalis</i> L. (48043)	Lamiaceae	Matičnjak, pčelinka, čelinčica, čelinka, limun trava, limunska trava, pčelijarka, čelinka, melisa	Lemon balm	l	Sedative (infusion), blood pressure regulation (infusion), acid reflux	Infusion	0.275
<i>Mentha longifolia</i> (L.) L. (48041)	Lamiaceae	Šumska metvica, divlja metvica, nana, prirodna nana, menta	Horse mint	ap	-	Infusion	0.125
<i>Mentha</i> sp. (48148)	Lamiaceae	Nana, metvica, menta	Mint	l	Sedative	Infusion, syrup, herbal grappa	0.475
<i>Morus alba</i> L. (48040)	Moraceae	Murva bila, bijela murva, murva	White mulberry	f, l	Diabetes (infusion)	Syrup, raw	0.075
<i>Morus nigra</i> L. (48037)	Moraceae	Crni dud, murva crna, murva	Black mulberry	f, l	Lowers blood sugar (dry leaves infusion)	Liqueur from fruit, syrup, raw	0.075
<i>Ocimum basilicum</i> L.	Lamiaceae	Bosiljak	Basil	l	Antibacterial (infusion)	-	0.025
<i>Olea europea</i> L. (49186)	Oleaceae	Maslina	Olive	l	General health (infusion)	-	0.025
<i>Ononis spinosa</i> L. (48029, 48032)	Fabaceae	Zečji trn, sikavac	Spiny restharrow	r, ap	Gynecological diseases, gout (infusion)	-	0.050
<i>Oxalis articulata</i> Savigny (48126)	Oxalidaceae	Djetelina ukrasna	Pink-sorrel	l	Vitamin C	Salad	0.025
<i>Paliurus spina-christi</i> Mill. (48067)	Rhamnaceae	Drača, divlja drača	Jerusalem thorn	f, fl	Urination, gout, blood cleansing, urinary tract cleansing (infusion)	Infusion, raw, children's snack	0.125
<i>Papaver rhoeas</i> L. (48097)	Papaveraceae	Makalj, boliglava, divlji mak, mak	Common poppy	l	-	Boiled wild veg mix	0.300
<i>Parietaria judaica</i> L. (48099)	Urticaceae	Crkvina, drenak	Pellitory-of-the-wall	l	-	Boiled wild veg mix	0.050
<i>Petroselinum crispum</i> (Mill.) Fuss (49185)	Apiaceae	Petrusimen, peršin	Parsley	l	Urinary tract, helps with urination, gynecological diseases	-	0.100
<i>Phaseolus vulgaris</i> L. (49184)	Fabaceae	Grah	Bean	s	Nose bleeding	-	0.025

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Pinus nigra</i> J. F. Arnold (48104)	Pinaceae	Bor, borčić	Black pine	sh, yf	Cough, bronchi, throat, tonsils, asthma, lungs, bronchitis (syrup)	-	0.175
<i>Plantago lanceolata</i> L. (48107)	Plantaginaceae	Muška bokvica, bokvica muška, trputac, bukvice muška, uska bukvice, bokvica	Narrowleaf plantain	l	Wounds, ulcers (leaf), cough (syrup), common cold, pneumonia, allergies (infusion)	-	0.225
<i>Plantago major</i> L. (48109)	Plantaginaceae	Ženska bokvica, bokvica ženska, bokvica, gavez, trputac, bukvice ženska, bukvice	Broadleaf plantain	l	Wounds, ulcers, thorn pricks, swelling, rheumatism (leaf), cough, heart, pain relief, pneumonia, allergies (infusion)	Boiled wild veg mix	0.425
<i>Podospermum laciniatum</i> (L.) DC. (48100)	Asteraceae	Kozja brada	Cutleaf vipergrass	l	-	Boiled wild veg mix	0.025
<i>Polygonum aviculare</i> L. (48076, 48112)	Polygonaceae	Oputa, kokina trava, oputica, kokošinjeva trava, kokošinjak, kokošija trava, oputina	Doorweed	ap	Heart, rheumatism, for hair loss (with walnut leaf, nettle and elder)	Boiled wild veg mix, infusion	0.125
<i>Portulaca oleracea</i> L. (48119)	Portulacaceae	Tuš, bljušt, debelica, debeľjak, tucalj	Common purslane	l	-	Boiled wild veg mix, boiled, salad	0.500
<i>Prunus avium</i> (L.) L.	Rosaceae	Trešnja	Cherry	p	Urinary tract	-	0.025
<i>Prunus avium</i> (L.) L. (feral) (48074)	Rosaceae	Divlja trešnja	Cherry (feral)	f	-	Syrup	0.025
<i>Prunus cerasifera</i> Ehrh (48073)	Rosaceae	Vinjika, denerika	Cherry plum	f	-	Syrup, liqueur, raw, jam	0.100
<i>Prunus domestica</i> L. (49182)	Rosaceae	Šljiva	Plum	f	Digestion (jam)	-	0.025
<i>Prunus dulcis</i> (Mill.) D. A. Webb (49181)	Rosaceae	Bajam	Almond	ns	Asthma, bronchi, cough (decoction)	-	0.050
<i>Prunus mahaleb</i> L. (48072)	Rosaceae	Rašeljka, magriva, vinika	Mahaleb cherry	bk, f	Stomach (infusion with wormwood)	Syrup, liqueur, raw	0.125
<i>Prunus persica</i> (L.) Batsch (feral) (48071)	Rosaceae	Vinogradske breskve, vinogradska praska	Peach (feral)	f	-	jam, raw	0.075

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Prunus spinosa</i> L. (48070)	Rosaceae	Trnina, glog, trnjina, crni trn, trnovača šljiva	Blackthorn	f, fl, l	Urinary tract (syrup), blood improvement, appetite, heart (infusion), anemia, lung diseases (fruit infusion and syrup)	Syrup, infusion, jam, raw, liqueur	0.350
<i>Pulmonaria officinalis</i> L.	Boraginaceae	Plućnjak, plućna trava	Lungwort	ap, l	Bronchitis, pulmonary diseases, tuberculosis	Infusion	0.025
<i>Punica granatum</i> L.	Punicaceae	Nar	Pomegranate	fh	Stomach	-	0.025
<i>Pyrus amygdaliformis</i> Vill. (48086)	Rosaceae	Krušnica	Almond-leaved pear	f	-	Boiled	0.025
<i>Quercus pubescens</i> Willd. (48082, 48084)	Fagaceae	Žir	Downy Oak	f	-	Boiled, roasted halves	0.025
<i>Ranunculus sardous</i> Crantz (48077, 48078)	Ranunculaceae	Medvjeda stopa, vučja stopica	Hairy buttercup	l	-	Boiled wild veg mix	0.150
<i>Robinia pseudoacacia</i> L. (48080, 48081)	Fabaceae	Ptoma drača	Black locust	fl	-	Made into fritters, syrup	0.050
<i>Rosa canina</i> L. (49180)	Rosaceae	Šipak, divlji šipak	Dog-rose	f	Obstipation, kidneys (infusion)	Tea, syrup, infusion, jam	0.650
<i>Rosmarinus officinalis</i> L. (49179)	Lamiaceae	Ruzmarin	Rosemary	ap	Heart, veins, mosquito bites, burns, varicose veins (tincture), rheumatism (herbal grappa), stomach, cough, common cold (infusion with wormwood, sage and mountain germander)	-	0.100
<i>Rubus ulmifolius</i> Schott (48083)	Rosaceae	Kapina, jagoda, divlja jagoda, kupina, divlje jagode	Elm-leaf blackberry	f, fl, l, sh	Immunity (syrup), blood improvement (wine), to stop smoking, heart (infusion), diarrhea (infusion, syrup), blood count improvement (with cornel), anemia (syrup)	Jam, infusion, liqueur, syrup, raw, wine	0.575
<i>Rumex pulcher</i> L. (48085)	Polygonaceae	Štavlj, divlje zelje, konjski štavlj	Fiddle dock	l	Diarrhea, menstrual cramps (infusion)	Boiled wild veg mix, infusion, sarma (rolls)	0.525
<i>Salvia officinalis</i> L. (49178)	Lamiaceae	Kadulja, žalfija	Common sage	fl, l	Lungs, hoarseness, for cough, sedative, toothache, decreased sweating (mild infusion), increased sweating (strong infusion), oral cavity, throat, gums rinsing (decoction), common cold (infusion), stomach (infusion with rosemary, wormwood and mountain germander)	Infusion, liqueur, spice, herbal grappa	0.600

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Salvia pratensis</i> L. (48088, 48090)	Lamiaceae	Proja	Meadow sage	l	-	Boiled wild veg mix	0.025
<i>Sambucus ebulus</i> L. (48093)	Caprifoliaceae	Aptovina	Dwarf elder	f	Anemia (syrup)	Added to wine for color	0.050
<i>Sambucus nigra</i> L. (48095, 48105)	Caprifoliaceae	Zova, zovka, zovika	Elderberry	fl, f, l	Bronchi (infusion), urinary tract, kidneys, problems with bladder (infusion), diabetes, hair loss (leaf; with common knotgrass, nettle and walnut leaf)	Syrup, infusion, jam	0.725
<i>Satureja montana</i> L. (49176, 49177)	Lamiaceae	Bijeli vrisak, vrisak, vrijesak, bli vrisak, bijeli vrijesak, divlji vrijesak	Winter savory	ap	High blood pressure (infusion), antiviral	Infusion, herbal grappa	0.325
<i>Satureja subspicata</i> Bartl. ex Vis. (49175)	Lamiaceae	Plavi vrisak, plavi vrijesak	-	ap	Antiviral	Herbal grappa, infusion	0.075
<i>Scorzonera villosa</i> Scop. (48098)	Asteraceae	Turutva, turutuša	-	l	-	Boiled, salad, boiled wild veg mix	0.050
<i>Sedum acre</i> L. (48096)	Crassulaceae	Mlječika	Goldmoss stoncrop	sp	Warts	-	0.025
<i>Sempervivum tectorum</i> L.	Crassulaceae	Čuvarkuća, čuvarkuća, čevrkuća, čevarkuća, čuvarkuća	Common houseleek	l	Digestion, thyroid, corns, earache, diabetes	Salad	0.150
<i>Silene latifolia</i> Poir. (48094)	Caryophyllaceae	Ušac, zečje uši, ušica	White campion	l	-	Boiled wild veg mix	0.350
<i>Silene vulgaris</i> (Moench) Garcke (48092)	Caryophyllaceae	Kliza, skliz, škripavac, debeljak	Bladder campio	l	-	Boiled wild veg mix	0.150
<i>Solanum americanum</i> Mill. (48091)	Solanaceae	Pasmica	Black nightshade	l	Wounds (boiled)	-	0.025
<i>Sonchus</i> sp. (49172)	Asteraceae	Kostriš	Sow thistles	l	-	Boiled wild veg mix	0.025
<i>Sorbus aria</i> (L.) Crantz	Rosaceae	Munjike, munike	Whitebeam	f	-	Raw	0.050
<i>Sorbus domestica</i> L. (48089)	Rosaceae	Oskoruša, oskruša	Service tree	f	Stomach	Infusion, syrup, raw	0.150
<i>Stellaria media</i> (L.) Vill. (48087)	Caryophyllaceae	Mišjakinja, mišakinja	Chickweed	l	-	Boiled wild veg mix	0.050

Tab. 1 Continued

Species*	Family	Local name(s)	English name	Parts used	Medicinal uses	Food uses	RFC (N = 40)
<i>Symphytum officinale</i> L. (49174)	Boraginaceae	Gavez	Common comfrey	r	Facelift (cream), wounds (herbal grappa)	-	0.025
<i>Tanacetum balsamita</i> L. (48115)	Asteraceae	Galoper	Costmary	l	Gout, diabetes, lipids	-	0.025
<i>Taraxacum</i> spp. (48114)	Asteraceae	Maslačak	Common dandelion	fl, l, r	Bile, cancer, blood cleansing, diabetes (infusion), lipids, sinuses, lungs (syrup)	Boiled wild veg mix, salad, syrup ("honey"), boiled	0.400
<i>Teucrium montanum</i> L. (48113)	Lamiaceae	Trava iva, iva	Mountain germander	ap	Stomach, cough, common cold (infusion with rosemary, sage and wormwood), bile cleansing	Infusion	0.450
<i>Thymus longicaulis</i> C. Presl (48111)	Lamiaceae	Majčina dušica, majčina dušica	Creeping thyme	ap	Stomach, high body temperature in children, lungs (infusion), common cold, cough (infusion with milfoil and nettle)	Infusion, spice, syrup	0.775
<i>Tilia cordata</i> Mill. (48108, 48110)	Tiliaceae	Lipa	Littleleaf linden	fl	-	Infusion	0.350
<i>Trifolium pratense</i> L. (48106)	Fabaceae	Crvena djetelina, djetelina	Red clover	fl	Menopause, urinary tract infection, insomnia (infusion)	Infusion	0.075
<i>Trifolium repens</i> L. (48121)	Fabaceae	Bijela djetelina	White clover	fl	Urinary tract inflammation	-	0.025
<i>Urtica dioica</i> L. (48122)	Urticaceae	Kopriva	Common nettle	l, r, ap	Anemia, blood count circulation, kidneys (infusion), common cold (infusion with thyme and wormwood), against hair loss (with walnut leaf, common knotgrass and elder leaf), urinary tract (hot water over dry root), vaginal infection, rheumatism	Boiled wild veg mix, syrup, infusion, boiled, soup	0.850
<i>Urtica urens</i> L.	Urticaceae	Kopriva	Burning nettle	l	-	Infusion	0.025
<i>Viola odorata</i> L. (48123, 48124)	Violaceae	Ljubičica	Common violet	fl, l, t	-	Boiled wild veg mix, children's snack (fl)	0.125
<i>Viola tricolor</i> L. (48125)	Violaceae	Divlja macuhica	Heartsease	l, t	-	Boiled wild veg mix	0.025
<i>Zea mays</i> L. (49173)	Poaceae	Kukuruz	Maize	sl	Urinary tract (infusion with field horsetail)	-	0.025

* Voucher specimens numbers are in brackets next to species name. RFC – relative frequency of citation; N – total number of participants; ap – aerial part; b – bulb; bk – bark; f – fruit; fh – fruit husk; fl – flower; l – leaf; ns – nut shell; p – petiole; r – root; s – seed; sh – shoot; sl – silks; sp – sap; t – tuber; wh – whole plant; yf – young fruit.

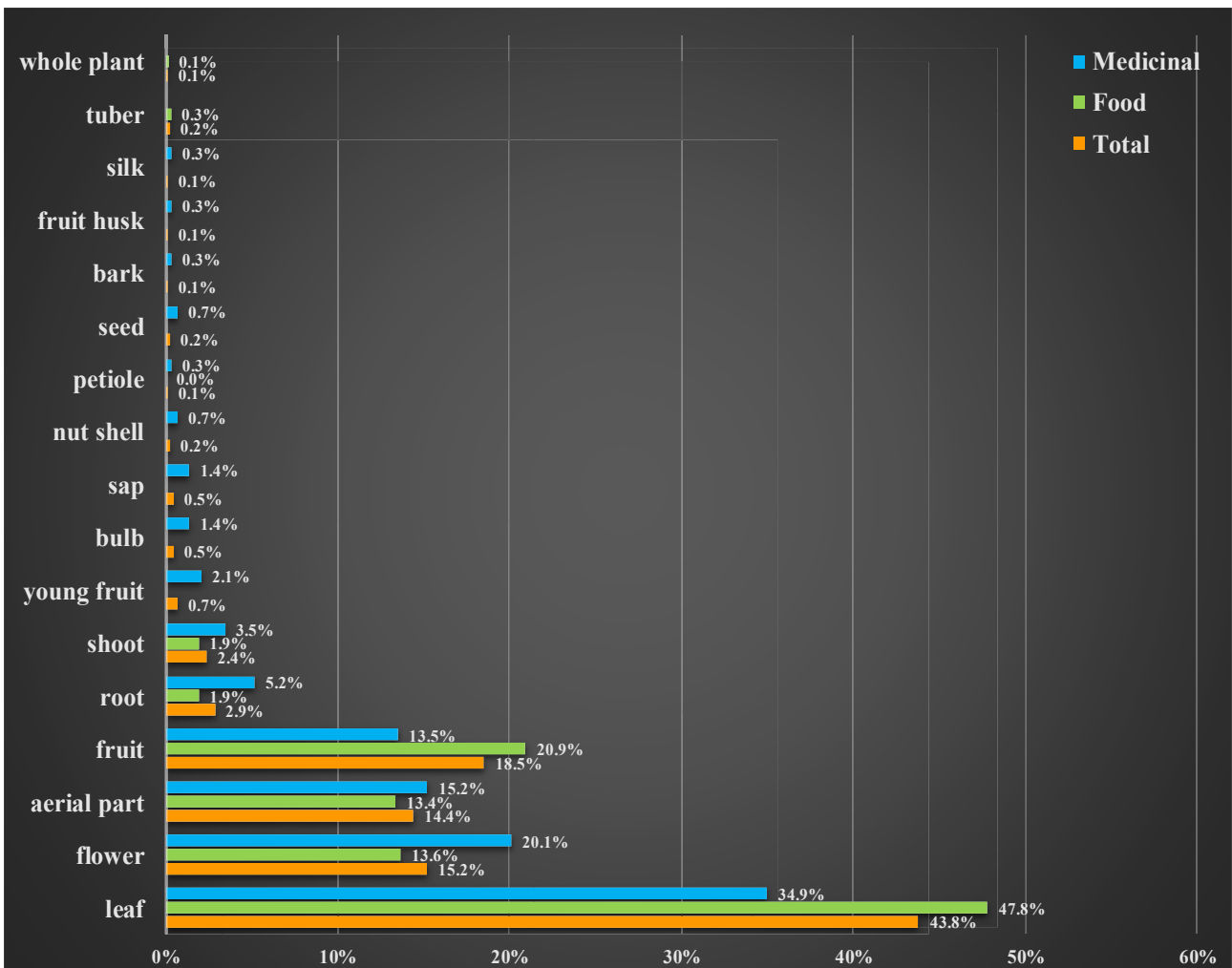


Fig. 3 Mentioned plant parts used by participants in this study.

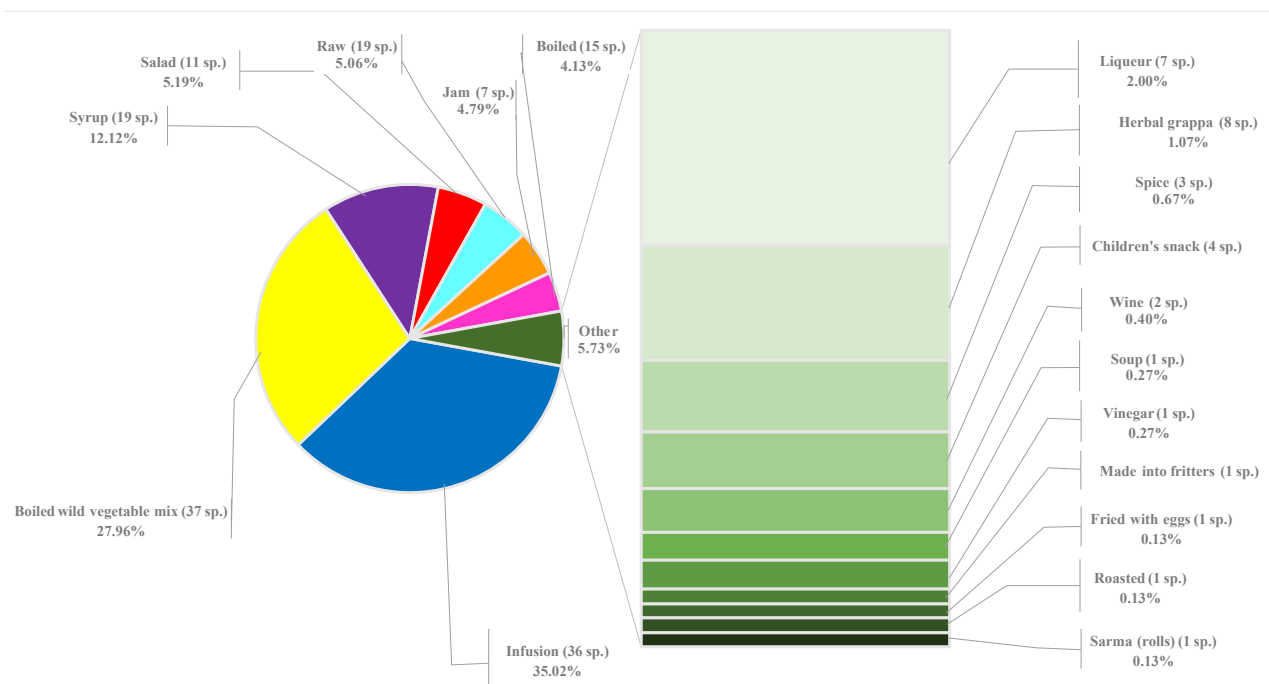


Fig. 4 Food preparation of plant species recorded in the Knin area.

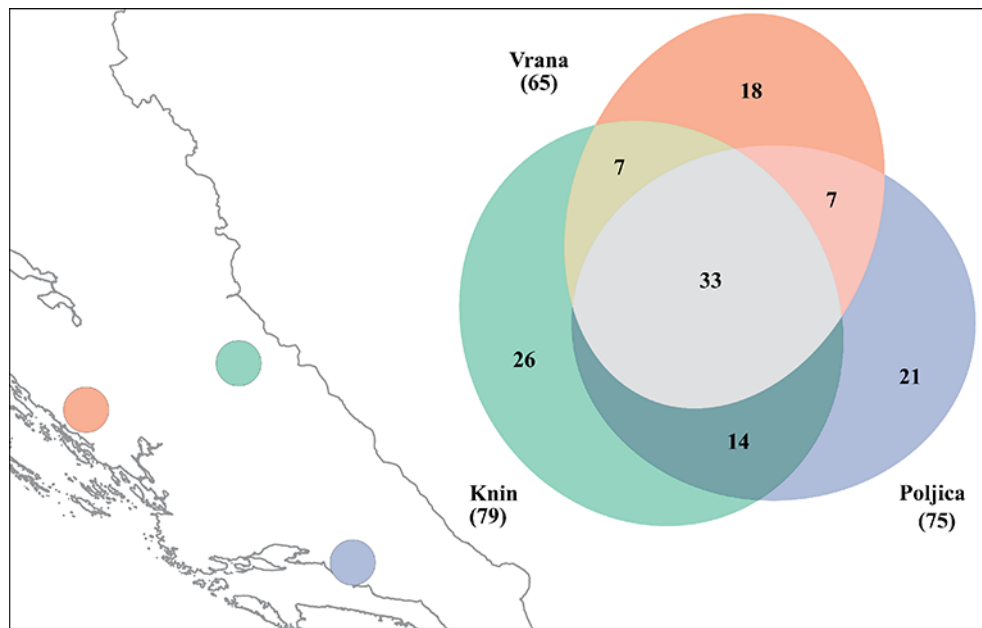


Fig. 5 Venn diagram comparing plant species used for food in this research to those found in similar studies conducted in Poljica and Vrana.

Tab. 2 Medicinal categories with corresponding unique uses, species used, number of informants using plants for treating the category, and total number of use reports.

Use category	No. of unique uses	No. of species used	No. of informants that treat category	No. of total use reports
Cardiovascular system disorders	15	19	23	43
Digestive system disorders	18	24	24	59
Endocrine system disorders	3	3	6	7
Genitourinary system disorders	15	18	19	37
Immune system disorders	2	7	3	6
Infections	5	15	8	17
Injuries	7	12	23	43
Mental and nervous system disorders	5	8	8	9
Metabolic system disorders	6	12	9	16
Muscular-skeletal system disorders	10	12	10	17
Neoplasms	1	1	1	1
Respiratory system disorders	15	22	19	45
Skin/subcutaneous cellular tissue disorders	15	15	15	32
Other disorders	5	5	12	13

Achillea cf. *pratensis* and *P. major* were the most diversely used plant species (six different medicinal category uses recorded and used as food) followed by *H. perforatum*, *P. lanceolata*, *Salvia officinalis*, *Sempervivum tectorum*, *Taraxacum* spp., and *U. dioica* (five different medicinal category uses and used as food). Fidelity level for medicinal plant species mentioned by three or more participants varied from 20% to 100% (Tab. 3). We found that the fidelity level was the highest for *Rumex pulcher* and *Cydonia oblonga* (100% for treating diarrhea), *Helichrysum italicum* (100% for face treatment), and *Chelidonium majus* (100% for treating warts).

Pharmacological ethnobotanical index was 0.41, which indicated that more than every third plant species growing in the investigated area was used to treat medical conditions. The value of ethnobotanical richness index was 0.46.

Tab. 3 Prioritized species for treating particular health problems based on the fidelity level index.

Medical condition	Taxa	Fidelity level
For warts	<i>Chelidonium majus</i> L.	1.000
For diarrhea	<i>Cydonia oblonga</i> Mill., <i>Rumex pulcher</i> L.	1.000
For face	<i>Helichrysum italicum</i> (Roth) G. Don	1.000
For urinary tract	<i>Equisetum arvense</i> L.	0.833
For earache	<i>Sempervivum tectorum</i> L.	0.833
For heart	<i>Crataegus monogyna</i> Jacq.	0.800
For cough	<i>Allium cepa</i> L.	0.667
For thyroid	<i>Juglans regia</i> L.	0.667
For kidneys	<i>Juniperus oxycedrus</i> L.	0.667
As sedative	<i>Melissa officinalis</i> L.	0.667
For wounds	<i>Plantago major</i> L.	0.615
For cough	<i>Plantago lanceolata</i> L.	0.600
For cough	<i>Pinus nigra</i> J. F. Arnold	0.571
For wounds	<i>Calendula officinalis</i> L., <i>Hypericum perforatum</i> L.	0.500
For urinary tract	<i>Petroselinum crispum</i> (Mill.) Fuss	0.500
For stomach	<i>Artemisia absinthium</i> L.	0.444
For cough	<i>Thymus longicaulis</i> C. Presl	0.400
For stomach	<i>Achillea cf. pratensis</i> Saukel & Länger	0.333
For respiratory tract, for common cold, for expectoration	<i>Althaea</i> sp. / <i>Lavatera</i> sp.	0.333
For swelling, to relieve pain, for lungs, for knees	<i>Arctium lappa</i> L.	0.333
For massage, for insect bites, for mosquito bites, for burns, for varicose veins, for surface veins, for sore back, for muscle pain	<i>Lavandula xintermedia</i> Emeric ex Loisel.	0.333
For urination, for gout, for blood cleansing, for urinary tract cleansing	<i>Paliurus spina-christi</i> Mill.	0.333
For throat rinsing	<i>Salvia officinalis</i> L.	0.333
For urinary tract, for blood improvement, for appetite, for heart, for anemia, for lung diseases	<i>Prunus spinosa</i> L.	0.250
For heart, for veins, for mosquito bites, for burns, for varicose veins, for mosquito bites, for burns, for varicose veins, for rheumatism, for stomach, for cough, for common cold	<i>Rosmarinus officinalis</i> L.	0.250
To improve blood count, for diarrhea	<i>Rubus ulmifolius</i> Schott	0.250
For bronchi, for urinary tract, for kidneys, for problems with bladder, for diabetes, for hair loss	<i>Sambucus nigra</i> L.	0.250
For common cold	<i>Urtica dioica</i> L.	0.250
For bile treatment, for cancer, for blood vessels cleansing, for blood cleansing, for lipids, for sinuses, for lungs, for diabetes	<i>Taraxacum</i> spp.	0.200

Discussion

The observed degree of overlap between food and medicinal plants is very typical in other areas of Europe [36–41]. Particularly similar are the results from a study in Istria (also in pericoastal but inland Croatia) [36], where, out of 121 species, 31 species are used exclusively in a food context, 50 species are used exclusively as medicine, and 40 species overlap (i.e., 33%). This is nearly identical to our study, where, out of 123 plant taxa, 41 are used exclusively for treating a variety of ailments, 43 exclusively as food, and 42 as both food and medicine (i.e., 34%).

Dominant families (34% of total species recorded) found in this study were also dominant in other ethnobotanical research conducted in the Mediterranean area [4,42]. This is not surprising, due to the fact that these families are typical for the Mediterranean region and are also most prevalent in Croatian flora [10]. It has been well documented that the more common the plant family is in the area, the higher is the probability of its popular use [43].

The occurrence of homonyms of vernacular plant names is very common between the regions in Croatia, but here we encountered 13 homonyms in a relatively small area. While this is understandable for two species of the genus *Plantago* and two species of the genus *Morus*, in other cases it was confusing, e.g., the local names “čelinka” and “pčelinka” used for *Lamium maculatum* and *M. officinalis*, as well as “borič” used for *Pinus nigra* and *Equisetum arvense*. The name “glog” is used for both *Crataegus monogyna* and *Prunus spinosa*, and has already been recorded in other parts of Dalmatia [14]. The most confusing was the vernacular name “bljušt”, a Croatian common name for *Dioscorea communis*, used for *Portulaca oleracea* in this area. However, there is a record of naming *P. oleracea* “bluč” in Nin [44].

We compared our data on the food use of wild plants to those of the two closest sites of ethnobotanical research in Croatia, Poljica and Vrana [33,34]. Poljica and Vrana are coastal areas, whereas Knin is located more inland and under great influence from the continental-mountain climate with its zonal vegetation. Based on ethnobotanical information, Vrana is more isolated than the other two sites, even though Vrana and Knin are geographically closer to each other, and Vrana has similar edaphic and climate conditions to Poljica. There was a long list of species used at all three study sites. These species are as follows: *Achillea millefolium*, *Artemisia absinthium*, *Capsella bursa-pastoris*, *Celtis australis*, *Chenopodium album*, *Chondrilla juncea*, *Cichorium intybus*, *Cornus mas*, *Crataegus monogyna*, *Daucus carota*, *Foeniculum vulgare*, *Helichrysum italicum*, *H. perforatum*, *Juniperus oxycedrus*, *Lactuca serriola*, *Malva sylvestris*, *M. officinalis*, *M. nigra*, *Paliurus spina-christi*, *Papaver rhoeas*, *Podospermum laciniatum*, *Portulaca oleracea*, *P. spinosa*, *Pyrus amygdaliformis*, *Rosa canina*, *Rubus ulmifolius*, *R. pulcher*, *S. officinalis*, *Silene latifolia*, *Silene vulgaris*, *Sorbus domestica*, *Stellaria media*, *Tilia cordata*, and *U. dioica*. There are some qualitative differences between wild vegetables used in coastal Vrana and Poljica and our study area, which arise from the fact that the Knin area is a place that has lower temperatures and less humidity stress. That is why species such as *L. maculatum* or *Salvia pratensis* occur and are gathered here. The use of the young leaves of *S. pratensis* in a boiled vegetable mix has been recorded for the first time in the literature, to our knowledge, whereas the use of the young leaves of *Cirsium arvense* (in a boiled vegetable mix) as food has been recorded for the first time in Croatia. The only place where it is still used in western Eurasia is Georgia in the Caucasus [45]. Another interesting species never previously recorded in the culinary context in the world literature is *Ranunculus sardous*. Nowadays, *Ranunculus* species are rarely used as food [12,40] as they are toxic in their raw form and need to be boiled for a long time, and they are usually markers of strong, old traditions of wild vegetable use.

Recently, Pieroni et al [46] hypothesized that the culinary uses of many edible weed species originated in the Near East during the post-Neolithic period before populations migrated west to Italy and the Mediterranean Basin via Greece and Greek diasporas. This is not unlikely, and our study area was also heavily influenced by Roman and Greek culture, which might have been responsible for the high cultural value of wild vegetables (called by Łuczaj [47] herbophilia) both in inland and coastal Dalmatia, in contrast to the parts of Croatia further north. However, the herbophilia of Dalmatians might date back to the times when the region was inhabited by Illyrians, who were also Indo-European farmers, like the Romans and Greeks.

The most interesting medicinal use is the application of emerged leaves of *A. millefolium* (mentioned as “tintorova trava”) for treating headaches by initiating nose bleeding. Even though in this research there are only two citations of *A. millefolium* for this use, a larger number of native inhabitants confirmed this, now abandoned, tradition. Dominant medicinal use categories suggest recurring or chronic conditions that bother the local community, with gastrointestinal diseases being prevalent, as noted in other research [4,48]. Other studies also report similar results regarding the plant parts most commonly used [14,49]. Aerial parts (leaves and flowers) are the most abundant, easiest to collect and preserve, and, as related by some of the participants, are used to

distinguish particular species from other similar species growing in the area. Aerial parts and flowers also have large quantities of secondary metabolites, making them the best choice for medicinal use [49].

Use of quantitative analyses in ethnobotanical studies is a tool for obtaining data comparable to other studies as well as deriving reasonable conclusions based on the data collected. The high ethnobotanical richness and pharmacological ethnobotanical index support the assumption that there is a strong bond between the local community and the plants growing in the Knin area. However, the pharmacological ethnobotanical index should be considered with some reservations due to the fact that there is still no complete floristic list available for this area. Instead, a list for calculating this index was built based on data found in the Flora Croatica Database [10]. In addition, only 57% of the taxa were mentioned by the participants more than twice and could be considered reliable, whereas 32% of the taxa were mentioned only once, but we listed them as the information was collected by in-depth interviews with knowledgeable informants. In contrast, the high rate of one-informant data may be an indicator of the gradual loss of ethnobotanical knowledge due to urban lifestyles, higher standards of living, and the availability of conventional medicine and cultivated plants. Species cited once could also be questionable citations as a result of participants confusing the mentioned species with another and should be verified in the future, if pharmacological interest in a particular species arises. Unfortunately, to our knowledge, there are no other knowledgeable informants left in the area. Low values of fidelity level index indicate that participants use plants for different purposes, as evidenced in the case of *Taraxacum*, *S. nigra*, and *Lavandula ×intermedia*. The results of this research suggest that there is a great knowledge of traditional plant use in the Dalmatia that is potentially disappearing, urging for further ethnobotanical research.

Acknowledgments

We would like to thank all the participants in this study as well as Antun Alegro and Vedran Šegota for their insights about the vegetation of the Knin area and the determination of certain species.

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