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Special Issue Reprint

New Insights into Ethnobotany and Ethnoecology

Edited by
Ivana Vitasović-Kosić and Łukasz Łuczaj

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Guest Editors

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About the Editors

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Ivana Vitasović Kosić, PhD, is a Professor in the University of Zagreb Faculty of Agriculture (Croatia). Her research focuses on ethnobotanical and ethnoecological concerns (including the traditional use of wild plants and the forage value of Mediterranean grasslands), biodiversity, vegetation, phytocenology, landscape ecology, natural protected areas, the conservation of ecosystems, and plant invasion. She teaches in various bachelor, master, and postgraduate programs in the fields of botany, phytocenology, ecology, and species and habitat diversity, and also works in the Faculty of Agriculture's ZAGR Herbarium, (http://herbarium.agr.hr/search.html). She has been involved in several specialized and research projects backed by the EU dealing with ethnobotany, ecosystem mapping, invasive species monitoring, landscape ecology, and the post-fire restoration of natural vegetation. She has also (co)authored several books and book chapters on wild plants and plant diversity.

Łukasz Łuczaj

Łukasz Łuczaj, PhD, is a Polish ethnobotanist and ethnomycologist, a Professor at the University of Rzeszów, and a popularizer of botanical knowledge. He is known for his work on wild edible plants and has conducted ethnobotanical research in Poland, China, Lao P.R., Croatia, Bosnia-Herzegovina, Romania, and the Caucasus. Additionally, he is a YouTuber and nature conservation activist, contributing to the popularization of botanical knowledge and ecological practices. He runs the oldest permaculture garden in Poland (started in 1997), organizes foraging workshops and wild garden design courses, and collects wildflower seeds for meadow restoration. He has authored several books on wild food and the natural lifestyle.

Preface

It is with great pleasure that we present this Reprint, "New Insights into Ethnobotany and Ethnoecology", a Special Issue of *Plants* (MDPI), which brings together thirteen scholarly contributions exploring the ever-evolving relationships between people, plants, and the environments they inhabit. This collection arises at a time when global climate change, intensified migration, and the rapid dissemination of knowledge through digital technologies are significantly transforming traditional ecological knowledge and plant use practices worldwide.

The Reprint takes a multidisciplinary and cross-cultural approach to understanding how communities across continents—including Europe, Asia, Africa, and the Americas—are adapting their relationships with wild and cultivated plants. These adaptations reflect both historical continuities and recent innovations in response to environmental change, socio-political shifts, and emerging global connections. Several papers investigate the enduring significance of wild plants and non-cultivated edible mushrooms in food systems and folk medicine, while others explore how changing climate conditions enable the local integration of once-exotic species, altering both ecological systems and culinary traditions.

This Special Issue also places considerable emphasis on the preservation of biocultural heritage through the study of local seed varieties, plant domestication practices, and agroecological management techniques. Such insights are essential not only for maintaining biodiversity and cultural identity, but also for enhancing food security in uncertain times. Furthermore, a number of contributions consider the impact of modern internet technologies on the transmission and transformation of ethnobotanical knowledge, raising important questions about the future of traditional practices in a globalized world.

Together, the articles in this Reprint provide a comprehensive and comparative perspective on the role of plants in human life, illuminating the resilience and adaptability of ethnobotanical traditions in the face of contemporary challenges. It is our hope that this Special Issue will serve as both a scholarly resource and an inspiration for continued research, conservation, and cultural appreciation.

Ivana Vitasović-Kosić and Łukasz Łuczaj
Guest Editors

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Review

Multilateral Use of Dandelion in Folk Medicine of Central-Eastern Europe

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Abstract: Background: Dandelion (*Taraxacum* sect. *Taraxacum*, also referred to as *Taraxacum officinale* F.H. Wiggers coll.), a collective species of perennial herbaceous plants of the Asteraceae family, is commonly considered weed; however, in the traditional societies of Central-Eastern Europe, it is a source of food and medicinal raw materials. The growing interest in the medicinal properties of herbal raw materials of dandelion encouraged us to focus on their use in the traditional folk medicine of Central-Eastern European communities. Aim: The hypothesis of the present study suggests that *Taraxacum* sect. *Taraxacum* (dandelion), which is widespread throughout Central-Eastern Europe and easily identifiable, has had notable applications in ethnopharmacology. The study aims to examine the medicinal properties of this species, focusing on its traditional uses in folk medicine across the region. The resulting data may serve as a valuable resource for contemporary pharmacognosy research. Methods: The analysis was based on publications dated from the end of the 18th century to the beginning of the 21st century, mainly from Poland. In addition, the study includes publications on contemporary Belarus, Ukraine, and European Russia. Results: The research showed that dandelion provided many medicinal raw materials, but the available literature did not mention the use of the herb's root, a raw material popular in contemporary natural medicine. During the period analysed, an increase in the types of raw materials was observed, and the order in which they appeared in the sources was as follows: latex > root = leaf = inflorescence > herb > herb with flowers. Additionally, a review of the literature indicated that the number of conditions under which they were used increased during the investigation period. The variety of ways to prepare the raw material is noteworthy; fresh and dried raw materials were used to make extracts, tinctures, decoctions, infusions, wrap compresses, syrups, and even wine or coffee substitutes. The mentioned preparations were prepared individually for particular ailments. Conclusions: The vast experience of rural communities in Central-Eastern Europe concerning the medicinal applications of common dandelion has developed through centuries. The experience of rural communities may influence the direction of further phytochemical and pharmacological research.

Keywords: *Taraxacum* sect. *Taraxacum*; pharmacological activity; traditional folk medicine; herbal medicine products

1. Introduction

Common dandelion (*Taraxacum* sect. *Taraxacum*, also referred to as *Taraxacum officinale* F.H. Wiggers coll.) is a collective species of perennial herbaceous plants of the Asteraceae family living throughout mild climates of the northern hemisphere and is widely recognised as a weed. Eastern Slavs named this flower 'the golden eye of God' or 'tiny sun' due to easily recognisable yellow inflorescences and silver-tufted, wind-dispersed achenes. Yellow inflorescences in full blooming stage were a sign that man was a child of God and should be as good as the Sun. Single inflorescences at the end of the blooming period indicated that there were much fewer good people and their lives were often bitter, like the taste of the dandelion latex [1]. For the rural communities of Central-Eastern Europe, dandelion was not only a colourful prairie plant and weed of the farmlands but also a supplementary food during famine, an ingredient in salads, and the raw material for the preparation of syrup, coffee, beer, and wine [2–14]. The population of the mentioned region has never underestimated the medicinal properties of dandelion, and, moreover, folktales refer to the medicinal uses of dandelion, e.g., in the treatment of eye problems (blindness) with latex or of warts with 'wart' [6,15–19]. The Latin name, *Taraxacum officinale*, also indicates its healing properties, derived from the Greek 'taraxis' that means 'inflammation' and 'akeomai' meaning 'healing', while '*officinale*' means 'medicinal' emphasising its therapeutic effects [20]. The curative effects of dandelion in folk tradition were included in collective elaborations covering these issues [6,18,21], although monographs of this species were not comprehensive, taking into account its widespread occurrence and use in folk medicine.

The increasing number of studies published in recent years revealed the healing properties of dandelion, including antiviral, e.g., against the SARS-CoV-2 virus [22–25]. The main hypothesis of the present study is that common dandelion, which is widespread in Central-Eastern Europe and easily identifiable due to its large yellow inflorescences, should be widely used in folk medicine. The aim of this study is to analyse the use of dandelion's raw materials by the rural communities inhabiting Central-Eastern Europe in order to present their possible applications in contemporary medicine. The collection and analysis of information from Slavic-language literature on the use of dandelion's raw material in the traditional medicine of the communities native to the mentioned regions is difficult for English-speaking scientists. However, it provides many novel links to the therapeutic applications of dandelion and indicates the direction of further research related to its use in modern medicine.

2. Materials and Methods

The analysis of the medicinal use of the common dandelion (*Taraxacum* sect. *Taraxacum*) in folk medicine of Central-Eastern Europe was carried out on the basis of printed studies including available elaborations since the 18th till 20th century, covering Central-Eastern Europe, with the particular emphasis on Poland, Belarus, European Russia, and Ukraine. The criticism method proposed by Topolski [26] was utilised in this study to analyse historical written sources and to evaluate the reliability of informants and information. External and internal source criticism was applied to achieve the proper interpretation of the source text and to verify the authenticity of the information provided by the authors based on the psychological and sociological background, as well as former social and physical environment [27]. The analysis was based on the database and card catalogue maintained by the 'Pracownia Etnolingwistyczna' at Maria Curie-Skłodowska University in Lublin. The results presented in this study are derived from 66 publications pertaining to the examined region, while 37 additional works from other global regions were included for comparative analysis. Only original and popular science publications were considered. In the process of source selection, folk names of *Taraxacum* (dandelion) were referenced

according to the works of Annenkov [19] and Hyrcyna [18]. The following criteria were applied in source selection: the publications focus on rural populations, their relationship with conventional medicine is not documented, and they originate from Central-Eastern Europe. The gathered data were systematically analysed with respect to the plant parts utilised, the methods of preparation, and the specific ailments or diseases for which the plant was employed. Since the aim of the study was to demonstrate the diversity of common applications of dandelion's raw materials in therapies, the regional diversity was not included in the discussion. Łuczaj [28] and Kujawska et al. [21] pointed out the problems with the correct nomenclature of plant species in ethnographic research. Kluk [2] wrote that "Peasants commonly use the name 'mniszek' (dandelion) for all similar plants that have their own latex ". In the present study, the analysis of plant species in the cited ethnographic sources was conducted to exclude species that were referred to with the same name but classified as separate taxa, for example, *Sonchus* spp. [28]. The manuscript was based on printed sources, but especially in the case of Polish-language sources, only a small number of them have been published online. Therefore, this work was created to make this unique knowledge available to a broader audience of international readers. The medicinal use of dandelion is presented from a historical perspective, dividing it into the following periods: 18th century (no earlier works were found), this period covers the period until the fall (1795) of the Polish–Lithuanian Commonwealth, a state that covered a large part of the studied area; the 19th century (domination of the Russian Empire); the period from the beginning of the 20th century until the end of World War II; the period from World War II to the fall of communism (1989); and the period of democratic rule after 1990. The basis for qualifying a publication for a given time period was the date of publication; however, in the case where the time from which the obtained sources originated was clearly stated, such work was included in this period, e.g., Kujawska et al. (2016) [21], a work based on materials collected by Adam Fischer (d. 1943). Regarding the nomenclature of dandelion's raw materials and formulations, the term 'latex' was used with reference to the 'juice' or 'milk' mentioned in the analysed literature, leaking from damaged plant tissues. Similarly, the term 'syrup' was used as a formulation made from dandelion inflorescences with sugar, sometimes with the addition of water, named 'syrup', 'honey', or 'jam' in the sources of the literature.

In the present study, we also tried to refer to the diseases or their symptoms mentioned in the historical sources by the current medical nomenclature, based on the 'Ethnological Atlas of the human body and diseases' [29] and 'Medical vocabulary of Stafan Falimirz' [30]. However, in some cases, especially those related to abdominal organs, it was uncertain or even impossible to link the symptoms mentioned in the former literature (commonly pain and colic) with certain diseases [31,32].

3. Results

Common dandelion is a well-known plant recognised by the local communities of Central-Eastern Europe as a weed but also as an herb. The health-promoting properties of dandelion were known and used in the therapy of many diseases by rural communities since at least the 18th century (Tables 1 and 2 and Figure 1). The general number of diseases treated with dandelion's raw material and formulations increased constantly, including several dozen uses at the end of the discussed period (Table 1). Initially, in the 18th century, latex was commonly used, but since the 19th century, information about the medicinal use of leaves or roots had been discussed in the analysed literature. On the other hand, sources published after the Second World War contained information on the use of herbs and inflorescences, and those published after 1990 contained information on the utilization of herbs with inflorescences (Table 2 and Figure 1). Latex and roots were used for the treatment

of most of the mentioned diseases in decoction and syrup, using inflorescence as a raw material (Table 2). However, the choice of the treatment procedure should be individual. Special formulations were recommended in the case of only three, two, and even individual diseases (Table 2). The rural population of the investigated regions considered dandelion an effective remedy for internal diseases [33], while populations native to the Balkans used syrup obtained from inflorescences as a panacea [34,35]. During the 18th to 20th centuries, many communities used dandelion for the treatment of dermatological, digestive, respiratory, and urinary diseases [6,14,18,21].

Table 1. Medicinal use of dandelion in historical periods.

Period	Medicinal Use
18th century	Body-cleansing agent [2], in ocular disease treatment [2], against wounds and ulcers [2].
19th century	Analgesic agent for earaches [36], toothaches [37], and during tooth eruption in children [38]. Antiswelling agent (*hydrops*) [39]. Vomiting [40] and laxative agent [41]. Treatment of ague (*febris flava*) [42], jaundice [41], vision loss [43], blindness [37], shortness of breath [36], and rheumatism [41], against warts [44,45] and rabies [37]. Aborifacient agent [46].
From 1901 to World War II	Antiswelling [21] and vomiting agent [47]. In cold [21], jaundice [21], and liver disease treatment [21,48]. In treatment of vision loss [21] and night blindness (*nyktalopia*) [15]. Against warts [15].
From World War II to 1989	Analgesic agent for earaches [36,49], toothaches [49], stomachaches [6,50], and abdominal pain in women [50]. Treatment of stomach [50], liver [6,51], biliary disorders [6], and haemorrhoids [51]. Antiswelling [49], constipation [50], and vomiting agent [49]. In erysipelas [49], jaundice [6,52], and vision loss treatment [6,49]. In bladder inflammation [50]. In diseases of the upper respiratory tract [6], including persistent cough treatment [50,51]. Against skin problems [6], including warts [6,17,49,52] and freckles [6,49]. Against rabies [49,52].
After 1990	Analgesic agent [13] in earache [53], toothache [54], stomachache [13], and back pain [55]. Against upper respiratory tract diseases [56], including asthma [54], pulmonary asthma [57], bronchitis [13], rhinitis [58], sore throat [13], hoarseness [10,59], shortness of breath [9,10], pneumonia [60], and tuberculosis [13]. Antitussive [8,10,12,56,59,61–63], body cleansing [10], immunostimulant [10,13,61], and recreational agent [13], source of vitamins [13]. Against skin problems [53,54], including wounds [64], mycoses [65], black spots [66], freckles [55,66,67], warts [53,55,58], eczema [65], hair loss [55], to refresh facial skin [18]. Against digestive diseases, including liver diseases [8,33,55,61,68], lung diseases [56], biliary ailments [68], and jaundice [69] and as laxative [68]. Vomiting agent [10,18]. To improve appetite and digestion [68], supporting slimming [12], against poisoning [70]. In cancer treatment [13]. Antipyretic in cold [8,10,13,61] and flu treatment [10]. In diabetes treatment [55]. In vision loss treatment [18,54,61]. Antiswelling [71] and diuretic agent [68,72]. Against kidney stones [13], hypertension [61], herpes zoster [64], rabies [54], and rheumatism [65].

Table 2. The use of dandelion in folk medicine of Central-Eastern Europe.

Part of Plant	Raw Material/Preparation	Medicinal Use
Herb	Dried herb, infusion	Against hypertension [15] and as immunostimulant [61]
	Extract	Against bladder inflammation [50]
	Infusion	In liver diseases [51,55], kidney diseases [55], haemorrhoids [51], diabetes [55], suspending hair loss [55]
	Tincture	Analgesic [13]

Table 2. *Cont.*

Part of Plant	Raw Material/Preparation	Medicinal Use
Inflorescence		In stomach [66] and heart diseases [61]; cosmetic to treat black spots [66] and freckles [49,55,67]
	Decoction	In kidney diseases [13], as an analgesic [13]
	Dried	Antitussive [56]
	Wine	Antipyretic [10], immunostimulant [13], causing vomiting [10]
	Fresh	Antipyretic [13], analgesic [13]
	Infusion	Antitussive [51], in stomach ache [50], rheumatism [65]
	Syrup	Antitussive [8,10,12,59,61–63], antipyretic [8,13,61], in hoarseness [10,59], shortness of breath [9,10], rhinitis [58], liver diseases [61], sore throat [13], bronchitis [13], tuberculosis [13], pneumonia [60], cancer [13], as immunostimulant [10], as a source of vitamins [13],
	Tincture	In stomachache [13], analgesic [13], skin treatment after cupping [33]
	Wraps	Against warts [53]
Herb during flowering	Crushed herb	In skin diseases [53]
Leaf	Compress	Against herpes zoster/chickenpox [64]
	Decoction	In stomach diseases [46], hair care [13]
	Fresh	Laxative [41], wound treatment [64]
	Infusion	Against constipation [50], persistent cough [50], and stomach ache [50]
	Tincture	In stomach ache [13], ague (Lat. *febris flava*) [42]
Latex		Analgesic in back pain [55], earache [36,49,53], toothache [37,49]; body cleansing [2]; in eye diseases [2], including night-blindness (Lat. *nyktalopia*) [15] and vision loss [6,18,49]; in jaundice [21,41,69]; in liver diseases [8], in rabies [49,52], in erysipelas (Lat. *erysipelas*) [49], in shortness of breath [36], skin problems [6]: wounds [2], mycoses [65], freckles [6,49,55], and warts [6,15,17,44,45,49,52,55,58]
Root		In biliary ailments [68], mild laxative action [68], increasing appetite and improving digestion [68], as diuretic [68], in liver diseases [68]
	Coffee substitute	In kidney stones [13], as recreational tea [13]
	Decoction	In biliary ailments [6], as diuretic (edema) [72], generalised swelling (*hydrops*) [21,39,49,71], in jaundice [6], in liver disease [6], abdominal pain in women [50], slimming [12], in stomach ache [6], in stomach diseases [49], in upper respiratory tract diseases [6], vomiting [49]
	Extract	Inflammation of the bladder [50]
	Fresh	Cancer [13]
	Grated root	Eczema [65]
	Infusion	Constipation [50], poisonings [70], rheumatism [65]
	Scraped and boiled in milk	Vomiting [18,40]

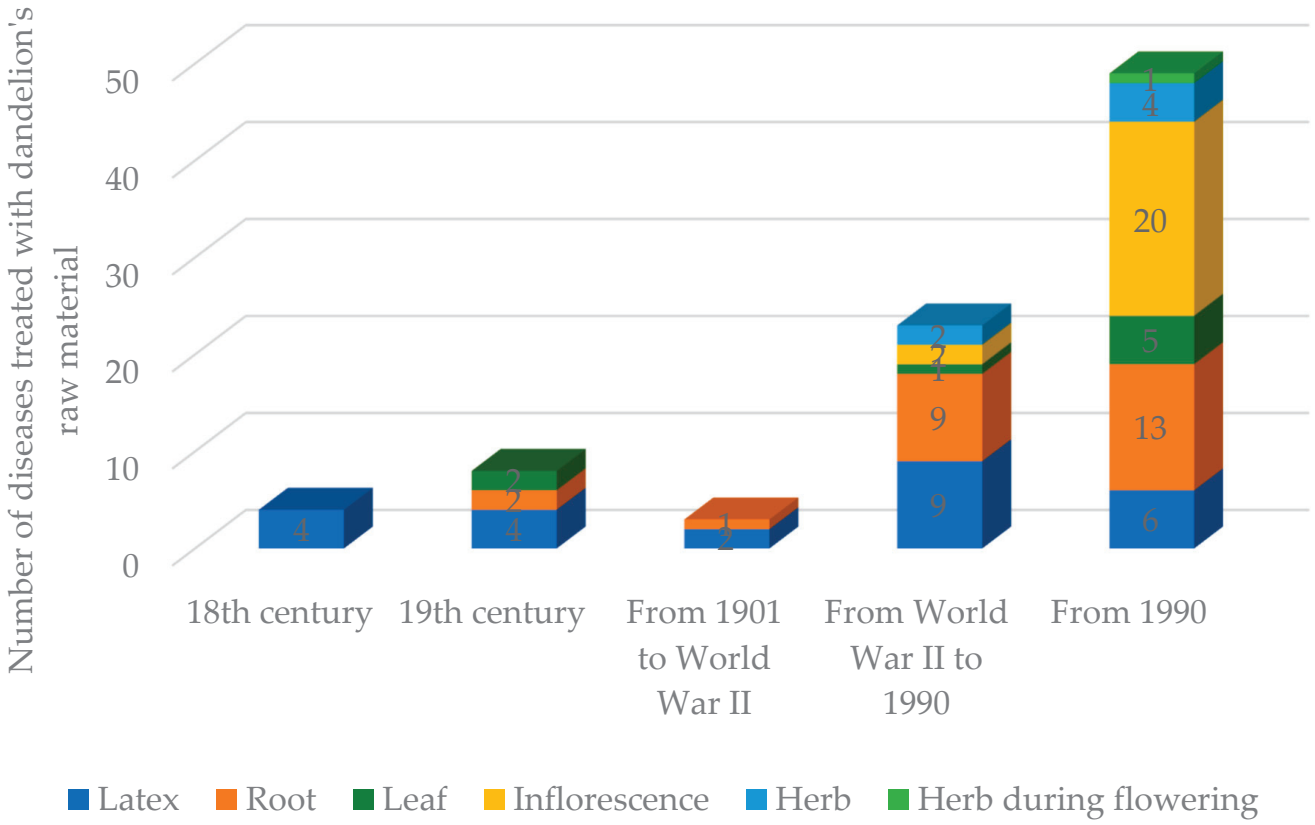

Figure 1. Number of medicinal uses of dandelion's raw materials in historical periods found in cited references.

3.1. Respiratory System Diseases

The populations native to Central-Eastern Europe exploited dandelion's herb in the treatment of respiratory diseases, such as asthma, flu, cold, fever, lung diseases, and the infections of the upper respiratory tract, mainly coughing. The syrup, commonly prescribed in these cases, was prepared by sprinkling the collected inflorescences with sugar and, in some cases, boiling it with lemon. The inflorescence syrup was used for the treatment of throat ailments, cough, hoarseness, cold, runny nose, flu, shortness of breath, bronchitis, pneumonia, and even tuberculosis. Sometimes, the syrup was added to tea, for example, to treat flu. The colds were also cured with fresh inflorescence. The infusion of dried inflorescences was used in the case of cough, while the infusion of leaves and roots was used to cure persistent cough. Latex was recommended for dyspnoea, and the wine made of inflorescence for fever. Leaf extract was considered an effective drug against fever, and the root decoction was prescribed for diseases of the upper respiratory tract (Table 3). References from other regions also contained information that dandelion inflorescence syrup was effective in treating the diseases of the respiratory system. In Italy, it was recommended for coughing [73], similarly to Slovenia [74], Serbia [75,76], and Croatia [77]. In Serbia, dandelion inflorescence syrup was also used to treat pulmonary ailments [75] and bronchitis [76]. In Kosovo, an infusion of inflorescences was prescribed to cure respiratory inflammation and the infusion of leaves in the case of lung disorders, such as bronchitis [78,79].

Table 3. The use of dandelion in folk medicine.

Symptoms/Disease Entity	Part of Plant *	Raw Material/Preparation	References
Respiratory system diseases			
Lung diseases			[56]
Diseases of the upper respiratory system	R	Decoction	[6]
			[56]
Cough	I	Syrup	[8,10,59,61–63]
		Infusion	[51]
		Dried	[56]
		Syrup	[12]
Persistent cough	L	Infusion	[50]
	R	Infusion	[50]
Sore throat	I	Syrup	[13]
Hoarseness	I	Syrup	[10,59]
For breathing problems	I	Syrup	[9,10]
	Lx		[36]
Pulmonary asthma			[57]
Cold	I	Syrup	[8,13,61]
		Fresh	[13]
		Drink	[21]
Flu	I	Tea with honey and dandelion	[10]
Fever	I	Wine	[10]
Ague (łac. *Febris flava*)	L	Macerate	[42]
Rhinitis	I	Syrup	[58]
Bronchitis	I	Syrup	[13]
Pneumonia	I	Syrup	[60]
Asthma			[54]
Tuberculosis	I		[13]
Digestive system diseases			
Liver disease	R	Decoction	[6]
			[68]
	H	Infusion	[51,55]
	Lx		[8]
	I	Syrup	[61]
			[21,33,48]
Stomach disease	R	Decoction	[49]
	L	Decoction	[46]
	I		[66]
			[54]

Table 3. *Cont.*

Symptoms/Disease Entity	Part of Plant *	Raw Material/Preparation	References
Stomach ache	L	Infusion	[50]
		Tincture	[13]
	R	Decoction	[6]
	I	Tincture	[13]
	I	Infusion	[50]
Biliary ailments	R		[68]
		Decoction	[6]
Vomiting	R	Decoction	[49]
	R	Scraped and boiled in milk	[18,40]
	I	Wine	[10]
		Cooked	[47]
Constipation	R	Infusion	[50]
	L	Infusion	[50]
Mild laxative	R		[68]
Laxative	L	Fresh	[41]
Poisoning	R	Infusion	[70]
Haemorrhoids	H	Infusion, baths, compresses	[51]
Jaundice	R	Decoction	[6]
	Lx		[20,41]
	S	Rubbing the face	[52,69]
Increasing appetite and improving digestion	R		[68]
Dermatological diseases			
Skin diseases	HF	Crushed	[53]
	Lx	Squeezed out of the plant stem	[6]
Warts	Lx	Fresh	[6,15,17,44,45,49,52]
			[54]
	Lx		[15,55]
	Lx from leaves	Lubrication	[58]
	I	Wraps	[53]
Eczema	R	Mixture of grated root and honey	[65]
Mycoses	Lx		[65]
Erysipelas	Lx		[6]

Table 3. *Cont.*

Symptoms/Disease Entity	Part of Plant *	Raw Material/Preparation	References
Urinary system diseases			
Kidney diseases	H	Infusion	[55]
	I	Decoction	[13]
Kidney stones	R	Coffee substitute	[13]
Diuretic	R		[68]
Inflammation of the bladder	H	Extract	[50]
	R	Extract	[50]
Diuretic (edema)	R	Decoction	[72]
Generalised swelling (łac. *hydrops*)	R	Decoction	[21,39,48,71]
Pain			
Toothache	Lx		[37,48]
			[54]
Earache	Lx		[36,49,53]
Ear diseases			[54]
Pain	I	Fresh, topical application	[13]
		Decoction	[13]
		Tincture, topical application	[13]
	H	Tincture, topical application	[13]
Back pain	Lx		[55]
Rheumatism	R	Infusion	[65]
	I	Infusion	[65]
		Decoctions	[47]
Skin after cupping	I	Tincture	[33]
Ocular diseases			
Eye diseases			[54]
Blindness	Lx		[6,18,49]
			[37,61]
Loss of vision		Seizure causes blindness	[21,43]
Night-blindness (*łac. nyktalopia*)	Lx	Seizure causes blindness	[15]
Cardiovascular system diseases			
Hypertension	H	Infusion of dried herb	[61]
Heart diseases	I		[10]

Table 3. *Cont.*

Symptoms/Disease Entity	Part of Plant *	Raw Material/Preparation	References
Obstetrics and gynaecology			
For lower abdominal pain in women	R	Decoction	[50]
Abortifacient agent			[46]
Other			
Diabetes	H	Infusion	[55]
Cancer	I	Syrup	[13]
	R	Fresh, eaten	[13]
Herpes zoster/Chickenpox	L	Compresses	[64]
Rabies	Lx		[6,52]
			[37,54]
Wounds	L	Compresses	[64]
Immunostimulant	I	Fermented with sugar	[13]
		Syrup	[10]
	H	Infusion of dried herb	[61]
Body cleansing			[10]
	Lx		[2]
Vitamins	I	Syrup	[13]
Recreational tea	R	Dried coffee substitute	[13]
Cosmetics			
Suspending hair loss	H	Infusion; washing	[55]
Hair care	L	Decoction	[13]
Refreshing the facial skin			[18]
Slimming	R	Decoction	[12]
Easier tooth-eruption in children		Chewing	[38]
Freckles	I		[48]
			[46,67]
	Lx		[6,49,55]
Cosmetics to treat black spots	I		[66]

* H—Herb; HF—Herb during flowering; I—Inflorescence; L—Leaf; Lx—Latex; R—Root.

3.2. Digestive System Diseases

Dandelion was considered an effective herb for the treatment of internal diseases among rural populations of the analysed area [33]; for example, abdominal pain was alleviated with infusions or tinctures made of its leaves and inflorescences. The data showed that the kind of formulation was of great importance in alleviating the symptoms of digestive system diseases. An infusion of dandelion roots and leaves was used against stomach disorders, but the decoction of these raw materials, as well as the latex and inflorescence syrup, was used against liver ailments. Dandelion root decoction was also a remedy for gall bladder ailments (Table 3). The available data relevant to the use of the herb in the treatment of digestive system diseases collected from various regions broadened the scope of knowledge in this field. For example, to treat stomach pain, the infusion of dandelion inflorescences had been used in Kosovo [78], the herb in the Venetian Diaspora in Eastern Romania [80] and Bolivia [81], and a decoction of the roots in North America [82]. Liver ailments were treated with dandelion's roots in Himachal Pradesh [83], with a decoction of leaves in the Tuscan Archipelago [84], with an infusion of leaves in Spain [85], and with an infusion of entire plants in Bolivia [81] and Syria [86]. The infusion of whole plants was also used in Bolivia [81] and Syria [86] against biliary ailments.

Dandelion was used in digestive problems, and, for example, the infusion of the roots was drunk in case of poisoning. The infusions of roots, leaves, or fresh leaves were considered a remedy for problems with defecation. The infusion of roots or the wine of inflorescences induced vomiting (Table 3). Dandelion was used as a laxative in Italy [73] and Pakistan [87]. North American Iroquois made a decoction of inflorescences and leaves as a laxative agent, while the infusion of roots was used to induce vomiting [82].

In Central-Eastern Europe, the infusion of the herb was used in the form of baths and compresses against haemorrhoids (Tables 2 and 3). To alleviate these ailments, dandelion was also used in Italy [88] and in Croatia [89]. Probably due to the signature doctrine attributed to Paracelsus, the determined colour of the dandelion inflorescence was considered to be effective in jaundice treatment; this involved rubbing latex on the face or drinking the infusion of the roots (Table 3). The latter use was also reported in the British Isles [90], Pakistan [91], India, Nepal, and China [92].

3.3. Dermatological Diseases

The literature sources from Central-Eastern Europe contain information that dandelion latex or compresses made of inflorescences were used in the treatment of many dermatological diseases, including common warts and boils. Latex was also recommended in the cases of erysipelas and purulent skin infections (Tables 2 and 3). The healing properties of dandelion reflect its Polish regional names, for example, 'brodawnik' or 'kurzajk' meaning 'wart' [16–18]. Similarly, latex was used to remove warts in the British Isles [90,93], Italy [94], and Spain [95]. Moreover, in folk medicine, dandelion was considered to be effective in preventing the formation of dark spots on the skin [75]. In Italy, the decoction of whole plants was recommended for the treatment of skin inflammations [88]. In Himachal Pradesh, the leaf compresses were used as a poultice against swelling and boils [83].

3.4. Urinary System Diseases

Dandelion was commonly used in the treatment of urinary system among populations native to Central-Eastern Europe. In the case of kidney disease, the herb or inflorescences were used to make a drink, while the dandelion root decoction was recommended to patients suffering from kidney stones, cystitis, and ascites (general swelling; Lat. hydrops) (Table 3). The diuretic properties of dandelion were recognised in many countries, although different raw materials or formulations were used; for example, the following

infusions were reported: leaves in Bolivia [96], whole plants in Syria [86], inflorescences in Kosovo [35], and roots in India [97,98]. In Italy, for this purpose, leaves, inflorescences, or roots were eaten raw or applied as decoction or syrup [73,84,99]. Among the raw materials and formulations recommended for kidney diseases, the following were used: roots in Himachal Pradesh [83] and North America [82], aboveground parts in Bolivia [81], and the infusion of leaves in India [98], Bolivia, and Peru [95].

3.5. Pain Treatment

In Central-Eastern Europe, the common dandelion was used to mitigate pain of different origins. Leaf and inflorescence infusions or tinctures were recommended as a remedy for headache, and latex was recommended for tooth or ear pain (Table 3). This application of dandelion herb and formulations was also reported in the literature from the British Isles [90], Balkans [78,100], and North America [82]. In Central-Eastern Europe, fresh inflorescences, as well as tinctures and decoctions of inflorescences and whole plants, were applied topically to relieve pain (Table 3). For this purpose, an infusion of the entire plant was also used in Syria [86] and compresses of roots in Pakistan [87].

Latex from the above-ground parts of dandelion was applied to relieve back pain, while an infusion of roots or inflorescence was prescribed to treat rheumatism (Table 3). Herb was also used for this purpose, as Talko-Hryncewicz [47] described, 'When a sick person is seated, naked, on a large stone, in the open air in summer, and in a cottage in winter, they lavage his body with a decoction of mullein (*Verbascum* sp.), violets (*Viola* sp.) and dandelion'. Data from the literature also indicated that rheumatism was treated with dandelion herb by people native to the British Isles [90], Syria [86], and North America [82].

3.6. Ocular Diseases

The literature related to the folk medicine of Central-Eastern Europe contains contradictory opinions on the effectiveness of dandelion in the treatment of ocular diseases. Some authors indicated that dandelion latex could cause vision loss or night blindness when it enters the eye, whereas others indicated that latex could be used in the treatment of blindness (Table 3). The external application of dandelion latex in cases of eye disease was also mentioned by Kluk in the 18th century [2]. Furthermore, the Iroquois communities of North America Iroquois [82] and those in the British Isles [90] used dandelions' herb in former ophthalmology.

3.7. Cardiovascular System Diseases

There are a few references that common dandelion was an effective remedy in the treatment of cardiovascular disease. Szot-Radziszewska [61] mentioned the use of dried herbs in the case of hypertension, while Kąś [10] provided information on the application of inflorescences to support cardiovascular capacity. In terms of references outside the study region, dandelion was a remedy in the treatment of hypertension in Croatia [89] and in Italy [73], while in Pakistan, the infusion of roots and inflorescences was a remedy applied in cases of heart diseases [82,90,91].

3.8. Obstetrics and Gynaecology

A root decoction was commonly recommended for women suffering from abdominal pain (Table 3). Köhler [46] mentioned the use of dandelions to induce a miscarriage. Data from the literature from other regions also provided information on the use of dandelion in relieving menstrual pain [78,82] and in cases of irregular menstruation [101].

3.9. Others

The population of Central-Eastern Europe considered the dandelion herb to have beneficial effects on the human body. The herb infusion was drunk to strengthen the body, while the syrup of raw or fermented inflorescence was used to improve the immune system, clean the body, and provide vitamins and minerals (Table 3). Kluk [2] wrote, "This white bitter juice is taken internally in the spring to clean". The mentioned strengthening and cleansing effect of dandelion did not go unnoticed by other rural communities. For this purpose, leaf salads were eaten in Bolivia [81] and by the Russian community in Germany [102]. In Italy, leaf decoction or the syrup of inflorescences was used [103], while the syrup of inflorescences was used in Slovenia [74]. In Central-Eastern Europe, an infusion of dandelion herb was recommended in cases of diabetes (Table 3), and, moreover, sources from other countries and regions, such as the British Isles [90], Mexico [104], Bosnia and Herzegovina [101], Pakistan [82], and Syria [86], contain similar information. Sõukand et al. [13] reported that in the Liubań region (Belarus), inflorescence syrup as well as raw roots were recommended in cancer cases (Table 3), and similar references originate from Slovenia [74]. The anticancer activity of the dandelion herb has been reported in sources from the British Isles [90] and Mexico [105]. Dandelion was a traditional wound-healing plant not only among the populations of Central-Eastern Europe but also the British Isles [90], Bulgaria, Serbia [106], and India [83,107].

The specificity of Polish folk medicine was the application of dandelion latex in the curation of patients with symptoms of rabies (Table 3). Furthermore, wet leaf dressings were used for herpes zoster and chickenpox (Table 3), but this usage seemed to be limited only to the mentioned regions.

3.10. Cosmetics

Common dandelion and its formulations have been widely used as natural cosmetics. The infusion of herbs was used in hair care to prevent hair loss and in skin care for anti-ageing, but in this regard, there is no exact information about the type of raw material or formulation used. Inflorescences and latex were effective in bleaching freckles (Table 3). In Belarus, the decoction of dried dandelion roots was valued as a recreational tea [13]. Information about the use of dandelion root decoction for slimming purposes comes from the Lublin region in Poland (Table 3), while in Syria, the whole plant was used for the same purpose [86].

3.11. Veterinary Medicine

The references from Central-Eastern Europe contain selective information on the use of dandelions in veterinary medicine. According to common opinion, dandelion was the favourite food of farm animals, including cows, horses, pigs, rabbits, and ducks (Table 4). It is also known to be used as a purification factor, contributing to wound healing by removing skin-penetrating parasites from livestock. The cattle were fed a decoction of roots as a remedy for flatulence and as a lactogenic. Information on its use as feed for livestock also comes from other regions of the world [83,91,108,109]. In addition, a figurative role was referred to dandelion inflorescences in folk culture. As an example, during Pentecost Sunday, cows were decorated with dandelion's wreaths to ensure breeding success [110].

Table 4. The use of dandelions' raw materials in folk veterinary medicine.

Animal	Disease	Part of Plant *	Manipulation and Way of Use	References
	Removing worms from wounds			[111]
Cows	Stomach bloating	R	Decoction	[6]
	Stimulation of milk production	H	Food	[6,10,43,55]
	Good for cows	I	Fresh	[13] [7]
Horses	Good for horses	I	Fresh	[13]
Pigs	Fodder	H	Fresh	[13]
		I	Fresh	[13]
		L	Fresh	[13] [112]
Goose	Fodder	H		[6]
Ducks	Fodder			[113]
Rabbits	Fodder			[113]
Home animals	Fodder	L	Fresh	[13]

* H—Herb; I—Inflorescence; L—Leaf; R—Root.

4. Conclusions

Due to its broad distribution, the common dandelion was an easily available herbal material in Central-Eastern Europe. The information collected indicated that this plant was widely used in folk medicine, and since 1990, the number of dandelion-cured diseases has systematically increased, covering dozens of ailments. Dandelion's raw materials and formulations were used to treat respiratory, digestive, urinary, cardiovascular system, dermatological, and ocular diseases; they were also used in pain treatment and in obstetrics and gynaecological disorders. Furthermore, dandelion was included among herbs with a beneficial effect on the human body as an immunostimulant and strengthening agent, as well as a cleansing agent. Furthermore, the present study showed a hitherto unknown possibility of using dandelion leaf compresses in the treatment of herpes zoster, chickenpox, and rabies, as these applications appeared to be limited only to the investigated regions. In traditional folk medicine, special attention was paid not only to the raw materials used, including roots, leaves, inflorescences, herbs, or latex, but also to the formulations applied internally, such as infusions, decoctions, syrups, and wine, or externally, such as compresses. This work also points to the individual approach in the utilisation of dandelion raw materials because the selection and preparation methods were specific to disease entities. In the period analysed, there are no reports on the use of the whole plant in folk medicine, while contemporary pharmacognosy indicates the possibility of using a root infusion or decoction of roots together with the herb [114]. The sources gave an ambiguous answer on the healing effect of a dandelion on eyesight because it was found that after latex use, people regained their eyesight, but putting this juice into the eye may even cause its loss. Therefore, phytochemical analysis and determination of the pharmacological effects of dandelion latex can be a very interesting prospect for further phytochemical studies. Furthermore, based on the analysis of the data from the literature, it can be assumed that the common dandelion was recognised as a very valuable feed for animals, suggesting the possibility of using it as a feed supplement in livestock farming.

The data collected reflect the state-of-knowledge of the communities of Central-Eastern Europe concerning the dandelion's healing properties during the investigated period. Scientific publications published in recent years confirmed the healing properties of common dandelion, indicating the legitimacy of research in this area. Furthermore, the experience of rural communities may indicate the directions for further phytochemical and pharmacological research.

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plants

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Article

Multiple Uses of Wild Edible Trees by a Nahua-Origin Community in Western Mexico

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Abstract: Wild edible trees (WETs) play an important role in the diet of many rural communities. Therefore, research on their use and management is important to support both food sovereignty and local conservation of biocultural resources. We evaluated the different uses of WETs by the community of Zacualpan, Colima, in western Mexico, through 32 semi-structured interviews registering the species richness, plant parts consumed, and non-food uses. Additional information was collected on their management, availability, and forms of preparation. We used a cultural salience index to determine the food importance of the WETs mentioned. We registered 33 edible tree species (26 wild, 3 native crops, and 4 exotic crops) that were most commonly consumed as fruits or seeds. WETs were also used for fuel, live fences, timber, handicrafts, medicine, shade, fodder, poles, utensils, construction, tanning, soap, and paper. *Pithecellobium dulce* had the highest food salience, followed by *Spondias purpurea*, *Leucaena esculenta*, *Leucaena leucocephala*, *Enterolobium cyclocarpum*, and *Jacaratia mexicana*. Salient wild trees were collected in the wild and promoted in agroforestry systems. These trees provided food during the dry season and also had the highest number of additional uses. Promoting the biocultural value of WETs and their sustainable use can favor ecosystem conservation and local food sovereignty.

Keywords: agrobiodiversity; agroecology; ethnoecology; food sovereignty; plant management; traditional foods; tropical dry forest; Sierra de Manantlán Biological Reserve

1. Introduction

The continuous search for and provision of food has been a major driver of plant management. Prehistoric vegetation management practices were used to increase the abundance and availability of edible annual and perennial plants, laying the foundation for plant cultivation and domestication [1,2]. These practices have persisted in traditional agricultural systems, generating a rich diversity of foods, knowledge, and skills for their use and procurement that sustain the sovereignty of many rural communities worldwide [3,4]. In recent centuries, however, human diets have become increasingly concentrated on a small number of domesticated species. As a result, 80% of the global dietary energy intake

now comes from just a few crops, while wild species receive far less attention. This shift has led to a significant decline in dietary and biocultural knowledge [5].

Despite the accelerated decline in the use of wild edible plant species, they are still consumed in both industrialized and developing countries [4]. Because of their cultural and economic importance and to ensure their availability, wild and domesticated plants are managed both in situ and ex situ [6,7]. Domesticated species are those that have been genetically modified by human selection, often resulting in morphological, physiological, reproductive, and genetic divergence from wild populations [8]. However, many wild species are subject to different types of management practices that may result in intermediate or advanced degrees of domestication. Over time, wild species may be cultivated and managed in other forms that procure and enhance their maintenance in forest and agroforestry areas as non-domesticated or semi-domesticated plants [7,8].

For example, ethnobotanists have identified 251 domesticated species of native crops in Mexico and Central America [9], nearly 700 species of semi-domesticated plants, and about 7000 species obtained through gathering, including 1700 useful trees [10]. These numbers correspond to plant species used for different purposes, but food plants are outstanding. Mapes & Basurto [11] recorded nearly 2200 edible plant species occurring in Mexico, of which 542 are trees used for food [12]. Most of these are wild edible trees (WETs), which play an important role in the diet of many rural communities [4,11,13,14].

WETs provide a variety of nutritional and nutraceutical products that contribute to dietary diversification and promote health benefits [5,15]. Furthermore, WETs also serve as a vital resource in times of scarcity or famine, especially when conventional crops are unavailable or fail [16,17]. In addition, their structural characteristics and longevity make them valuable multipurpose resources that are commonly used for construction, fuel, fodder, medicine, and other purposes [18,19]. All these characteristics make WETs an important source of household income through the sale of their products in local markets and nearby urban areas [6,13]. To obtain multiple benefits, these species are often managed in wild vegetation, agroforestry systems, fallow land, and home gardens, making them an important component of agrobiodiversity [20–22].

In this context, WETs have cultural values, where traditional ecological knowledge (TEK) is intricately woven into local culinary practices, sentiments, spirituality, agriculture, and ecosystem management, shaping community identity and biocultural heritage [19,23,24]. These food systems also include means to communicate and transmit environmental knowledge, including information on the harvesting, processing, and sustainable use of edible plants, their seasons and production cycles, their habitats, and their use by other species [25]. Thus, the cultural importance of WETs can promote their management over time as they are passed down through generations, which can promote ecosystem regeneration and conservation [22].

WETs also serve as food resources for wildlife, such as birds and bats, which act as important dispersers and pollinators [26,27]. In addition, their presence in agroecosystems and even in urban areas promotes ecosystem connectivity, supports soil fertility, and helps prevent erosion [28,29]. These functions reinforce the importance of local knowledge and biocultural memory in protecting, promoting, conserving, and restoring biodiversity [24]. However, research on WETs in the Americas has often been relegated to general studies of useful wild plants [4,11,17,19,30–32] and the management and domestication of edible trees [6,9,33–35]. Given the diversity of WETs, research in understudied regions focusing on their multiple uses, nutritional and nutraceutical properties, economic importance, and ecology is still needed.

Our study aimed to (1) evaluate the cultural importance of WETs in meeting human needs, analyzing their use as food sources, including the plant parts consumed, their availability, preparation forms, and additional non-food uses; (2) examine the relation of these uses with actions to procure, conserve and promote the abundance of trees by people of the community of Zacualpan, Colima, in western Mexico; and (3) evaluate the cultural values of forest components and the importance of maintaining such values for promoting

biodiversity conservation programs. The area where the study was conducted is part of the Central–Western Mexico Biocultural Corridor and the Nevado de Colima-Sierra de Manantlán Biological Corridor, which is shared by the states of Colima and Jalisco. It is, therefore, an area of high priority for biodiversity conservation and biocultural importance, as indigenous people have been present in the area for hundreds of years. However, despite this importance, biological inventories and ethnobotanical research remain limited, especially in Colima.

Zacualpan is one of the last two indigenous communities in the state of Colima with communal land tenure, recognized for its efforts to preserve local traditions and common goods. They faced the threat of an extractive mining project and several problems associated with the provision of water to urban areas of the city of Colima [36]. Our research in the area has recognized local initiatives from the community to document their culinary traditions, and more recently, our research group has conducted studies on Zacualpan's agroforestry systems [22,37]. Therefore, documenting the cultural motivations for conserving forest elements in agroforestry systems is particularly important for promoting conservation programs. In-depth research on these issues is therefore needed. In this context, our study contributes to a deeper understanding of indigenous uses of tree resources and highlights the importance of WETs for human well-being, food sovereignty, and ecosystem conservation.

2. Results

2.1. Species Richness and Composition of WETs

We recorded 33 species of edible trees belonging to 18 botanical families, based on the local classification of trees by the Zacualpan people, which included trees, an arborescent cactus (*Stenocereus queretaroensis* (F.A.C. Weber) Buxb.), and a bamboo (*Otatea acuminata* Munro (C.E. Calderón & Soderstr.). The highest number of species was found in the families Fabaceae (six species), Anacardiaceae (four species), and Annonaceae (three species). The local population consumed 26 WETs, including six endemic and one threatened species. Domesticated trees included three native and four introduced species (Table S1).

Guamúchil (*Pithecellobium dulce* [Roxb.] Benth.) [frequency = 29] had the highest food salience among edible trees, followed by ciruelo (*Spondias purpurea* L.) [frequency = 16], guaje rojo (*Leucaena esculenta* [DC.] Benth.) [frequency = 15], guaje verde (*Leucaena leucocephala* (Lam.) de Wit) [frequency = 13], parota (*Enterolobium cyclocarpum* [Jacq.] Griseb.) [frequency = 12], and bonete (*Jacaratia mexicana* A. DC.) [frequency = 11]. Four of the most salient species belong to the Fabaceae family (guamúchil, guaje rojo, guaje verde, and parota) (Figure 1; Table 1). There were no statistical differences between women and men related to the knowledge of edible trees (χ^2 = 28.1, df = 32, P = 0.6). According to our estimates, 39 edible tree species could be detected (lower confidence limit: 31.1; upper confidence limit: 46.1) if more people were included in the survey (64 respondents) (Figure S1; Table S2).

Table 1. WETs and their edible parts, harvest season, forms of preparation, and other uses recorded in the community of Zacualpan, Colima, Mexico. Tree species: (E) = endemic; (T) = threatened. RFM = relative frequency of mention, B'score = food salience. Harvest: DS = dry season; RS = rainy season; D&RS = dry and rainy season. Management types: (G) = gathering, (T) = tolerance, (SP) = special protection, and (P) = promotion. See descriptions of these management types in the main text.

Family/Tree Species/Common Name	RFM	B' Score	Management	Edible Part	Harvest	Preparation Forms	Other Uses of WETs
FABACEAE *Pithecellobium dulce* (Roxb.) Benth. (Manila tamarind; guamúchil)	0.91	0.71	G, T, SP, P	Fruit	Jan–May (DS)	Fresh, cooked with maize dough	Fuel, medicinal, live fence, fodder, pole, tanning, timber, shade, handicrafts
ANACARDIACEAE *Spondias purpurea* L. (Hog plum; ciruelo)	0.50	0.37	G, T, SP, P	Fruit	Mar–May (DS)	Fresh, flavored water, preserves, alcoholic beverages, chili sauce, unripe fruits in stew with beans, dried fruits are consumed all year	Fuel, handicrafts, fodder, shade, live fences

Table 1. *Cont.*

Family/Tree Species/Common Name	RFM	B′ Score	Management	Edible Part	Harvest	Preparation Forms	Other Uses of WETs
FABACEAE *Leucaena esculenta* (DC.) Benth. (E) (Guaje Rojo o Colorado)	0.47	0.40	G, T, SP, P	Seed, leaf sprout	Dec–Feb (DS)	Fresh, grounded in chili sauce. Fresh leaf sprout	Fuel, fodder, live fences, timber, pole
Leucaena leucocephala (Lam.) de Wit (White leadtree; guaje verde)	0.41	0.29	G, T, SP, P	Seed, leaf sprout	Jan, Jun, Sep (D&RS)	Fresh, ground in chili sauce. Fresh leaf sprout	Fuel, live fences, timber, pole, handicrafts, shade
Enterolobium cyclocarpum (Jacq.) Griseb. (Guanacaste tree; parota)	0.38	0.25	G, T, SP, P	Seed, germinated seed	Mar–Jun (DS)	Cooked unripe seeds in soups and dishes, dry seeds preserved toasted as popcorn, germinated seeds cooked	Timber, shade, fodder, soap, fuel, live fences
CARICACEAE *Jacaratia mexicana* A. DC. (Bonete)	0.34	0.24	G, T, SP, P	Fruit	Nov–Apr (DS)	Mature fruit eaten fresh; unripe fruit eaten fresh and cooked as a vegetable. Unripe fruit preserved in vinegar	Live fence
ANNONACEAE *Annona macroprophyllata* Donn. Sm. (Ilama)	0.25	0.18	G, T, SP, P	Fruit	Sep–Nov (RS)	Fresh	Medicinal, fuel, live fences
Annona reticulata L. (Custard apple; Anona)	0.22	0.16	G, T, SP, P	Fruit	Mar–Nov (D&RS)	Fresh	Shade, fuel
ANACARDIACEAE *Cyrtocarpa procera* Kunth (E) (Chupandia; chupalcojote)	0.16	0.11	G, T, SP, P	Fruit	Sep–Oct (RS)	Fresh	Fodder, medicinal
Spondias mombin L. (Plum; ciruelo de monte, ciruelo de aguas)	0.16	0.09	G, T, SP	Fruit	Jul–Nov (RS)	Fresh, flavored water	Handicrafts, medicinal
POACEAE *Otatea acuminata* (Munro) C.E. Calderón & Soderstr. (E) (Mexican weeping bamboo; otate)	0.16	0.08	G, T, SP, P	Sprout	Jul–Sep (RS)	Grilled	Handicrafts, utensils, live fences, construction, paper
MALVACEAE *Guazuma ulmifolia* Lam. (Bastard cedar; guásima)	0.09	0.05	G, T, SP, P	Fruit	Jan–Mar (DS)	Fresh and dried fruits as candy	Fodder, medicinal, fuel, live fences
MALPIGHIACEAE *Byrsonima crassifolia* (L.) Kunth (Nance)	0.06	0.03	G, T, SP, P	Fruit	May–Sep (D&RS)	Fresh, flavored water	Fuel
CACTACEAE *Stenocereus queretaroensis* (F.A.C. Weber) Buxb. (E) (pitayo)	0.06	0.03	G, T, SP, P	Fruit	Apr–May (DS)	Fresh	
CORDIACEAE *Cordia dentata* Poir. (Tambora)	0.06	0.03	G, T	Fruit	Apr–Jul (D&RS)	Fresh	Fuel
SAPOTACEAE *Sideroxylon capiri* (A. DC.) Pittier (T) (Capire)	0.06	0.03	G, T, SP	Fruit	Mar–Jun (DS)	Fresh, cooked	Timber, shade
PETIVERACEAE *Ledenbergia macrantha* Standl. (Embiona)	0.06	0.02	G, T, SP, P	Flower sprout, leaf sprout	Jan–Mar (DS)	Cooked flower sprouts, fresh leaf sprouts	Live fences
MALVACEAE *Ceiba aesculifolia* (Kunth) Britten & Baker f. (Pochote)	0.06	0.02	G, T	Fruit, root	Jan–Mar (DS)	Fresh	Medicinal, handicrafts
FABACEAE *Leucaena macrophyla* Benth. (E) (Guaje de Hoja Redonda)	0.03	0.02	G, T	Seed, leaf sprout	Jul–Sep (RS)	Fresh, ground in chili sauce. Fresh leaf sprout	Fuel, pole, timber
MYRTACEAE *Psidium sartorianum* (O. Berg) Nied. (Little guava; guayabillo)	0.03	0.02	G, T, SP, P	Fruit, leaves	Dec–Feb, Jul–Sep (D&RS)	Fresh, flavored water	Fuel
CAPPARACEAE *Morisonia americana* L. (Zapote Barranqueño)	0.03	0.02	G, T, P	Fruit	Nov–Dec (DS)	Fresh	
CANNABACEAE *Celtis iguanaea* (Jacq.) Sarg. (Iguana hackberry; granjeno)	0.03	0.01	G	Fruit	Sep–Nov (RS)	Fresh	
SAPOTACEAE *Pouteria campechiana* (Kunth) Baehni (Zapote calentura)	0.03	0	G, T, SP	Fruit	Aug–Sep (RS)	Fresh	
RUTACEAE *Casimiroa edulis* La Llave (White sapote; zapote dormilón)	0.03	0	G, T, SP	Fruit	Jun–Aug (D&R)	Fresh	

Table 1. *Cont.*

Family/Tree Species/Common Name	RFM	B′ Score	Management	Edible Part	Harvest	Preparation Forms	Other Uses of WETs
EBENACEAE *Diospyros* sp. L. (Zapotillo negro)	0.03	0	G, T	Fruit	Dec (DS)	Fresh	
LAMIACEAE *Vitex mollis* Kunth (E) (Ahuilote)	0.03	0	G, T	Fruit	Apr–Oct (D&RS)	Fresh	

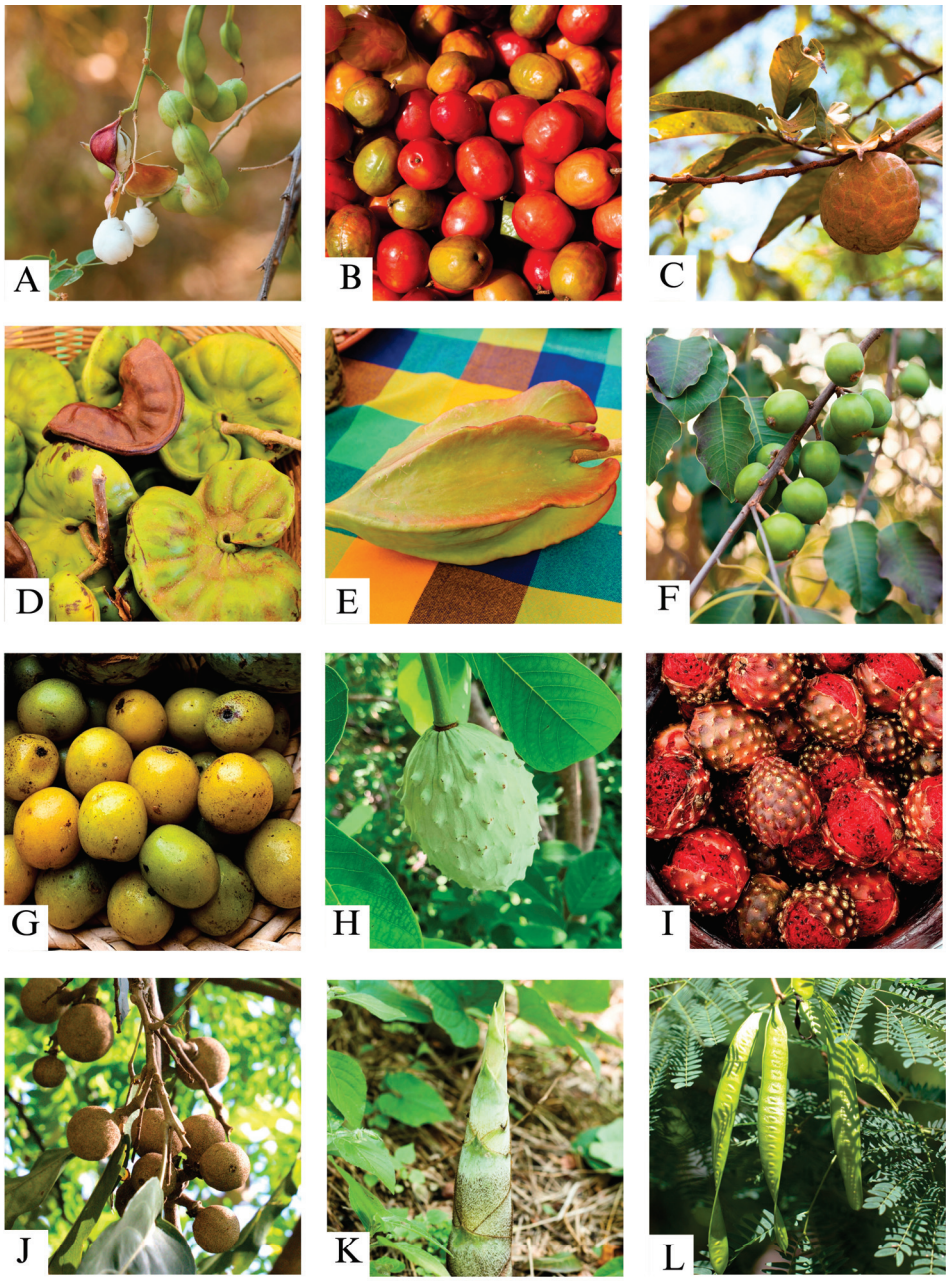

Figure 1. Wild edible trees consumed by the community of Zacualpan: (**A**) *Pithecellobium dulce* (guamúchil) fruits; (**B**) *Spondias purpurea* (ciruelo) fruits; (**C**) *Annona reticulata* (anona) fruits; (**D**) *Enterolobium cyclocarpum* (parota) seed pods; (**E**) *Jacaratia mexicana* (bonete) fruits; (**F**) *Sideroxylon capiri* (capire) fruits; (**G**) *Cyrtocarpa procera* (chupalcojote) fruits; (**H**) *Annona macroprophyllata* (ilama) fruits; (**I**) *Stenocereus queretaroensis* (pitayo) fruits; (**J**) *Morisonia americana* (zapote barranqueño) fruits; (**K**) *Otatea acuminata* (otate) sprouts; and (**L**) *Leucaena leucocephala* (guaje verde) unripe seed pods.

2.2. Parts of the Plant Consumed

Fruits, seeds, sprouts, flowers, roots, and leaves were consumed by the community (Figure 2). However, the frequency of citation counts was not evenly distributed among the edible parts of the trees (χ^2 = 358.09, df = 5, $P < 0.001$), as fruits and seeds were locally preferred for consumption. Although 28 tree species were used to obtain fruits, guamúchil (frequency = 29; 25.2%), ciruelo (frequency = 16; 13.9%), and bonete (frequency = 11; 9.5%) were the main sources of this resource. Only guajes (three species; frequency = 29; 69%) and parota (frequency = 12; 31%) were valued for their seeds.

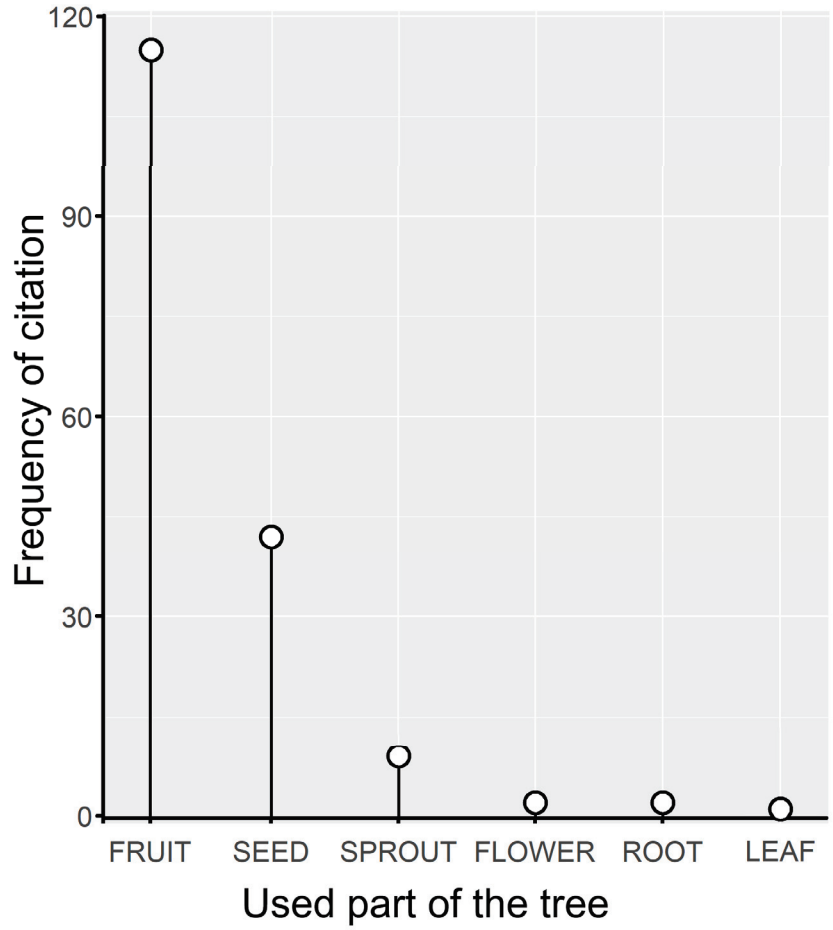

Figure 2. Tree parts consumed by people of the community of Zacualpan, Colima, Mexico.

The availability of edible parts of the WETs was variable throughout the year and helped to supplement people's diets. The most salient species (guamúchil, ciruelo, guaje rojo, guaje verde, parota, and bonete) and 10 other species were consumed during the dry season (i.e., Nov–Jun) (Table 1). These species also had different ways of consumption and incorporation into traditional dishes, including cooked, dried, fresh, flavored water, roasted, and toasted (Figure 3, Table S3). All fruits were consumed fresh. In addition, the unripe fruits of the bonete were used as a vegetable. Ciruelo showed the most diverse forms of preparation, including fresh, flavored water, preserves, alcoholic beverages, chili sauce, stew, and dried. The leafy sprout of the guajes was consumed fresh while the otate sprout was roasted. Only the flower sprout of the embiona tree was consumed. Ciruelo fruits and mature parota seeds were dried for later consumption, as were the unripe bonete fruits preserved with vinegar.

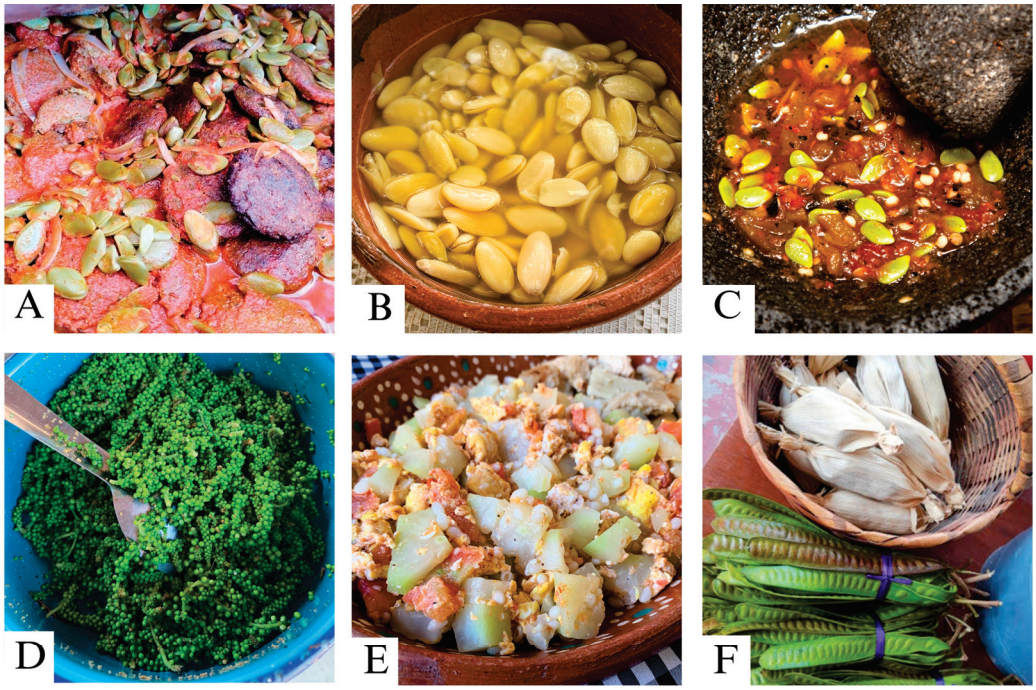

Figure 3. Preparation forms of some WETs recorded in the community of Zacualpan: *E. cyclocarpum* (parota) seeds as (**A**) tortitas, (**B**) soup; (**C**) chili sauce with guaje verde (*L. leucocephala)* unripe seeds; (**D**) *L. macrantha* (embiona) flower sprouts cooked for tacos; (**E**) scrambled eggs with *J. mexicana* (bonete) unripe fruits; (**F**) unripe seed pods of guaje verde and *S. purpurea* (ciruelo) fruits preserves as tamalitos.

2.3. Multiple Uses of WETs

Edible trees were also used by the community for 13 different purposes: fuel, live fence, timber, raw material for handicrafts, medicine, shade, fodder, poles, utensils, construction materials, tanning material, soap, and paper (Figure 4). Frequencies varied across uses ($\chi 2 = 268.69$, df = 12, $P < 0.001$). Fuel (frequency = 64; 35.3%), live fence (frequency = 29; 16%), and timber (frequency = 27; 14.9%) were the most common non-feed uses of edible trees. Guamúchil had the highest number of other uses among the trees (9), followed by parota (6), guaje verde (6), guaje rojo (5), ciruelo (5), and otate (5). All the parts of these trees were used by the community to meet many of their household needs, such as medicine, fuel, and utensils, as well as to support their work, such as fodder, live fences, poles, and shade (Table S1).

2.4. Management of WETs

Edible trees were managed in different ways within home gardens, agroforestry systems, fallow land, and forest areas: (1) gathered or collected in the wild; (2) tolerated or left standing in the areas that were cleared for various purposes; (3) providing special protection against damage from fire, herbivores, wind, and other factors, or by providing to them light or shade for some individual plants; (4) promoting their abundance by sowing their seeds, planting vegetative propagules or transplanting young plants; and (5) cropped (planting domesticated plants that are subject to human selection).

The most salient species (guamúchil, ciruelo, guaje rojo, guaje verde, parota, and bonete) had economic importance, as did anona (*A. reticulata* L.), chupalcojote (*C. procera* Kunth), guayabillo (*P. sartorianum* (O. Berg) Nied.), ilama (*A. macroprophyllata* Donn. Sm.), nance (*B. crassifolia* (L.) Kunth), and pitayo (*S. queretaroensis* (F.A.C. Weber) Buxb.), which were commonly sold in local markets. These species were specifically protected and promoted in home gardens and through agroforestry practices, such as live fences, isolated trees, and vegetation patches. Conversely, species such as ahuilote (*V. mollis* Kunth),

granjeno (*C. iguanaea* (Jacq.) Sarg.), and zapotillo negro (*Diospyros* sp. L.), were tolerated, and their fruits were typically consumed when encountered in the wild. Domesticated species were cropped and included avocado (*Persea americana* Mill.), guanábana (*Annona muricata* L.), guava (*Psidium guajava* L.), lemon (*Citrus aurantifolia* (Christm) Swingle), mango (*Mangifera indica* L.), papaya (*Carica papaya* L.), and tamarind (*Tamarindus indica* L.).

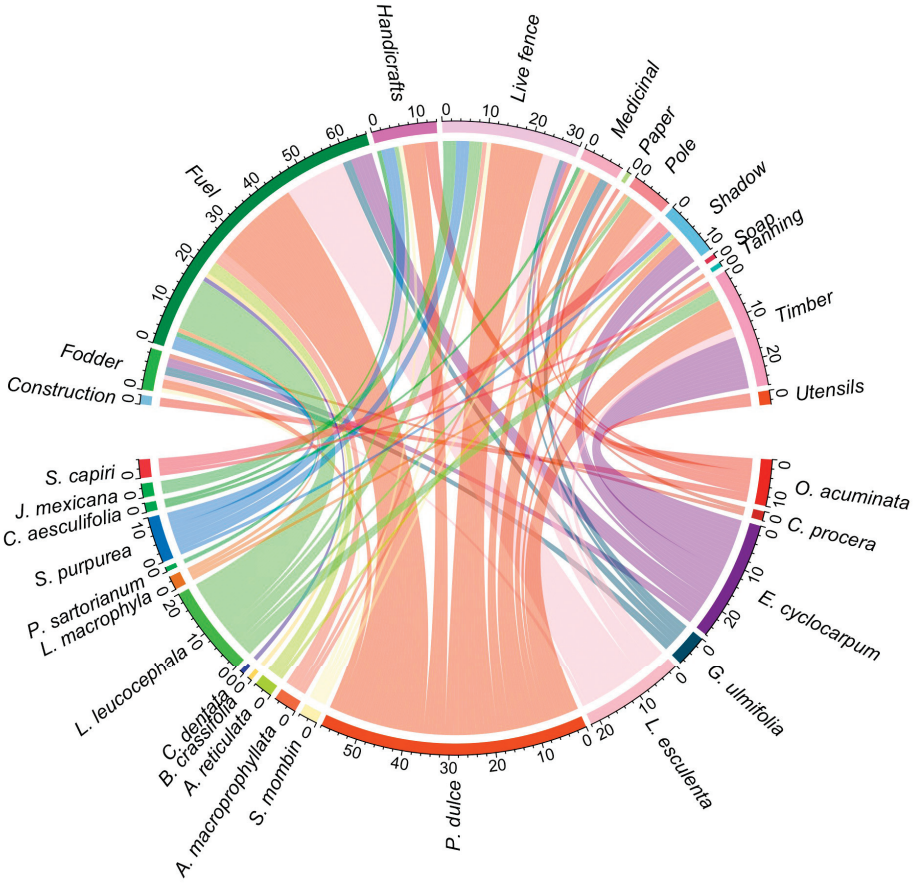

Figure 4. Chord diagram representing the other uses of wild edible tree species by the community of Zacualpan, Colima, Mexico.

3. Discussion

3.1. Species Richness and Composition of WETs

Our results show that the use of wild edible tree species (26) recorded in Zacualpan is high (79%) compared to domesticated species (21%); this may reflect the importance of TEK and local adaptations to drought in the use and management of the tropical dry forest (TDF). Sixteen WET species were consumed during the dry season, with the most salient species (guamúchil, ciruelo, guaje rojo, guaje verde, parota, and bonete) providing abundant fruits and seeds. Furthermore, the use and management of TDF in western Mexico, dating back to 9000 years BP, has been closely associated with the domestication and diversification of milpa species (i.e., maize, squash, beans), but also with the management of edible trees such as ciruelo and guaje rojo [2]. This highlights WETs as vital ancestral resources with significant implications for human culture, health, ecosystem management, and conservation.

The Fabaceae family had the highest number of edible species and four of the most salient species (guamúchil, guaje rojo, guaje verde, parota). This family is particularly abundant in tropical dry forests due to its various adaptations to drought and resource limitation, allowing many species to be established in disturbed areas such as cultivated fields and fallow land [38]. Such is the importance that Fabaceae species are widely used for medicinal purposes in Mexico, followed by species used for animal feed, material

resources, environmental modification, and food additives [39]. In addition, these species are rich in protein, making them a valuable food source not only for humans but also for livestock [40].

The most salient edible species was guamúchil, which was also valued for the income generated by the fruit trade. Other economically important tree products were commonly sold in local markets such as anona, bonete, ciruelo, chupalcojote, guajes, guayabilla, ilama, nance, parota, and pitaya. In Zacualpan, these trees are found managed in nearby forests, home gardens, and various agroforestry areas, often undergoing several cycles of fallow and cultivation [22]. For these reasons, some of these species can be classified as wild or semi-domesticated cultivated plants. In the case of bonete, studies have shown an incipient domestication syndrome in cultivars from central and northwestern Mexico [41]. In the case of ciruelo, this tree is particularly important in the diet of the Zacualpan people, as 11 varieties of this fruit have been reported [37]. In fact, western Mexico is part of its Mesoamerican domestication range, where it coexists with wild populations [35].

3.2. Plant Parts Consumed

Studies of WETs conducted in Africa have shown similar patterns of use, with fruits being the most important component of edible trees, followed by seeds, roots, and leaves [16,42]. In Zacualpan, fruits were the most consumed part of the trees by the community, followed by seeds. The fruits of the ciruelo and bonete trees were particularly favored, possibly because of their abundance, versatility in preparation forms, ease of clonal propagation, and forms of preservation. Different products complement each other due to their seasonal availability, and the storage of certain items increases food security, especially during the dry season [17]. For example, ciruelo fruit, which spoils quickly, is often dried and processed into various products that can be stored and consumed throughout the year. Meanwhile, parota seeds were preferred to be cooked unripe, although dried seeds are also consumed and can be stored for later use. In fact, some forms of preparation of these trees in Zacualpan, such as sun-drying ciruelo fruits for later rehydration to make *tamales* or toasting and grinding parota seeds, are considered pre-Ceramic archaic components of the region's human diet [43].

However, many WETs species were consumed only occasionally. Flower sprouts and leaf sprouts were the least consumed tree parts, mainly due to their quantity and short period of edible availability. Given the cultural importance of many species, their promotion by the Zacualpan people is common, but the consumption of fruits and seeds of endangered (e.g., capire) and endemic species that are less promoted (e.g., ahuilote) needs to be evaluated in future studies from a sustainability perspective.

3.3. Multiple Uses of WETs

In Zacualpan, the main non-food uses of WETs were for fuelwood, fencing, and timber, which have been reported as common additional uses of WETs in other parts of the world [14,18,44]. Fuelwood collection is common in rural communities to meet their heating needs and is largely determined by the proximity and accessibility of trees. Typically, a wide variety of trees are used for fuelwood, many of which are also used for edible purposes [45]. Live fences are mainly used in tropical areas to demarcate and protect agricultural plots and home gardens, but they also serve as multifunctional systems that provide fodder, fuel, timber, food, medicine, and wind barriers and help prevent soil erosion [46]. In Zacualpan, the most salient species, the guamúchil tree, was particularly valued, with nine non-food uses in addition to its role as a food source, and was commonly managed in live fences and home gardens as previously reported [22,27].

Other studies have shown that, in addition to providing food, edible trees serve multiple purposes that support the livelihoods of many communities worldwide [13,14, 18,19]. However, many of these species are often exploited more for their non-food uses than for their nutritional value. Overharvesting of WETs for fuelwood, medicine, fencing, construction, and fodder can exacerbate the degradation of certain species [42]. Selective

harvesting of forest resources can lead to localized declines in species, basal area, and density, favoring those more resilient to extraction [47]. In addition, livestock browsing contributes to soil compaction, the loss of forest understory, and the inhibition of new plant recruitment [48].

3.4. Ecological Implications and Challenges in the Management of WETs

Some of the ecological impacts associated with the use of trees and land use change can be mitigated through local sustainable practices. For example, in Mexico, WETs are often protected and promoted both in situ and in cultivated stands to increase their availability and favor desirable phenotypes [6]. Similarly, in other countries these forms of interactions have been recorded. For instance, in Ethiopia, WETs have been managed by deliberately leaving trees on farmland and occasionally planting important species in home gardens, reflecting common shared cultural practices for managing edible trees [42]. These agroforestry practices can help reduce pressure on conservation and protected areas [49]. In addition, systems such as home gardens and practices such as live fences act as in situ gene banks that serve as reservoirs of genetic diversity for cultivated species, especially when native populations of their wild ancestors are declining [35]. Furthermore, these species also provide food resources for wildlife and act as stepping stones that enhance ecological connectivity among populations, communities, and processes [27,28,50].

Despite their ecological importance, WETs and other wild foods are often stigmatized and associated with poverty [13,44]. In addition, several challenges limit their promotion and commercialization, such as the lack of experience, low profitability, limited availability, and the lack of recognition of the market value of these species [13]. To address these challenges, the biocultural promotion and sustainable cultivation of WETs can serve as a key strategy. Local efforts to reclaim the importance of wild foods as part of the biocultural heritage have emerged, led by women through traditional cuisine movements. In Zacualpan, initiatives such as Grupo Xolocuahuitl, the Indigenous Council of Zacualpan, and their collaboration with other collectives such as Mujeres del Fuego, Frente en Defensa del Maíz de Colima, and Jardín Etnobiológico La Campana are examples of these efforts [37,51–53]. Thus, by incorporating WETs into cultural and agroforestry programs that emphasize their nutritional benefits, economic potential, and role in conserving TEK, WETs can contribute significantly to local food sovereignty and ecosystem conservation.

4. Materials and Methods

Our research was conducted in the Nahua-origin community of Zacualpan, municipality of Comala, Colima, Mexico. The area is part of the Nevado de Colima-Sierra de Manantlán Biological Corridor and the Central–Western Mexico Biocultural Corridor (Figure 5). The main local productive activity is agriculture, which consists mainly of traditional rainfed agriculture and livestock ranching (i.e., goats and cows). Trade, livestock, and river fishing are other important economic activities in the community. Tropical dry forest is the main type of vegetation, followed by riparian forest. About 2000 people live in the territory, which consists of a small urban settlement (~30 ha), a matrix of agricultural fields, forest, fallow land, springs, and the Armería River. According to the Köppen climate classification system modified by García [54], the climate of Comala is semi-warm subhumid with summer rains [(A)C(wo)(w)], with an average annual temperature of 21.5 °C, a total annual precipitation of 761 mm, rainfall from June to November, and a pronounced dry season from November to June. Zacualpan is one of the last indigenous communities in the state of Colima with communal land tenure; it is recognized for its efforts to preserve its traditions and biocultural heritage.

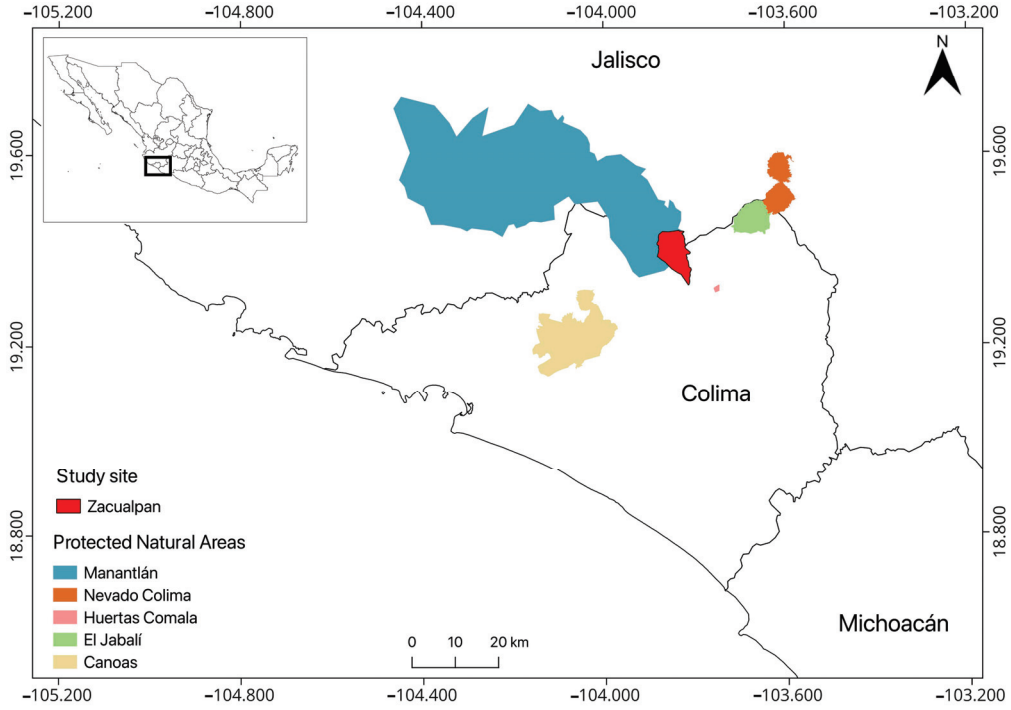

Figure 5. Localization of the community of Zacualpan, Colima, Mexico.

In July and August of 2022, we conducted 32 random semi-structured interviews to learn about the trees used for food by the community of Zacualpan. We focused our survey on farmers because they have extensive knowledge of the biocultural edible resources that are used by the community. People interviewed also reported other occupations, including trader, mason, artisan, teacher, and housekeeper. We included an equal number of men and women in the survey (16 participants of each gender), ranging in age from 30 to 90 years old (median = 53 years). During the interviews, we asked the people to name the tree species that provide food for the community, as well as the parts of the plants that are consumed. We listed the species that were mentioned by the interviewees and then asked about the non-food uses that the local people gave to each of them. Again, we recorded the parts of the trees that were used by the local people.

For trees, we used the local classification of the Zacualpan people, which included two perennial species: the columnar cactus (*Stenocereus queretaroensis* (F.A.C. Weber) Buxb.) and a bamboo (*Otatea acuminata* Munro (C.E. Calderón & Soderstr.). Botanical samples for species identification of WETs were collected, preparing voucher specimens and photographic records and during field surveys in collaboration with local botanists, as described in Pacheco-Flores et al. [22]. To determine the food importance of the trees that were mentioned by the community members, we used a free list method to calculate a cultural salience index [55]. Specifically, we used the B'score index because it allows the comparison between the elements of the list regardless of its length or the number of respondents since it varies between 0 and 1 [56]. The B'score was calculated by combining the frequency of mention and the rank of citation of each item in the list. We used the open-source software FLARES v 1.0 to calculate the index [57].

We estimated the number of tree species that could be used as food sources by the community. Estimates were made using the "iNext" package [58] in R (R Core Team 2020). Each respondent was considered as a sampling unit for our analysis (n = 32). The frequency of occurrence of trees reported by respondents was used to compute sample-size-based rarefaction (interpolated estimation) and extrapolation (predictive estimation) sampling curves for edible tree species richness. We compared (i) the consumption of different parts of the plants and (ii) their non-food uses with a Chi-Squared Test of Homogeneity. Finally, we used additional interviews, field notes, direct and participant observation, and local

phenology data of WETs to learn about tree management, temporal availability, and the preparation forms of these foods.

5. Conclusions

The knowledge of wild edible plants and their multiple uses is an invaluable heritage that is being steadily eroded by shifts in food systems and the globalization of diets, which has led to a significant decline in health and TEK. The continuing loss of these resources highlights the urgent need for expanded research and social initiatives to safeguard this knowledge for future generations and to strengthen food sovereignty, security, and sustainability.

Wild edible trees play an important role in the livelihoods of the community of Zacualpan, not only for food but also to provide materials for their daily life and work activities. The use of 26 native species, especially 16 that were consumed during the dry season, reflects the importance of TEK and local adaptations to drought in the use and management of the tropical dry forest. This highlights WETs as ancestral resources with significant implications for human culture, health, and ecosystem management.

Strengthening fair market incentives through community-based initiatives, education, and policy support can help to change perceptions, making WETs a valuable biocultural resource rather than a symbol of scarcity or poverty. Therefore, the culinary promotion, cultivation, and sustainable management of WETs in agroforestry systems can be a key strategy to support both local food sovereignty and biodiversity conservation. Ultimately, these efforts can promote the dual objectives of supporting human well-being and conserving ecosystems, which are in line with the global goals of sustainable development.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/plants13233334/s1, Table S1: Trees that were used for food by the community of Zacualpan, Colima, Mexico; Figure S1: Estimated richness of tree species that were used for food by the community of Zacualpan, Colima, Mexico; Table S2: Estimations of the number of tree species used by the community of Zacualpan for food purposes. Table S3. Preparation methods for some WETs.

Author Contributions: Conceptualization, A.P.-F., A.C. and R.O.-Á.; methodology, A.C., A.P.-F. and R.O.-Á.; validation, A.P.-F., A.C. and R.O.-Á.; formal analysis, R.O.-Á., A.P.-F., M.G.C.-G. and M.J.C.-P.; investigation, A.P.-F., E.R.-V. and R.O.-Á.; data curation, A.P.-F. and R.O.-Á.; writing—original draft preparation, A.P.-F., A.C. and R.O.-Á.; writing—review and editing, A.P,-F., R.O.-Á., A.C., M.G.C.-G., M.J.C.-P. and E.R.-V.; visualization, A.P,-F. and R.O.-Á.; supervision, A.C. and R.O.-Á.; project administration, A.C. and R.O.-Á.; funding acquisition, A.C., A.P.-F., E.R.-V. and R.O.-Á. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Data supporting the reported results and datasets generated during the study can be found in the Supplementary Information included with this manuscript.

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plants

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Article

Commercialized "Smudge Sticks" Used as Incense in the Netherlands: An Inventory of Plants and Trends Behind a New Age Fashion

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Abstract: Incense is essential in religious ceremonies, even in relatively new religious and spiritual movements such as New Age and Neopaganism. These garner little attention from ethnobotanists, although they trigger an international trade in wild-harvested plants. In this paper, we studied the botanical ingredients of smudge sticks (dried plant bundles burned for purification) in the Netherlands, and people's motivations to use them posing the following questions: what plant species are included in smudge sticks? what are they used for? and are exotic plants preferred over native Dutch plant species? We visited online and physical shops in Dutch cities, acquiring a total of 29 different smudge sticks containing at least 15 species. We held semi-structured interviews with 11 users, vendors, and herbal experts, and collected data from 33 questionnaires. *Salvia apiana* L. was most frequently found, along with North American species of the genus *Artemisia*. The rise of the New Age movement resulted in North American ritual plant species being easily available in (online) shops in the Netherlands and smudge sticks being used for personal protection and cleansing. Despite the smudge sticks' commercial demand, there is no data regarding the pressure on wild populations of species used in these bundles. For the preservation of these species it is crucial that scientific monitoring of their harvest is undertaken in the future.

Keywords: California; cultural appropriation; Ethnobotany; Europe; Native American; Neo Paganism; ritual plants; United States; Wicca; witchcraft

1. Introduction

The smoke of incense has been an essential component in sacred religious ceremonies for millennia [1–3]. Incense is also used in relatively new movements such as New Age and Neopaganism, including Wicca, and resulting popular religions [2,4–8]. Although in the last few decades a growing body of literature was published on these movements, in fields such as history and sociology of religion, and anthropology (e.g., [9–11]), from the viewpoint of ethnobotany, New Age, Neopaganism, and contemporary Western popular religions are virtually unstudied. Yet, these relatively new beliefs influence the harvest and trade of wild plants (e.g., [12]) making them a fascinating case for ethnobotanical investigation.

Incense is made of dried plant material, usually processed as incense sticks, granules (usually tree resins), or bound bundles of dried plant leaves and stems. The smoke produced by fire and incense is used ritually to connect with entities or "energies", to create a certain sacred atmosphere, and for ritual healing by peoples all over the globe. In southwestern China, ritual fumigation is currently practiced to communicate with ancestors, deities and spirits [13]. In Brazil, fumigation is performed in healing ceremonies, among others by practitioners of the Umbanda religion [14]. In Native North American

cultures, there are several documented instances of ritual and healing uses of incense [15] (naeb.brit.org, accessed 2 May 2024). Incense smoke is not only used in a religious or ritual context, but also purely as medicine against, for example, respiratory tract and skin diseases [13,16], for repelling house flies [17], disguising bad smells [7], and even measuring time based on how long an incense stick takes to burn completely [18]. These examples just scratch the surface of a wide and vast variety of incense usage in the world [3].

Although incense, especially frankincense (*Boswellia* spp.), has been ceremonially used in the Catholic church for centuries [19,20], including in the Netherlands where this study was conducted, a new and secular market has emerged for smudge sticks made from dried plant bundles. Their packaging and sales pitch typically associate them with Native North American spirituality. Tightly bound dried plant bundles are indeed used by some Native North American cultural groups in traditional ceremonies [2,15] (naeb.brit.org, accessed 2 May 2024). They are ignited on one end to create smoke which, depending on the area or people, is intended as medicine, to purify spaces and/or people, to keep danger at bay, to provide a nice smell, and to deter insects [2,21,22] (naeb.brit.org, accessed 2 May 2024). In the United States of America (USA), examples of plant species employed for smudging in the Native American Ethnobotany Database (naeb.brit.org, accessed 29 July 2024) are sweetgrass or vanillagrass (*Hierochloe odorata* (L.) P.Beauv.), various species of *Artemisia* and *Salvia apiana* Jepson, grouped under the name 'sage', Eastern Arborvitae (*Thuja occidentalis* L.), and juniper (*Juniperus* spp.), depending on the cultural groups and geographical area. The local terms applied to these plant bundles differ per group, but they are generally referred to as incense or, more commonly, smudge sticks in (popular) literature.

Indigenous smudge sticks were adopted for ceremonial purposes in the USA by practitioners of New Age [23], Paganism [2,24,25], and Wicca [26–28] in the 20th century. The definitions and contours of these (religious) movements are debated (e.g., [6,10,11,29]). Notably, they are growing in the Netherlands [30]. Especially New Age and to a lesser extent Neopaganism commodify rituals and associated objects from other religions and cultures, not only smudge sticks, but also drums, precious stones, and dreamcatchers [23, 31]. This use of ritual objects outside their original native context sparked controversy and is recurrently termed cultural appropriation [23,32–34]. There are indications that some plants traditionally used for smudging, such as white sage (*Salvia apiana*), are unsustainably harvested to meet the growing demand in Western countries [35]. However, academic literature mentioning plant use by New Age or Neopagan practitioners during ceremonies is hardly backed up by herbarium specimens, photographs of plants, or plant identifications during fieldwork by botanists (e.g., [23,24,36]). Additionally, so far no research has been carried out on species used in smudge sticks and their uses.

The first aim of this paper is to identify the diversity of botanical ingredients in commercialized smudge sticks in the Netherlands. Our second aim was to determine why people choose certain species for smudging. We posed the following questions: (1) what plant species are included in smudge sticks in the Netherlands, (2) for what reason are they included, and (3) are exotic plants preferred over native Dutch species, and why? To answer these questions, we collected smudge sticks from shops to identify the species and interviewed users, vendors and herbal experts. We argue that the rise and commercialization of the New Age movement in the 1980's, its idealization of Native North American spirituality favoring certain smudge stick plant species, and the subsequent easy availability of smudge sticks in shops in the Netherlands, and beyond, led to their growing popularity and thus demand. This is possibly causing the unsustainable harvest of wild species for smudge sticks, which should compel conservationists to develop conservation strategies to protect the species' populations resilience.

2. Results

2.1. Botanical Ingredients of Smudge Sticks Sold in Dutch (Web) Shops

In the Netherlands, smudge sticks are found in (web)shops that specialize in spiritual and esoteric products, but also in (herbal) tea shops with an 'esoteric product corner'. Such

products are imported in the Netherlands without restrictive regulations unless they contain CITES species, in which case a phytosanitary permit is necessary (https://www.nvwa.nl/onderwerpen/op-reis-welke-planten-dieren-en-producten-mogen-mee/ik-wil-planten-of-plantaardige-producten-meenemen-naar-nederland, accessed on 7 October 2024). We collected a total of 29 smudge sticks from the online and physical shops, some of them containing several species (Figures 1 and 2). In total, we identified 14 genera in 12 families. Of these, we were able to identify 15 species, but 27 plant ingredients were not identifiable to species level because they missed crucial morphological characteristics (Table 1). In particular, the fragments of *Artemisia* subg. *Tridentatae*, cf. *Pseudognaphalium* and *Eriodictyon* lacked sufficient flower and fruit material and leaf characteristics for species identification. The Asteraceae family was the most represented with at least six species, of which there were at least four in the *Artemisia* genus (*A. californica*, *A. ludoviciana, A. tridentata*, and *A. vulgaris*), one or two cf. *Pseudognaphalium* species, and *Matricaria chamomilla*, followed by Lamiaceae with four *Salvia* species (*S. apiana*, *S. fruticosa*, *S. officinalis*, and *S. rosmarinus*). Most species that we found in the smudge sticks have their natural distribution range in the USA and were bought from North American wholesalers. *Bursera graveolens* was the only solely woody stick that we found, and has a Middle to South American distribution range [37]. One vendor made the smudge sticks herself with wild or cultivated plant material collected around her town. The species used were *Artemisia vulgaris*, *M. chamomilla*, *Hypericum perforatum*, *S. officinalis*, *Rosa* sp., and *Verbena bonariensis*. One couple grew *A. ludoviciana*, which has its natural distribution in North America, on a small commercial scale and made smudge sticks out of this species to sell to an online shop. Of the collected smudge sticks, ten were made of or included leaves and stalks of white sage (*S. apiana*), which has its natural range in California. Fourteen smudge sticks were mixed bundles of two or more species, sometimes they had different geographic origins and cultural traditions, such as *S. apiana* (USA) combined with *Eucalyptus* sp. leaves, which has an Australian origin but is cultivated world-wide; and *S. apiana* with colored rose petals (*Rosa* sp.) referring to chakras from Hinduism and Buddhism. We were unable to identify one plant specimen because it was painted and too few morphological characters could be recognized (dark blue in Figure 2c).

Table 1. Species found in our collected smudge sticks sourced from online and physical shops in the Netherlands.

Family	Species/Collection [1]	Names Product Label [2]	Species Distribution Range
Anacardiaceae	indet. [3] (not *Pistacia lentiscus*)/IPG317	Pistacia lentiscus	-
Asteraceae	*Artemisia* subg. Tridentatae/BZ1, BZ3, BZ15, IPG315	Mountain sage (BZ1, BZ3), wee sage (BZ3), shasta sage (IPG315), blue sage (IPG315) (English), blauwe salie (BZ15), woestijnsalie (BZ3) (Dutch)	Western USA
Asteraceae	*Artemisia californica* Less./BZ13	Desert sage (English)	California (USA) and Baja California (Mexico)
Asteraceae	*Artemisia ludoviciana* Nutt./BZ5, IPG183	Dakota witte salie (Dutch)	Canada, USA, and Mexico
Asteraceae	*Artemisia tridentata* Nutt./BZ10	Blue sage, big sagebrush (English)	Western Canada to Baja California (Mexico)
Asteraceae	*Artemisia vulgaris* L./BZ17, BZ19, BZ22, BZ25	Bijvoet, zwarte salie (Dutch), Mugwort (English)	Temperate Eurasia, introduced in Canada and USA

Table 1. *Cont.*

Family	Species/Collection [1]	Names Product Label [2]	Species Distribution Range
Asteraceae	*Matricaria chamomilla* L./BZ24	Kamille (Dutch)	Eurasia, introduced in Canada and USA
Asteraceae	*cf. Pseudognaphalium* sp. 1 (including colored specimens)/IPG318, IPG319, IPG320, IPG314	Verbascum	-
Asteraceae	*cf. Pseudognaphalium* sp. 2/IPG313, IPG331	Groene salie (Dutch)	-
Boraginaceae	*Eriodictyon californicum* (Hook. & Arn.) Decne. or *Eriodictyon trichocalyx*/BZ9	Yerba Santa (Spanish)	Western USA (Oregon and California)
Boraginaceae	*Eriodictyon angustifolium* or *Eriodictyon altissimum*/BZ16	Yerba Santa (Spanish)	Western USA
Boraginaceae	*Eriodictyon* sp./IPG319	Yerba Santa (Spanish)	Western USA
Burseraceae	*Bursera graveolens* Triana & Planch/IPG316	Palo Santo (Spanish), holy wood (English)	Mexico to northwestern Venezuela and Peru
Cupressaceae	*Calocedrus decurrens* (Torr.) Florin/BZ2	Pine (Dutch)	Western USA (Oregon and California) and Mexico (Baja California)
Cupressaceae	*Thuja* sp./BZ6	Cedar sage (English)	USA and Canada, introduced in Europe
Hypericaceae	*Hypericum perforatum* L./BZ18	Sint-Janskruid (Dutch)	Eurasia, introduced in USA and Canada
Lamiaceae	*Lavandula dentata* L./SS2024-5	Lavendel (Dutch)	Western Mediterranean region and north-eastern Africa
Lamiaceae	*Salvia apiana* Jeps./BZ4, BZ8, BZ11, BZ12, BZ14, IPG318, IPG317, IPG320, IPG324, IPG321	Witte salie, Californische witte salie, salie (Dutch), White sage, White Californian Sage (English), Dragon's blood salie (name given to a red colored smudge stick; English and Dutch)	Western USA (California) and northwestern Mexico
Lamiaceae	*Salvia fruticosa* Mill./IPG323	Griekse salie (Dutch), Greek ceremonial sage (English)	Eastern Mediterranean region
Lamiaceae	*Salvia officinalis* L./BZ20, BZ23, BZ26, IPG322	Salie (Dutch), smudge salie (both)	Europe and cultivated worldwide
Lamiaceae	*Salvia rosmarinus* Schleid./IPG322	Rozemarijn (Dutch)	Europe and cultivated worldwide
Myrtaceae	*Eucalyptus* sp. (colored (claiming with red dracaena dye) and uncolored)/IPG325, IPG318	Eucalyptus & Dragon's blood (English)	Australia and cultivated worldwide
Plumbaginaceae	*Limonium sinuatum* Mill./IPG320, IPG319	Sinuata, Statice sinuata (Latin/Scientific name)	Mediterranean region, introduced in western USA and Mexico
Poaceae	indet./BZ7	Sweet grass (English)	-
Poaceae	*Phalaris* sp./IPG317	Phalaris (Latin/Scientific name)	-

Table 1. *Cont.*

Family	Species/Collection [1]	Names Product Label [2]	Species Distribution Range
Poaceae	indet. (painted blue)/IPG320	- [4]	-
Rosaceae	*Rosa* sp./BZ21	Rozen (Dutch)	Northern Hemisphere and cultivated
Rosaceae	*Rosa* sp. (colored petals)/IPG324	Chakra blaadjes (Dutch)	Northern Hemisphere and cultivated
Verbenaceae	*Verbena bonariensis* L./BZ27	IJzerhart [sic] (Dutch)	South America and cultivated elsewhere
Indet.	indet. (painted blue)/IPG318	- [4]	-

[1] Voucher specimens of collected smudge sticks were deposited at the herbarium of Naturalis Biodiversity Center (L) in Leiden, the Netherlands. [2] Vernacular names (local and "scientific") used in trade which do not always reflect official vernacular names as used in floras. [3] Indeterminate species. [4] Species is not listed on store label.

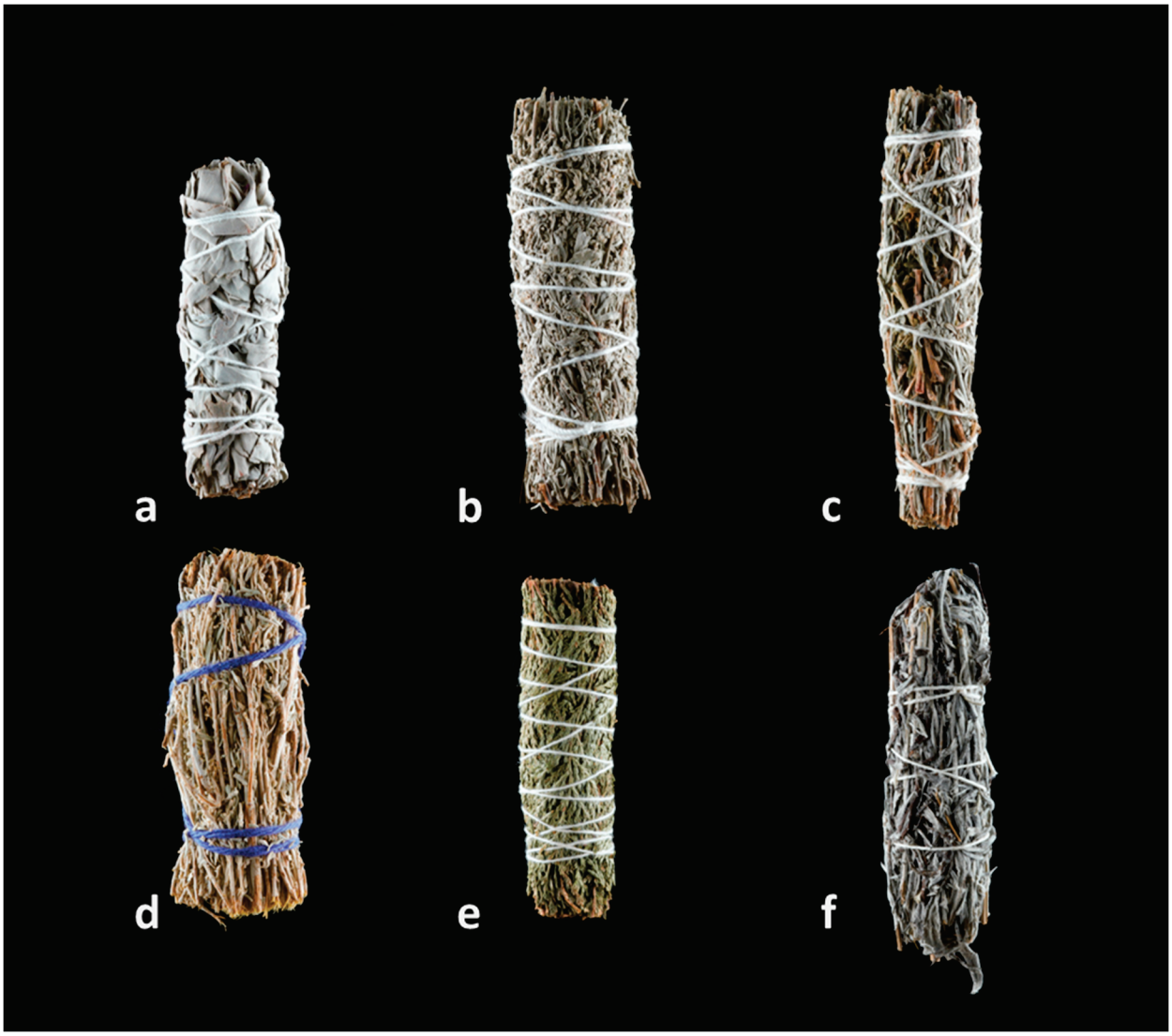

Figure 1. Collage of collected smudge sticks sourced from (online) shops in the Netherlands. (**a**) *Salvia apiana*; (**b**) *Artemisia tridentata*; (**c**) *A. ludoviciana* and *Calocedrus decurrens*; (**d**) *A. tridentata*; (**e**) *Thuja* sp.; (**f**) *A. ludoviciana*. Pictures by I. Pombo Geertsma and C. van der Linden.

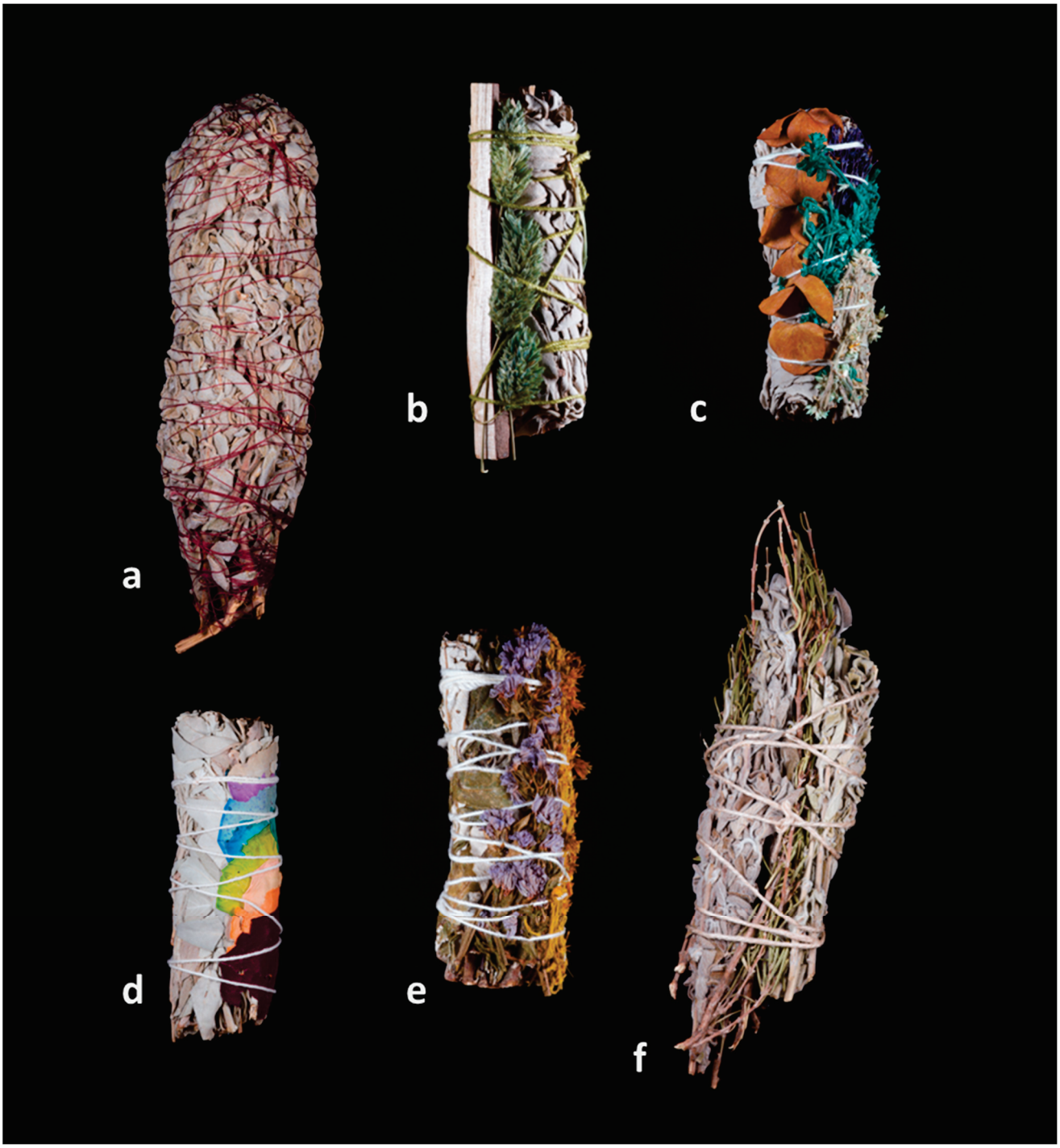

Figure 2. Collage of partly colored smudge sticks composed of *Salvia apiana* mixed with other species, and smudge sticks composed of only European species. (**a**) *S. fruticosa;* (**b**) *S. apiana*, *Phalaris* sp., and *Anacardiaceae* sp.; (**c**) *S. apiana*, *Eucalyptus* sp., cf. *Pseudognaphalium* sp., and one unidentified plant. (**d**) *S. apiana* with *Rosa* sp. petals; (**e**) *Eriodictyon* sp., *Limonium sinuatum*, and cf. *Pseudognaphalium* sp.; (**f**) *S. officinalis* and *S. rosmarinus*. Pictures by I. Pombo Geertsma and C. van der Linden.

We found smudge sticks or loose white sage leaves added to "cleansing kits" (Figure 3). Some vendors only included Dutch, wild or cultivated, plant species in their smudge sticks, such as *A. vulgaris*, *S. officinalis*, and *M. chamomilla*. One significantly larger smudge stick bought in 2023 contained *S. fruticosa* (Figure 2a) and was sold as "Greek Ceremonial Sage". The picture on the packaging placed it on an abalone shell that is normally associated

with *S. apiana*. The Dutch text on the box was translated as: "*This wild-picked sage from the mountains of Greece has traditionally been used to purify and smudge spaces. In contrast to the North American variant, this sage is much softer. The scent is fresh, feminine, and with a hint of lemon. Partly due to the slow drying process in the Greek sun, the scent and strength of this sage is exceptional.*"

Figure 3. Energy cleansing packages on sale in a shop in Utrecht, March 2023. To the left, a package is sold combining a white sage smudge stick with an iron pan, and to the right, an energy cleansing kit combining white sage (probably *S. apiana*) with palo santo (possibly *Bursera graveolens*), Florida water, colorful gemstones ("chakra stones"), an energy card and an instructions booklet. Picture by I. Pombo Geertsma.

One of our collected smudge sticks contained a woody stick that was incorrectly labeled as *Pistacia lentiscus* (Figure 2b). Although we did find out that this identification was incorrect, we were unable to identify it further than the family level (Anacardiaceae) due to the challenge in finding out where the species originated from, as wholesalers did not respond, answered that they could not disclose that information, or simply said that they did not know.

2.2. Species and Uses Mentioned in Interviews and Questionnaires

Only two species associated with smudge sticks were mentioned by all four interviewees who were active in the herbal industry: bijvoet (*Artemisia vulgaris*) and lavendel (can refer to several cultivated *Lavandula* species). For lavendel, *L. dentata* was identified in commercialized smudge sticks, and also *A. vulgaris*. The reasons for smudging these species were diverse and differed among the interviewees. Reasons for burning *A. vulgaris* included: to prepare for a workshop, it is easily found, the smell is nice, to gain creative thoughts, to bring a good "vibe" into the house, to cleanse, against angry spirits, and for improving the atmosphere. Reasons for burning *Lavandula* were to cleanse, its calming properties, for love rituals, to protect children, its nice smell, and its protective and cleansing ability 'on another level' compared to other smudge sticks.

In the 33 questionnaires at the witches' fair, 22 people mentioned the use of sage ("salie", likely *Salvia* spp.), of which three people specifically wrote white sage ("witte salie" presumably *S. apiana*, but they could also mean *S. officinalis*). White sage and sage were

most often (17 people) used for purification (sometimes of the house) while two people mentioned protection. Others did not clarify its use or wrote smoking, disinfecting, cooking, ritual, and spiritual as uses for (white) sage. Two other species were also mentioned specifically for ritual incense: *A. vulgaris* (bijvoet) and engelwortel (most likely *Angelica archangelica* L. or possibly *A. sylvestris* L.).

2.3. Reasons for White Sage Preference

During our semi-structured interviews, when North American plant species were mentioned, we specifically asked why North American species were preferred over species easily available in the wild in the Netherlands. The following explanations were given: people don't know that you can use native plants for the same purposes; exotic plants work better; native [Dutch] species are boring; white sage is more easily obtainable than native Dutch plants; white sage works better (than native Dutch plants); people don't even know where the plants are from; people don't know the difference between native and exotic plants; it's marketing; white sage smells better; people forgot traditional species; people don't know that there is a difference between exotic and native species.

Some answers revealed knowledge of the Native American origin of white sage: because it is an American tradition, so you should use white sage; there is an ideal image of the Native North American peoples and to come closer to this ideal people incorporate some of their cultural elements into their own culture; it is from Native Americans, so it should be amazing; it is not a Dutch tradition (at least, not to our knowledge), so no Dutch species are used for this; smudging has to be done with white sage.

3. Discussion

3.1. Sustainability of Smudge Sticks

Our results show that multiple species are used in smudge sticks, of which a considerable portion originate from the USA, specifically western USA, *Salvia apiana* being the most prevalent one in shops. Unlike the other species that we identified, *S. apiana* was encountered in different forms (sticks, loose leaves, and "torches") and in mixtures with other species. In the wild, it is found in North America in the same ecosystems as *Artemisia californica* [38], which was also found in our smudge sticks. These types of vegetation, coastal sage scrub and chaparral, are known to be threatened by anthropogenic activities such as urban construction and the establishment of agricultural fields [38]. Other taxa that we collected, such as the difficult to identify *Artemisia* subg. *Tridentatae*, cf. *Pseudognaphalium*, and *Eriodictyon* species, are perhaps found in the wild in the same areas and possibly collected at the same time as *S. apiana*.

Although previous research has exposed that the (commercial) demand for ritual plants may lead to taboos and Indigenous nature conservation strategies [39,40], in the case of white sage there are signals that it is being overharvested in the wild to supply its increased demand [12,41–44] (https://www.gabrieleno-nsn.us (accessed on 21 October 2024)). These news articles have drawn attention to a possible decline in wild white sage populations, negatively affecting both the wild populations of the species and the peoples that depend on the species for ceremonial purposes. Overharvesting of important ceremonial plant species for commercialization is documented for the small cactus species *Lophophora williamsii* in the USA and Mexico negatively impacting the species' population resilience and its availability for traditional medicine [45]. It is unknown whether the other North American species found in smudge sticks and the *Bursera graveolens* wooden sticks that probably originate from Middle and/or South America, suffer due to a similar growing commercial demand for ritual plants [24]. Although no ecological research has been done on the effects of commercial wild-harvesting of smudge stick ingredients on wild plant populations, the popularity of *S. apiana* (and possibly to a lesser extent *A. californica*) might pose an extra risk for the resilience of local wild populations, adding significant pressures on the availability of this preferred wild plant species.

Some of our interviewees were concerned about the potential overharvesting of the species from their natural wild populations. One of them, a keen gardener, managed to grow a collection of *S. apiana* on his balcony. He gathered seeds to grow new ones which he handed for free to anyone wanting their own "sustainable" supply of white sage for personal ritual use. Furthermore, to cater to the demand for locally harvested smudge stick plants, *A. ludoviciana* is grown commercially on a small scale in the Netherlands and sold to a smudge stick vendor. One vendor stated awareness of the potential overharvesting and illegal harvesting of white sage and palo santo although they still chose to sell it due to its demand by customers. Other exotic smudge stick species (e.g., *Eriodictyon* sp., *A. tridentata*, and *A. ludoviciana*) have a wider distribution range (Table 1), are probably in less demand, and there are no signs of a potential decline in species populations due to overharvesting.

The smudge sticks themselves are also often mixes of plants from all over the world. For example, palo santo (Middle and South America) combined with white sage; *Eucalyptus* (Australia) combined with white sage; palo santo combined with an abalone shell; or white sage combined with colored rose petals probably representing the chakra's (a concept originating from Hinduism and Buddhism). Such combinations seem to reflect an uncritical appropriation of traditions from all over the world (see Section 3.4). Also, these species may indicate a declining supply or increasing price of *S. apiana* on the world market. This might also be the reason behind the commercial presence of Greek ceremonial sage (*S. fruticosa*), which we first noticed in shops in the beginning of 2023.

Unfortunately we were unable to identify a number of plant fragments to the species level. This was especially the case for *Artemisia* species in the subgenus *Tridentatae* and species in the genus *Eriodictyon*. Our specimens were often highly fragmented and lacked morphological characteristics. For a full assessment of species commercialized for smudge sticks and the sustainability issues these species may face, we suggest collecting plant specimens together with the smudge stick plant gatherers themselves in the USA.

3.2. Non-American Smudge Stick Ingredients

A native Dutch plant that came up during the in-depth interviews and the questionnaires and is commercialized to a small extent is *A. vulgaris*, clearly the preferred native Dutch herb for smudging. Perhaps this preference stems from the fact that it was sometimes labeled as "black sage" (not to be confused with *S. mellifera*), linking it to white sage (*S. apiana*), and in this way associating it with smudging. Commonly known in Dutch as bijvoet, *A. vulgaris* is a widespread and very common weed in Dutch pioneer vegetation, and easily identifiable. It was historically used for smudging to protect against evil and lightning strikes in the southern parts of the Netherlands [46]. However, similar uses are known for many other native Dutch plants that are likewise abundant and easily recognizable, such as boerenwormkruid (*Tanacetum vulgare* L.,) [46], but do not appear in smudge sticks. Possibly, the custom of burning *A. vulgaris* entered the New Age movements via moxa therapy, a type of acupuncture where this species is burned. Moxa therapy is part of the medicinal corpus of Traditional Chinese Herbal Medicine and is also performed in the Netherlands [47,48]. However, *A. vulgaris* for smudging was only found in the form of dried plant bundles, not as moxa sticks or moxa powder, although these may also be used by New Age practitioners.

Another noteworthy example of a non-American ingredient is *S. fruticosa*. Smudge sticks composed of this species are marketed as the feminine variant of the white sage smudge stick. *Salvia fruticosa* is a Mediterranean lowland species, yet it is advertised as originating from wild-harvested individuals from the mountains of Greece, displaying a careless attitude by the wholesalers towards a correct description of the species in question. Moreover, the label claims that this sage "has traditionally been used to purify and smudge spaces". In the eastern Mediterranean, *S. fruticosa* is known as an ingredient in (medicinal) teas and for the production of essential oils [49,50], but we did not find records of its use in burning rituals, making it plausible that this was made up to diversify the market of smudge sticks. Although smell is the most important indicator for selecting incense

species [13], in this case *S. fruticosa* may have also been chosen to substitute *S. apiana* due to morphological resemblance, as both species are covered by dense white indumentum, a common adaptation of plants growing in Mediterranean-type habitats.

3.3. Forgotten Knowledge on Native Plants

As knowledge about common plant species in industrialized countries like the Netherlands is relatively low in laypeople [51,52], so is traditional knowledge associated with these species [53]. Thus, consumers tend to turn towards (web)shops believing that they have done the correct species selection for them and provide them with the "knowledge" of their use. This was confirmed by one of our herbalist interviewees, who, in response to the question of why people prefer exotic plants, answered that "people forgot traditional species" and "it is not a Dutch tradition to burn plants" (as incense).

Interestingly, in the southern Netherlands fumigation rituals exist in which plants are burned for protection. There, wild and cultivated plants are picked each year and formed into bouquets, blessed in the church on special Roman Catholic dates, dried and kept to burn for protection against evil and thunder if needed. This custom was more widespread across Europe in the past [46] and has been extensively described for Poland [54,55]. Remarkably few people know about this ritual in the rest of the Netherlands, but two of our interviewees (both herbal experts) were aware of it. Its connection to the Catholic church might be a throw-off, assuming that most New Age and Neopagan adherents have more secular backgrounds, but according to Jespers [6] people in the folk religion domain that were influenced by New Age are often also Catholic, so there may have been some influence of these blessed herbal bouquets on the smudge stick species and their popularity. This would need further investigation.

3.4. Preference for North American Species in Smudge Sticks and the New Age Movement

From our interviews on smudge sticks and our collection of specimens from shops, we noticed an interplay between the perceived loss of traditional knowledge associated with Dutch plant species (see section above), romanticized ideas about Native Americans, and the wide availability of smudge sticks in (online) shops. The supply of products in New Age shops seems to drive people's choice of ritual plants alongside online blogs, and social media posts, affecting peoples' prior knowledge on types of smudge sticks. This is illustrated in remarks such as "it's marketing" and the fact that only two interviewees reported going out to search for potentially useful plants in nature, although this was not a specific question in our interviews. Smudge sticks were probably introduced through the commercialization of the New Age movement, although none of the interviewees remembered when smudge sticks exactly started appearing on the Dutch market.

Ideas about Native Americans were visible in some participants' answers like "North American plants work better than native ones." The admiration of the natural and Indigenous world is characteristic of New Age and related movements [23,56,57]. This does not only apply to North American Indigenous peoples, but also, for example, Indigenous South African peoples. Although we did not find this specific smudge stick in the Netherlands, in South Africa a native *Helichrysum* sp. is commercialized for smudging (marketed as "South African Sage Smudge Stick") and labeled to be useful for cleansing, protection, and to connect with "your spirit, guides, and angels" (https://www.michakra.co.za/products/imphepo-smudge-stick, accessed on 31 July 2024). Several species in this genus were traditionally used as incense to connect with ancestors, for protection, to drive away sickness, and as medicine [58]. This idealization has its roots in Romanticism, an 18th-19th century philosophical, literary, and art movement that idealized the natural and Indigenous world and had a huge impact on current Western thought and significantly influenced New Age and affiliated movements. Although New Age has its origins in Western society, elements from other cultures are transformed and squeezed into its framework [9]. The movement developed from the 1950s onwards, and from the 1980s it started becoming commercialized [9]. This commercialization incorporated and fused elements and symbols

from countless religions or world-view systems, such as yoga, ayurveda, Tibetan Buddhism, and various Aboriginal Australian [59] and Native North-American [33] ones. It seems to be this commodification of spirituality that turns out to be a strong driver for people to buy certain ritual objects. Just as in New Age, Neopaganistic religions, such as Wicca and contemporary witchcraft that also formed and expanded in the 20th century, are known to tap into the capitalist mindset of Europeans and Euro-Americans, where several objects and artefacts are sold to answer to the demand for spirituality [60].

Interviewees also mentioned that white sage smells better, so a preference for white sage could be caused by its volatile aromatic compounds, giving it a biological interpretation. The chemical composition of essential oils present in *Salvia* species is, among other factors, influenced by abiotic variables such as temperature and precipitation [61,62]. This might be an additional driver for people in the Netherlands, where the weather is generally cooler and wetter than in Mediterranean and Californian regions, to avoid the native flora and look for commercialized species coming from warmer and dryer conditions for its use in smudging.

The appropriation of non-Western cultural elements is often seen in a negative light, especially when these tendencies are commercialized and cause adverse impacts on the culture these elements are originally associated with [23]. Commercialized smudge sticks containing North American species are not always labeled as Native American ritual ingredients and Dutch consumers seem generally unaware of the potential negative ecological and social impact on Native American livelihoods, including cultural health and traditions. The availability of smudge sticks in the Netherlands may also have inspired people to transform and personalize smudge sticks by creating them with native or cultivated plants, in a sense reminding the Dutch population that plant smoke can be used for cleansing and protection (see Section 3.3). However, to guarantee the sustainable availability of smudge stick species, scientific research is needed to study the potential impacts of commercial harvesting with the aim of providing a guideline for harvest control and conservation plans.

4. Materials and Methods

4.1. Collecting Specimens

We collected smudge sticks, loose leaves for burning (only species that were also seen in smudge sticks to aid with identification), and woody material sold to use as incense between September and November 2021, in March 2023 and in May–June 2024 from online and physical shops. Online shops directed to the Dutch market were found through Google queries using the keywords: "smudge sticks" combined with the Dutch terms for ordering ("bestellen") and buying ("kopen"). We visited physical New Age shops in the cities Amsterdam, Utrecht, and Wageningen and attempted to obtain as many different plant species as possible.

Species present in smudge sticks were identified using the Naturalis Biodiversity Center herbarium (L) and online scans from Kew Data Portal (https://data.kew.org/). Furthermore, for identifying North American species in the Asteraceae family we consulted the Flora of North America (http://floranorthamerica.org), to identify species in the *Salvia* genus and *Eriodictyon* we used [63–66]. For the identification of a possibly horticultural *Lavandula* we consulted KeyBase (https://keybase.rbg.vic.gov.au/keys/show/7633, accessed 6 August 2024). Woody material was identified by a wood anatomy expert at Naturalis. We checked the current scientific names by consulting The World Flora Online (https://www.worldfloraonline.org/). To aid with plant identification, wholesalers were contacted and asked where certain plant material originated from. Plant species' distributions were found in https://plants.usda.gov and in https://powo.science.kew.org (both accessed 6 June 2024).

Voucher specimens were deposited at the herbarium of Naturalis Biodiversity Center (L) in Leiden, the Netherlands. When species could be identified without disassembling the smudge sticks, we deposited the intact sticks in the Economic Botany collection of the same institute. For the figures, we photographed smudge sticks in front of a black velvet canvas and created a collage using PowerPoint.

4.2. Interviews

Semi-structured interviews were held in the same fieldwork periods as above with 11 persons, of which four vendors of smudge sticks, five persons working in the herbal industry (e.g., phytotherapists and organizers of herbal medicine workshops) and two distributors of self-made smudge sticks. Participants were recruited through the first author's contacts, further snowball sampling and Google searches. Most informants were interviewed by phone, while two were visited in-person. After introducing our research and obtaining permission to use their interview data in our research, we asked them the following questions: What plant species are included in smudge sticks? What is the use of each species in a smudge stick? Do you or people that you know prefer white sage (*Salvia apiana* Jeps.) instead of native Dutch species (e.g., *Artemisia vulgaris* L.) and why? We made sure that when we asked about white sage the interviewees knew we were specifically interested in *S. apiana* (as opposed to other species that look like it and are confused with it such as *S. officinalis*) by discussing its morphological characteristics and its origin. Interviews were conducted in Dutch, following the ethical guidelines of the International Society for Ethnobiology [67].

4.3. Questionnaires

Apart from the in-depth semi-structured interviews, we used data from 33 questionnaires that were distributed and filled in during the witches fair "Hexfest" in Oss, the Netherlands, in February 2020. These questionnaires were used for another project to gain insights into plant species and their uses, plant origins (i.e., wild-picked, garden-grown or bought), and origin of knowledge of plant use (i.e., family, books, internet), among people that self-identify as witches. In these questionnaires people were also asked to freelist plants that they used for medicinal, ritual, and/or religious purposes. The specific data collected regarding plants used for smudging were used in our analysis.

5. Conclusions

Smudge sticks in the Netherlands are found in shops that specialize in esoteric products. These dried plant bundles are often made up of different North American species, although mainly *Salvia apiana*. The current demand for smudge sticks possibly has a negative impact on local plant species' populations and on essential cultural practices of local Native American livelihoods. An assessment of the smudge sticks species' population status and trends is recommended, as well as an inventory of the commercial supply and demand of their herbal products. Also, considering that more steps in the chain of smudge stick commercialization are presumably observed in North America, a collaboration between ethnobotanists on both the European and North American continents, could prove fruitful to give further insights into plant conservation necessities regarding smudge stick plant species.

As capitalist-oriented New Age and Neopagan movements, such as Wicca, modern Witchcraft, and others, attain a growing number of followers, it will be necessary to keep track of their ethnobotanical journey. What drives people in these movements in their choice of ritual plants? How will plant preferences change over time? And how will these preferences impact species' populations in the wild? These movements are relatively new, but do not stand on their own, as they assimilate and adapt rituals and ceremonies from all over the globe [9,68], including plant usage as we have shown. Smudge sticks are only one example of ritualistic commodified objects containing plant material that were assimilated. Resins are another example, but they are challenging to identify, especially when shops are not transparent about the origin of their products. Other plant species, that are not burned, but, for example, rather used as decoration or ingested (e.g., "cacao ceremonies") in New Age and Neopaganistic ceremonies are still open for investigation. Further research might elucidate if people intrinsically associate smells with protective properties, but "forgot" traditional native ritual plants making it possible for the exotic smudge sticks to fill this ethnobotanical niche.

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An Ethnobotanical Study in Kırşehir (Türkiye)

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Abstract: A comprehensive ethnobotanical study was carried out in the province of Kırsehir, in the Central Anatolia region. The result of that study is this publication containing information about the main traditional folk medicine, wild food plants, and other plant uses in the area. Our goal was to collect, identify, and provide information about plants traditionally used by the local population. This inquiry focused on the plant specimens obtained during field work. Data were gathered through open and semi-structured interviews conducted with local individuals, and use report (UR) values were computed. A total of 79 taxa of plants used in folk medicine, belonging to 33 families, were identified in this study. Of these, 67 taxa were wild and 12 were cultivated. The most common families were Asteraceae, Lamiaceae, and Rosaceae. Based on the results of this study, 77 taxa with ethnobotanical uses were recorded. The plants were used as folk medicine (45 taxa), as food (46 taxa), and for other purposes (34 taxa). This study determined that plants are still traditionally used in the region.

Keywords: ethnobotany; folk medicinal plants; wild edible plants; Kırşehir; Türkiye

1. Introduction

Local communities possess traditional ecological knowledge (TEK) which offers valuable insights into the cultural and ecological significance of many plant species, as well as their potential for sustainable utilization [1,2]. One of the important components of traditional ecological knowledge is ethnobotany [3]. The documentation of ethnobotanical knowledge is highly valuable from a scientific perspective, especially in the current era characterized by rapid social change, declining plant biodiversity, and loss of traditional knowledge regarding wild plant usages [4,5].

In recent decades, there has been a significant increase in global initiatives aimed at safeguarding ethnobotanical knowledge, particularly in Europe, Mediterranean countries, and Türkiye [5–8]. However, it seems that these initiatives are mostly related to medicinal and wild food plants. In Türkiye, ethnobotanical studies are carried out with the efforts of researchers and the support of the government. This study has been supported by The Turkish Ministry of Agriculture and Forestry [7]. Kırşehir Province has seen only two ethnobotanical studies [9,10], both conducted in the same district. With its rich cultural and biological heritage, Kırşehir demands further investigation from an ethnobotanical perspective. The aim of this study is to carry out a comprehensive ethnobotanical study in the region and examine how the role of plants in human life has been determined, and how traditional knowledge can be used as a resource to help future generations.

2. Results and Discussion

We have created a comprehensive list of 79 taxa belonging to 33 distinct families. Of these taxa, 67 were wild and 12 were cultivated. The family Asteraceae had the highest representation, with a total of 16 plant species. This was followed by Rosaceae and Lamiaceae, with six and five species, respectively (Figure 1).

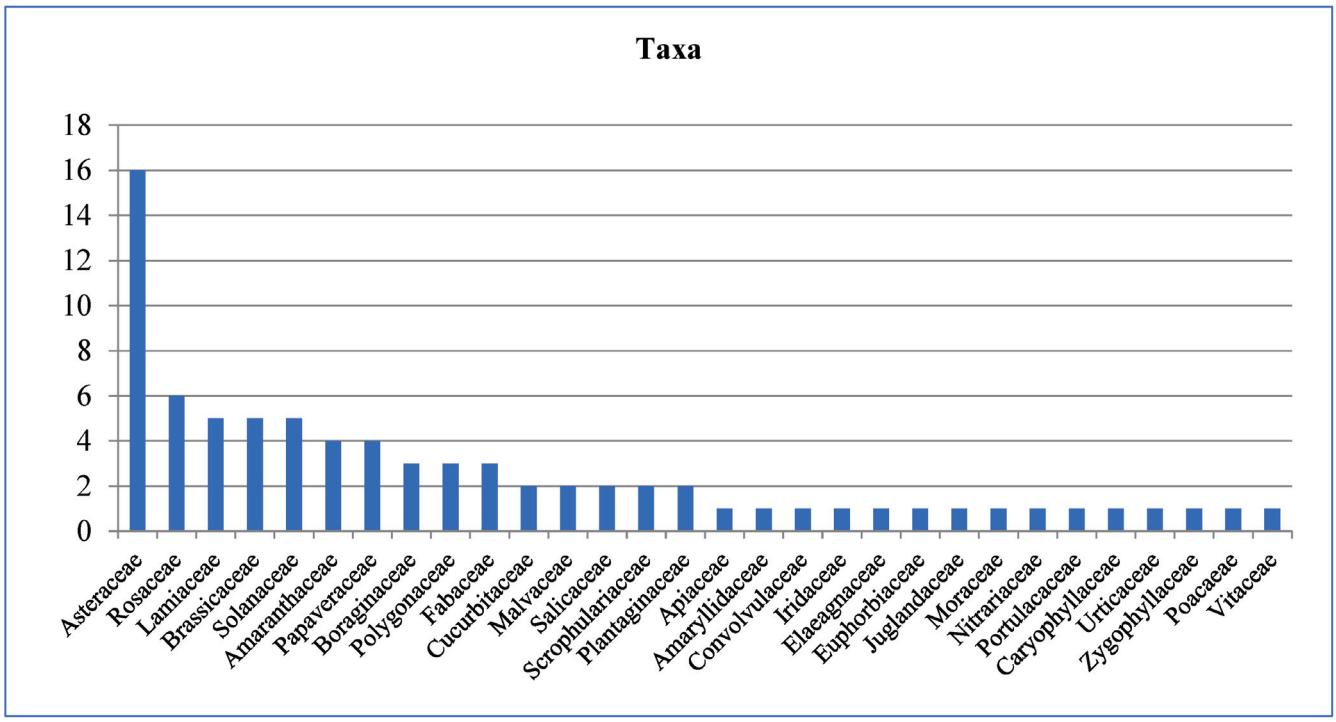


Figure 1. Number of taxa per family.

As a conclusion of the study, 45 plants were recorded to be used in medicinal treatment, while 46 plants were consumed as edible and 34 plants were classified in other purposes. Also, the data collected in the region has been compared with the neighboring provinces [9–25] (Table 1).

A total of 1291 use reports were identified in terms of ethnobotanical uses of plants in the study area. According to use reports, the most popular plants were *Peganum harmala* L. (89 URs), *Malva neglecta* Wallr. (78 URs), *Vitis vinifera* L. (62 URs), and *Malva sylvestris* L. (55 URs). It has been determined that *P. harmala* is used in medicinal and other plant usages; *Malva neglecta-M.sylvestris* are used in medicinal and edible usages; and the *V. vinifera* is used in medicinal, edible, and other plant usages.

During our studies it has been observed that the medical and nutrient plants are still used commonly in the region. However, today it has been determined that their usage as dyes and toys have decreased compared to other usage categories. It has been determined that animal origin usage has been rarely used today.

From a total of 99 people interviewed in the settlements during the field studies, 63 were aged 50–70. It was determined that the people aged 50–70, from whom the most information was obtained, were mostly primary school graduates.

Astragalus melanophrurius Boiss., *Centaurea urvillei* DC. subsp. *stepposa* Wagenitz, *Convolvulus galaticus* Rostan ex Choisy, and *Papaver pilosum* Sibth. et Sm. are endemic species (Table 1). The distribution of these endemic species is throughout Central Anatolia. These endemic plants used ethnobotanically in the study area are not in the CR, EN, or VU categories, and their risk of extinction is almost non-existent [11].

Table 1. Ethnobotanical usages of plants in Kırşehir (Türkiye).

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Achillea biebersteinii Afan. [*Achillea arabica* Kotschy.] (Asteraceae, MARE 22745, 22854)	Sıçan otu	Aerial parts	Wound	Crushed, ext.	12	Med [10,12,15,17] [b]
		Aerial parts	Ornament		5	
Achillea wilhelmsii C.Koch [*Achillea santolinoides* Lag. subsp. *wilhelmsii* (K.Koch) Greuter]	Sıçan otu	Aerial parts	Wound	Crushed, ext.	14	Toothache [12] Med [20] [b]
		Aerial parts	Toothache	Mouthwash, ext.	4	
(Asteraceae, MARE 2272, 22746)		Bulbus	Wound	Digged into the ashes, ext.	8	
		Bulbus	Sprain	Digged into the ashes, ext.	3	
Allium cepa L. [a] (Amaryllidaceae, MARE 15136)	Soğan	Bulbus	Fracture	Crushed, mixed with egg, and wrapped in a cloth, ext.	3	Wound [14,24] Med [12,19,21] [b]
		Bulbus	Gynecological diseases	Decoction, int.	1	
		Tunic	Abortive	Decoction, int.	1	
		Tunic	Dye		12	
Amaranthus sp. (Amaranthaceae, MARE 22767, 22782)	Karagöz	Aerial parts	Cooked		10	Food [20]
Anchusa leptophylla Roemer et Schultes subsp. *leptophylla* [*Anchusa leptophylla* Roem. et Schult.] (Boraginaceae, MARE 22797)	Sormuk otu	Nectar	Children snack		2	Food [9,16,22]
Anchusa undulata L. subsp. *hybrida* (Ten.) Coutinho (Boraginaceae, MARE 22804)	Sarmuk	Nectar	Children snack		5	Food [22,25]
Astragalus melanophrurius Boiss. [e] (Fabaceae, MARE 22824)	Geven, Keven	Latex	Hand-foot cracks	–, ext.	10	
		Latex	Wound	–, ext.	14	
		Latex	Fracture	–, ext.	3	
		Roots	Fuel	–, ext.	4	
		Aerial parts	Fodder		3	
Beta lomatogona Fisch. et Mey. (Amaranthaceae, MARE 22764)	Kızılca, Kızılca pancarı	Aerial parts	Boiled then cooked		4	Food [13]
Brassica deflexa Boiss. (Brassicaceae, MARE 22866)	Sarı hardal	Young leaves	Raw		9	
		Young leaves	Raw in salads		9	
Capsella bursa-pastoris (L.) Medik. (Brassicaceae, MARE 22844)		Aerial parts	Raw		8	Food [9,16,18,20,22,25]

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Capsicum annuum L. [a] (Solanaceae, MARE 21420)		Fruits	Cough	Crushed, mixed with melted beef suet and molasses, int.	2	Med [14,21] [b]
		Fruits	Cough	Crushed and wrapped around the chest, ext.	4	
Cardaria draba (L.) Desv. [*Lepidium draba* L.] (Brassicaceae, MARE 22739)	–	Aerial parts	Fodder		2	
Carthamus tinctorius L. (Asteraceae, MARE 22803)	Aspir	Oleum	Fuel		14	
Centaurea depressa Bieb. (Asteraceae, MARE 22786, 22787)	Düğmecik otu, Gökbaş	Capitula	Flower crown		16	
		Aerial parts	Fodder		1	
Centaurea iberica Trev. ex Sprengel (Asteraceae, MARE 22820)		Capitula	Wound	Crushed then boiled, ext.	4	[15,20] [b]
Centaurea solstitialis L. subsp. *solstitialis* (Asteraceae, MARE 22736, 22813)	Boz diken, Çakırdiken, Sarıbaş	Capitula	Abdominal pain	Crushed, int.	5	Constipation [13] Med [23] [b]
		Capitula	Constipation	Decoction, int.	3	
Centaurea urvillei DC. subsp. *stepposa* Wagenitz [e] (Asteraceae, MARE 22795)	Kadıgöbeği, Köygöçüren	Roots	Carminative	Decoction, int.	2	
		Receptaculum	Cooked		1	
Centaurea virgata Lam. (Asteraceae, MARE 22788)	Acımık otu	Capitula	Flower crown		9	
		Capitula	Used to remove louse from clothing		1	
Chenopodium album L. subsp. *album* var. *album* [*Chenopodium album* L.] (Amaranthaceae, MARE 22859)	Kızılca, Sirken	Aerial parts	Boiled then cooked		6	Food [9,10,16,18,20,22]
		Aerial parts	Boiled then made börek		6	
		Aerial parts	Soup		4	
Chondrilla juncea L. (Asteraceae, MARE 22868)	-	Latex	Chewed		5	Food [18,22,25]
Cichorium intybus L. (Asteraceae, MARE 22794)	Çıtlık	Latex	Wound	Ext.	1	Wound [10] Med [13] [b] Food [9,16,22,25] Broom [9]
		Young shoots	Boiled and served with eggs, fried with (or without) eggs		11	
		Young shoots	Raw		2	
		Latex	Chewed		4	
		Aerial parts	Broom		6	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Citrullus lanatus (Thunb.) Matsum. et Nakai. [a] (Cucurbitaceae, MARE 22248)	Karpuz	Pericarpium	Toy		2	
Convolvulus galaticus Rostan ex Choisy [e] (Convolvulaceae, MARE 22808)	Dağ sarmaşığı	Leaves	Wound	Crushed wrapped in a cloth, ext.	1	Fodder [25]
		Aerial parts	Fodder		7	
Crataegus monogyna Jacq. subsp. *azarella* (Gris.) Franco [*Crataegus monogyna* Jacq.] (Rosaceae, MARE 22845)	Alıç	Fruits	Shortness of breath	Decoction, int.	2	
		Fruits	Raw		8	
		Fruits	Colorant for desserts		1	
Crocus chrysanthus (Herbert) Herbert (Iridaceae, MARE 16649)	Bivangk (K), Bivongk (K), Çiğdem, Katırçiğdemi	Whole plant	Raw		3	Food [22]
		Corm	Raw		3	
		Flowers	Recreational tea		2	
		Flowers	Jam		2	
Cydonia oblonga Mill. (Rosaceae, MARE 23350)	Ayva	Leaves	Cold	Decoction, int.	16	Shortness of breath [13,14,24] Cold [19] Med [10,15,21] [b] Food [25]
		Leaves	Shortness of breath	Decoction, int.	6	
		Leaves	Diarrhea (in animals)	Decoction, int.	4	
		Leaves	Recreational tea		11	
		Fruits	Cooked (stuffed quince)		13	
Descurainia sophia (L.) Webb ex Prantl (Brassicaceae, MARE 22758)	Kaba süpürge, Karabacak, Şıjıng (K)	Aerial parts	Broom		2	
Echium italicum L. (Boraginaceae, MARE 22805)	Kurtkuyruğu, Tilkikuyruğu	Young shoots	Raw		4	Food [16,20,22]
Elaeagnus angustifolia L. [a] (Elaeagnaceae, MARE 22749, 22853)	Dara bi (K), İğde	Leaves	Boils	Wrapped in a cloth, ext.	5	Boil [14] Med [15,17,19,21] [b] Food [25]
		Leaves	Abdominal pain (in animals)	Wrapped in a cloth, ext.	1	
		Fruits	Raw		14	
		Young shoots	Amulet		18	
		Flowering branches	Fragrant		3	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Eryngium campestre L. var. *virens* Link (Apiaceae, MARE 22778, 22790, 22867)	Şeker dikeni, Yer kestanesi	Young stem	Peeled then eaten		6	Food [9,16,20]
		Roots	Rennet		1	
Euphorbia macroclada Boiss. (Euphorbiaceae, MARE 22811)	Sütleğen, Xaşule (K)	Latex	Wound	–, ext.	6	Wart [23] Callus [15] Med [20] [b]
		Latex	Blood stopper	–, ext.	1	
		Latex	Malaria	Prepared a poultice with barley flour, ext.	1	
		Latex	Warts	–, ext.	1	
		Latex	Calluses	–, ext.	11	
		Latex	Tattooing		3	
Glaucium grandiflorum Boiss. et Huet. (Papaveraceae, MARE 22806)	Gelincik	Petals	Toy		1	
Gundelia tournefortii L. (Asteraceae, MARE 22865)	Kenger, Gareng (K)	Latex	Gum diseases	Chewed	1	Med [9,10] [b] Food [9,10,20,22,25]
		Shoots	Cooked		4	
		Capitula	Soup		2	
		Latex	Chewed		6	
		Fruits	As coffee		4	
		Receptaculum	Cooked		1	
		Young stem	Peeled then eaten		4	
Hyoscyamus reticulatus L. (Solanceae, MARE 22857)	–	Seeds	Against itching in the eyes	Seeds are spread on dying embers and eyes are exposed to fume	2	Against itching in the eyes [15] Med [23] [b]

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Juglans regia L. [a] (Juglandaceae, MARE 22748)	Ceviz	Leaves	Abdominal pain	Maseration with water, int.	1	Abdominal pain [17] Med [13,19–21,23,24] [b] Dye [20] Food [25]
		Leaves	Foot odor	Infusion, ext.	1	
		Leaves	Headache	Crushed and mixed with henna, ext.	2	
		Leaves	Vermifuge	Decoction, int.	1	
		Pericarp	Headache	Crushed, ext.	1	
		Pericarp	Hair remover	Ash is used to make a paste with water, ext.	1	
		Seed	Raw		12	
		Leaves	Dye		10	
		Pericarp	Dye		10	
		Endocarp	Toy		1	
		Wood	Musical instrument		1	
Kochia scoparia (L.) Schrad. [*Bassia scoparia* (L.) A.J. Scott] (Amaranthaceae, MARE 15200)	Çalgı	Aerial parts	Broom		18	
Lactuca serriola L. (Asteraceae, MARE 22747, 22862)	Çıtlık	Young leaves	Cooked		6	Food [16,20,22,25]
		Young leaves	Raw in salads		4	
		Young leaves	Choped and added into a mixture of yogurt + water to make 'Cacık'		3	
		Latex	Chewed		2	
		Aerial parts	Fodder		2	
Lagenaria siceraria (Mol.) Standl. [a] (Cucurbitaceae, MARE 9639)	Süs kabağı	Fruits	Musical instrument		1	
		Fruits	Ornament		1	
Lycium depressum Stocks (Solanaceae, MARE 22773)	Çalı	Branches	Wart	–, ext.	9	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Lycopersicon esculentum Miller [a] (Solanaceae, MARE 23351)	Domates	Fruits	Athlete's foot	Crushed wrapped in a cloth, ext.	2	Burn [21] Med [14] [b]
		Fruits	Scorpion bite	Crushed and boiled (paste), ext.	6	
		Dried fruit	Snow burn	Boiled, ext.	3	
		Dried fruit	Burn	Boiled in water, ext.	1	
Malva neglecta Wallr. (Malvaceae, MARE 22753, 22829)	Çobançöreği, Sultan-mercimeği, Toluk (K)	Aerial parts	Hemorrhoids	Decoction, ext.	7	Abdominal pain [20] Hemorrhoids [13,14,20,23] Wound [17] Gynocological disases [9] Med [12,15,21] [b] Food [9,16,18,20,22]
		Aerial parts	Expectorant	Infusion, int.	1	
		Aerial parts	Wound	Roasted and prepared a poultice with flour, ext.	14	
		Aerial parts	Abdominal pain	Boiled with bulgur and wrapped in a cloth, ext.	16	
		Leaves	Abdominal pain	Infusion, int.	2	
		Leaves	Abdominal pain	Roasted and wrapped in a cloth, ext.	8	
		Leaves	Gynecological diseases	Infusion, int.	1	
		Roots	Infertility	Boiled and sit against the steam	2	
		Roots	Menstrual disorders	Decoction, int.	1	
		Young leaves	Cooked		20	
		Young leaves	Raw		2	
		Immature fruits	Children snack		4	
Malva sylvestris L. (Malvaceae, MARE 22753a)	Ebegümeci, Evelik	Roots	Gynecological diseases	Ext.	1	Med [10] [b] Food [18,22]
		Leaves	Wound	Cooked with flour, wrapped in a cloth, ext.	17	
		Leaves	Abdominal pain (in babies)	Cooked then wrapped in a cloth, ext.	4	
		Leaves	Gynecological diseases	Cooked, ext.	1	
		Young leaves	Cooked		20	
		Leaves	Dolma		8	
		Immature fruits	Children snack		4	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Matricaria chamomilla L. var. *recutita* (L.) Grierson (Asteraceae, MARE 22850, 22873)	Papatya	Capitula	Sore throat	Inhalation	2	Med [14,24] [b] Recreational tea [20]
		Capitula	Gynecological diseases	Infusion, int.	2	
		Capitula	Recreational tea		9	
Mentha longifolia (L.) Hudson subsp. *typhoides* (Briq.) Harley (Lamiaceae, MARE 22860)	Pung (K), Pungha (K), Yarpız	Aerial parts	Headache	Wrapped in a cloth, ext	3	Med [12–14,21,23] [b] Food [9,16,18,20,22]
		Leaves	Spice		17	
		Aerial parts	Dye		4	
		Leaves	Used as a soap (foamed with water after crushed)		2	
Mentha x *piperita* L. [a] (Lamiaceae, MARE 22863)	Pung (K), Pungha (K), Nane	Leaves	Spice		21	Food [18]
Morus alba L. [a] (Moraceae, MARE 23348)	Dut	Leaves	Eczema	Boiled, wrapped in a cloth, ext	1	
		Leaves	Dolma		1	
		Branches	Walking stick		2	
		Branches	Musical instrument		1	
Nasturtium officinale R.Br. (Brassicaceae, MARE 22852)	Kusuk	Leaves	Raw in salads		7	Food [10,20]
Papaver argemone L. [*Roemeria argemone* (L.) C. Morales, R. Mend. et Romero García] (Papaveraceae, MARE 22830)	Gelincik	Petals	Jam		4	Food [16]
		Aerial parts	Cooked		4	
Papaver pilosum Sibth. et Sm. [e] (Papapveraceae, MARE 22840)	Gelincik	Petals	Jam		4	Food [16]
Papaver rhoeas L. (Papaveraceae, MARE 22756a)	Gelincik	Petals	Jam		4	Food [16,22]
		Aerial parts	Cooked		4	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Peganum harmala L. (Nitrariaceae, MARE 22743, 22779)	Üzerlik	Aerial parts	Eye infections	Inhalation	1	Med [10,12,15,17,19] [b] Amulet [9,10]
		Seeds	Amulet		10	
		Fruits	Amulet (strung on a rope)		28	
		Aerial parts	Amulet (hung on the wall in bunches)		28	
		Whole plant	Ashes were used to wash clothes		1	
		Fruits	Toy		1	
		Aerial parts	Incense		11	
		Fruits	Incense		9	
Plantago lagopus L. (Plantaginaceae, MARE 22733)	Kırksinir	Leaves	Wound	Wrapped in a cloth, ext.	9	
Plantago major L. subsp. *intermedia* (Gilib.) Lange (Plantaginaceae, MARE 22737, 22856)	Kırksinir, Yedidama rotu	Leaves	Wound	Wrapped in a cloth, ext.	9	Wound [14,15,21] Med [12,13,20,23] [b]
		Leaves	Bronchitis (in children)	Mixed with honey, int	1	
		Leaves	Hemorrhoids	Boiled, int.	3	
		Leaves	Abdominal pain	–, int.	1	
		Leaves	Stomachache	–, int.	1	
		Leaves	Headach	–, int.	1	
Polygonum cognatum Meissn. (Polygonaceae, MARE 22810, 22861)	Madımak, Madımalak	Aerial parts	Cooked		26	Food [9,10,13,16,18,20,22]
		Aerial parts	Stuffing in pastries		4	
		Aerial parts	Raw in salad		8	
		Aerial parts	Dye		1	
Populus sp. (Salicaceae, MARE 23345)	Kavak	Bark	Fracture	Crushed, added egg then wrapped in a cloth, ext.	1	Med [15] [b]
		Branches	Stick		2	
		Branches	Whistle		2	
		Wood	Fuel		1	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Portulaca oleracea L. (Portulacaceae, MARE 22771, 22781)	Semiz otu, Soğukluk otu	Aerial parts	Cooked		11	Food [14,16,18,20,22]
		Aerial parts	Raw in salads		11	
Pyrus elaeagnifolia Pallas subsp. *elaeagnifolia* Pallas [*Pyrus elaeagnifolia* Pall.] (Rosaceae, MARE 22741)	Ahlat, Çördük	Fruits	Diarrhea	–, int.	3	Diarrhea [21] Med [24] [b] Food [9]
		Fruits	Pickle		5	
		Fruits	Raw		1	
		Branches	Stick		1	
Pyrus elaeagnifolia Pallas subsp. *kotschyana* (Boiss.) Browicz (Rosaceae, MARE 22846)	Ahlat, Çördük	Fruits	Diarrhea	–, int.	3	
		Fruits	Pickle		5	
		Fruits	Raw		1	
Quercus sp. (Fagaceae, MARE 15063)	Meşe, Pelit	Fruit	As coffee after roasted and ground		1	
		Fruit	Roasted		6	
		Fruit	Ornament		2	
		Ashes	Washing cloths		4	
Rosa canina L. (Rosaceae, MARE 22754)	İtburnu, Kuşburnu	Fruits	Cold	Infusion, int.	16	Cold [13,14,17,19,23,24] Diabetes [12,15] Med [20,21] [b] Food [9,18,22]
		Fruits	Cough	Infusion, int.	9	
		Fruits	Immunostimulant	Infusion, int.	2	
		Fruits	Diabetes	Infusion, int.	1	
		Fruits	Recreational tea		7	
		Fruits	Jam		4	
Rubus sp. (Rosaceae, MARE 23344)	Böğürtlen	Branches	Boil	Burned after mixed with water, ext.	2	
		Fruits	Jam		12	
Rumex cristatus DC. (Polygonaceae, MARE 22796)	Ekşimen, Kuzukulağı, Sımask (K)	Leaves	Constipation	Cooked, int.	2	
		Leaves	Kidney stones	Decoction, int.	1	
		Leaves	Raw in salads		3	
		Leaves	Dolma		6	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Rumex tuberosus L. (Polygonaceae, MARE 22791)	Ekşimen, Kuzukulağı	Leaves	Raw in salads		2	Food [16]
		Leaves	Dolma		6	
Salix alba L. (Salicaceae, MARE 22793)	Söğüt	Leaves	Headache	Chewed	1	Med [13,14] Med [15] [b] Walking stick [9]
		Leaves	Antipyretic	Infusion, int.	3	
		Leaves	Antipyretic (in babies)	Decoction, int.	1	
		Flowers	Children snack		1	
		Branches	Basket		6	
		Branches	Walking stick		2	
		Branches	Whistle		2	
		Branches	Cigarette holder		1	
		Wood	Laundry stick		1	
		Wood	Toy		1	
		Wood	Fuel		1	
Scrophularia sp. (Scrophulariaceae, MARE 22752)	Girişik otu, Kaşıntı otu	Aerial parts	Antifungal	Decoction, ext.	1	
Silene vulgaris (Moench) Garcke (Caryophyllaceae, MARE 22792)	–	Fruits	Toy		3	
		Aerial parts	Fodder		1	
Solanum tuberosum L. [a] (Solanaceae, MARE 23346)	Gumbıl, Kumpir, Patates	Tubers	Headache	Sliced, wrapped in a cloth, ext.	2	Headache [12,21]
		Tubers	Mumps	Wrapped in a cloth after boiled and mashed, ext.	2	
Teucrium polium L. (Lamiaceae, MARE 22774, 22776, 22802, 22855)	Muradi, Periyavşan otu, Yavşan otu	Aerial parts	Abdominal pain	Bath, ext.	16	Appetizer [9,12,15,20] Med [10,14,17,21] [b]
		Aerial parts	Itching	Bath, ext.	11	
		Aerial parts	Appetizer	Decoction, int.	2	
Thymus longicaulis C. Presl subsp. *longicaulis* C. Presl var. *subisophyllus* (Borbas) Jalas [*Thymus longicaulis* subsp. *chaubardii* (Boiss. et Heldr. ex Rchb.f.) Jalas] (Lamiaceae, MARE 22760)	Kekik	Aerial parts	Sorethroat	Infusion, int.	4	Food [13] Med [14]
		Aerial parts	Shortness of breath	Infusion, int.	6	
		Aerial parts	Cough	Infusion, int.	5	
		Aerial parts	Spice		11	
		Aerial parts	Recreational tea		7	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Thymus sipyleus Boiss. subsp. *rosulans* (Borbás) Jalas [*Thymus sipyleus* Boiss.] (Lamiaceae, MARE 22858)	Kekik	Aerial parts	Cold	Decoction, int.	8	Cold [19] Med [12,15] [b] Food [22]
		Aerial parts	Spice		10	
		Aerial parts	Recreational tea		5	
Tragopogon dubius Scop. (Asteraceae, MARE 22789, 22801)	Dedesakalı, Emlik, Tatazkalı, Tekecen	Young stem	Raw		8	
		Young stem	Soup		1	
Tribulus terrestris L. (Zygophyllaceae, MARE 22818)	Çobandiken	Aerial parts	Diabetes	Decoction, int.	1	Diabetes [10] Med [19,23] [b]
		Aerial parts	Weight loss	Infusion, int.	1	
		Fruits	Weight loss	Infusion, int.	1	
Tripleurospermum parviflorum (Willd.) Pobed. (Asteraceae, MARE 22842)	Papatya	Capitula	Sore throat	Infusion, int.	4	Med [15,20] [b]
		Capitula	Sore throat	Inhalation	3	
		Capitula	Gynecological disorders	Infusion, int.	2	
		Capitula	Recreational tea		3	
		Capitula	Flower crown		6	
Urtica urens L. (Urticaceae, MARE 22751)	Isırgan	Aerial parts	Rheumatism	Crushed, wrapped in a cloth, ext.	3	Shortness of breath [14] Rheumatism [15,23] Med [20] [b] Food [16,18,22]
		Aerial parts	Wound	Crushed, wrapped in a cloth, ext.	2	
		Aerial parts	Shortness of breath	Decoction, int.	1	
		Aerial parts	Constipation	Cooked, int.	1	
		Leaves	Hemorrhoids	–, ext.	1	
		Leaves	Cooked		5	
		Leaves	Soup		2	
		Leaves	Borek		4	

Table 1. *Cont.*

Botanical Name, Family and Voucher Specimen Number	Local Name	Plant Part Used (Medicine, Food or other Usages)	Ailments Treated/ Therapeutic Effect, Modes of Consumption or Usages	Preparation and Administration	Use Reports	References
Verbascum sp. (Scrophulariaceae, MARE 22744)	Sığırkuyruğu, Zarmas	Aerial parts	Hemorrhoids	Decoction, int.	1	
		Flowers	Shortness of breath	Infusion, int.	3	
		Flowers	Wart	Crushed, ext.	1	
		Leaves	Hemorrhoids	Crushed, ext.	1	
		Aerial parts	Broom		6	
		Aerial parts	Fuel		2	
Vicia cracca L. (Fabaceae, MARE 22738, 22759)	Dağ yoncası, Fiğ	Fruits	Children snack		2	Food [16]
Vitis vinifera L. [a] (Vitaceae, MARE 15033)	Asma, Üzüm	Fruits (dried)	Fracture	Crushed, wrapped in a cloth, ext.	1	Fracture [10,14,15,24] [21] [b]
		Branches	Eye diseases	Crushed and dropped into the eye	1	
		Leaves	Dolma		18	
		Fruits	Pekmez		18	
		Fruits	Dessert		20	
		Branches	Used as a lighter		3	
		Leaves	Dye (mixed with henna)		1	
Xeranthemum annuum L. (Asteraceae, MARE 22869)	Süpürge otu	Aerial parts	Broom		13	
Zea mays L. subsp. *mays* [a] (Poaceae, MARE 21466)	Mısır	Stylus	Antiinflammatory	Infusion, int.	1	Diuretic [14,15] Med [19,24] [b]
		Stylus	Diuretic	Infusion, int.	2	

Abbreviations: Int.—Internal use; Ext.—External use; Med.—Medicinal usage. [a] Cultivated plant; [b] Different usages; [e] Endemic plant. The language of local names are in Turkish and Kurdish (K).

2.1. Medicinal Plants

The plants used for medicinal purposes in Kırşehir are presented in Table 1 and arranged alphabetically according to their botanical names, together with any further relevant information. During this study, 59 plant specimens were collected in the research area. Of these, 45 medicinal plant species belonging to 22 families were identified, of which 36 species were wild and 9 species were cultivated. The most common medicinal plant families were Asteraceae (45.5%), Rosaceae (27.3%), Solanaceae (22.7%), and Lamiaceae (18.2%).

Based on a total of 419 use reports, the plant parts used to treat ailments were leaves (27.6%), aerial parts (23.8%), subterranean parts (9.5%), fruit (8.3%), and other parts such as latex, resin, and the bark of a stem (30.8%).

A total of 112 medicinal uses were recorded. The preparation methods were infusion (18.8%), direct application without any preparation (18.8%), application after crushing (17.8%), decoction (14.8%), and other common methods (39.8%).

Remedies were mainly administered externally (55.4%) (Table 1).

Remedies were sometimes prepared with additional components: eggs, molasses, melted beef suet, flour, henna, or bulgur.

Of the medicinal plants used for veterinary purposes, *Cydonia oblonga* Mill. and *Elaeagnus angustifolia* L. were used to treat both humans and animals. While leaves of *C. oblonga* are used internally against diarrhea, the leaves of the *E. angustifolia* are used externally against abdominal pain in animals.

When our own study was compared with two previous studies [9,10] conducted in the same city, the use of ten plants in treatment was determined. These planst are: *Achillea biebersteinii* Afan., *Cichorium intybus* L., *C. oblonga*, *Gundelia tournefortii* L., *Malva neglecta*., *M. sylvestris*, *Peganum harmala*, *Teucrium polium* L., *Tribulus terrestris* L., and *Vitis vinifera*. It has been determined that the uses of *C. intybus*, *M. neglecta*, *T. polium*, *T. terrestris*, and *V. vinifera* in the treatment of these plants are the same.

According to our results, *Malva neglecta* (51 URs), *T. polium* (29 URs), *R. canina* (28 URs), *Euphorbia macroclada* Boiss. (27 URs), and *C. oblonga* (25 URs) were the most cited plant species for medicinal uses. The highest number of use reports (123) were for skin disorders, followed by respiratory (95) and gastrointestinal (70) ailments (Figure 2).

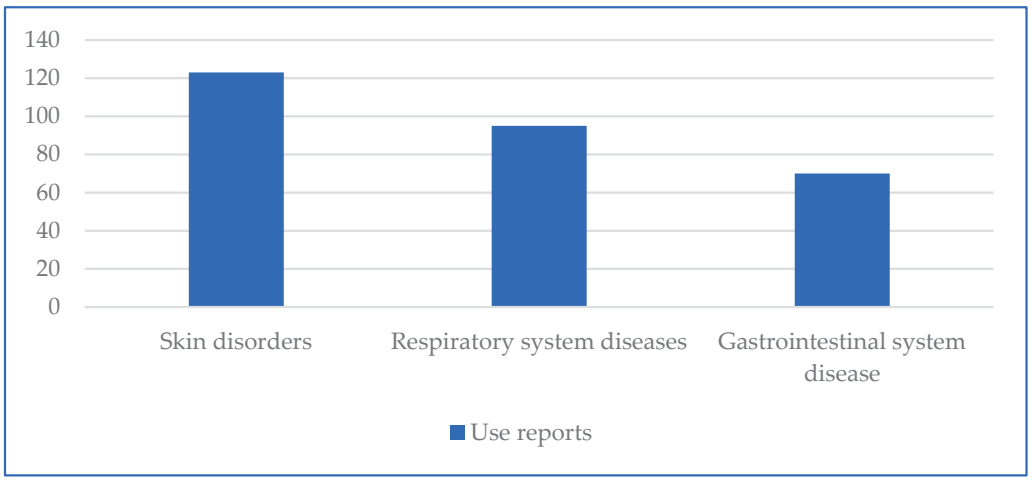


Figure 2. Number of use reports for each ailments category.

To the best of our knowledge, *Malva neglecta* and *Rosa canina* L. were found to be the most commonly used herbal medicinal plants and were recorded at ten localities in Kırşehir and its environs in accordance with previous studies [9,10,12–25], as shown in Table 1. *M. neglecta* is used in the treatment of wounds, hemorrhoids, gynecological diseases, and abdominal pain, and *R. canina* is used for cold, cough, and diabetes in our research area and the Central Anatolia region.

Analysis of the most often utilized plants in the area showed that similar plants are employed for the same purposes in neighboring provinces and European countries [9,10,12–45].

A poultice of *M. neglecta* and bulgur is used for abdominal pain. A poultice of *M. neglecta* is also used to treat wounds. These two usages are similarly employed in surrounding places [17,20]. *M. neglecta* is also used in the Balkans and Europe to treat coughs and bronchitis [26]. Similarly, *Malva sylvestris* is commonly utilized in medical treatment [3–26,33,34].

A poultice of the leaves of *M. sylvestris* is used to treat wounds. The leaves of *M. sylvestris* have been documented to possess strong anti-inflammatory, antioxidant, anti-complementary, anti-carcinogenic, and skin tissue integrity properties. Furthermore, a recent study has confirmed the anti-ulcerogenic property of the aqueous extract. It was found to be more efficacious than cimetidine, a strong medication prescribed to treat gastric ulcers [34].

Teucrium polium is widely utilized in the region, particularly as an appetite stimulant, and its use has been documented in nearby towns [9,12,15,20]. *T. polium*, a wild flowering perennial widely distributed in North Africa, Europe, and South-Western Asia, is used to treat various disorders. In Iran, it is used for inflammation, gastrointestinal disorders, rheumatism, and diabetes [35]. In Jordan, it is used for diabetes, rheumatism, kidney stones, and fever [36]. In Mediterranean countries, it is used for several disorders. It is used for gastrointestinal disorders in Bosnia and Herzegovina [35–39] and as an anti-icteric, anthelmintic, and tonic in Spain [39]. *T. polium* contains various classes of compounds, i.e., monoterpenes, diterpenes, fatty acid esters, sesquiterpenes, polyphenolics, and flavonoids. It has been reported that these compounds have anti-proliferative, anti-diabetic, anticarcinogenic, and pro-apoptotic properties [40].

Rosa canina fruit infusion is widely utilized in the region and other provinces to treat colds [13,14,17,19,23,24]. Reports indicate that it has been used to treat colds in other countries [5,6,28–30,42], as *R. canina* has antioxidant and anti-inflammatory properties [39].

Cydonia oblonga is commonly ingested as a decoction to help relieve shortness of breath and cold. These applications are similar to therapeutic applications in neighboring areas and other countries [5,6,14,19,24,42,43]. There is scientific evidence that quince possesses antimicrobial properties that specifically target gram-positive bacterial infections [44].

The latex of the *Euphorbia* plant is often used, locally and in the surrounding areas [15,23], to treat skin diseases. Its biological properties and pharmacological functions include antibacterial, antioxidant, free radical scavenger, cytotoxic, tumor, anti-inflammatory, healing, hemostatic, anti-angiogenic, insecticidal, genotoxic, and mutagenic [45].

2.2. Edible Plants

We documented 566 use reports detailing the application of 45 taxa for culinary purposes (Table 1).

The plant taxa most frequently indicated for food were *Vitis vinifera* (56 URs), *Polygonum cognatum* Meissn. (38 URs), *Malva sylvestris* (32 URs), and *M. neglecta* (28 URs).

Vitis vinifera is widely cultivated in numerous locales in the area, and molasses is produced from its fruit. This molasses is frequently utilized in the preparation of sweets (Figure 3).

Polygonum cognatum, an extensively distributed species, is a popular wild plant known for its nutritional value. Once food is prepared, inhabitants gather and dry it throughout the spring and then consume it during the winter. Several participants go so far as to collect the plant when it is still fresh and store it in a deep freezer (Figure 4). It has been determined that this plant, prevalent in the inland regions of Türkiye, is consumed in similar ways in the neighboring areas [9,10,13,16,18,20,22].

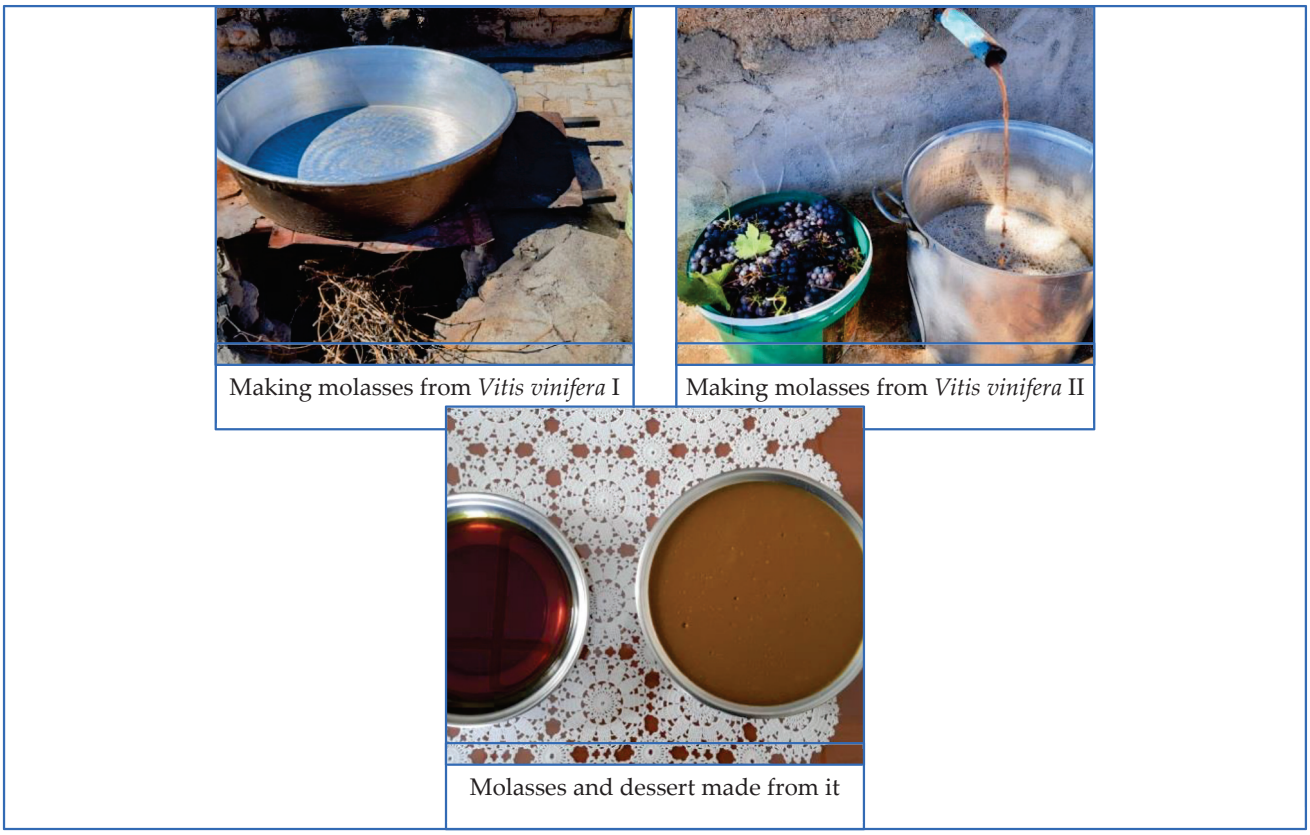


Figure 3. Dessert and molasses made from *Vitis vinifera* (İ. Yılmaz, 2021).

Figure 4. *Polygonum cognatum* and a dish made from this plant (İ. Yılmaz, 2021).

Malva neglecta and *M. sylvestris*, frequently utilized in local remedies, were discovered to be consumed cooked, raw as dolma, and as snacks (for children). Both plants have been identified as wild food plants in surrounding regions and in Europe [5,9,12,16,18,20,22,44–50].

Plants that lack therapeutic properties but are commonly ingested as infusions, such as recreational tea, are also taken into account in this context (Table 1).

It was learned from interviewees that the endemic *P. cognatum, Centaurea urvillei* DC., and *Papaver pilosum* Sibth. et Sm. plants are used as wild food sources (Table 1).

It was determined that the majority of the plants used in this region are both raw and cooked. It was ascertained that they are ingested in the form of spices, baked products (borek), coffee, and jam.

2.3. Other Plant Usages

Upon examining the various uses of plants indicated by the informants, it becomes apparent that some roles are prominent: dyes, brooms, amulets, musical instruments, sticks, fodder, and fuel. There were a total of 248 URs (Table 1).

One of the main applications of *Peganum harmala* (66 URs), which is abundant in the area, is as an amulet. Local residents place this plant both inside and outside of their houses, in their barns and in their gardens or fields when planting new crops. The use of this element, which is the Irano-Turanian element, as an amulet or as incense is also recorded elsewhere [10,12,51,52] (Figure 5).

Figure 5. *Peganum harmala* used as amulet (İ. Yılmaz, 2021, O. Tugay, 2022).

A crucial aspect is that the plant is situated in a conspicuous location. In addition, local people believe that this plant will help them find solutions to their problems with this plant. This belief is expressed in a poem:

"Üzerlik yüzbin ellik
Başında yeşil terlik
Göz edenlerin gözü çıksın
Atmış, yetmiş dağlara çıkmış gitmiş
Üzerliksin, üzerliksin cefasın
Her dertlere devasın
Karga gelsin, kavursun
Bütün dertlerimiz savrulsun"
"Harmal seed, a hundred thousand hands
Green cap is on his head.
The one with the evil eye, may his eye fall out
Sixty, seventy went to the climb the mountain
You are the harmal seed, you are the harmal seed, you are the pain
You heal all the troubles
Let the crow come, let the crow blight all the troubles
And all the troubles are blown away"

Elaeagnus angustifolia is another plant commonly used as an amulet (18 URs). Charms crafted from the branches of this plant are utilized in the region to ward off the evil eye.

The leaves and outer covering of the *Juglans regia* L. (40 URs) plant are utilized as a coloring agent.

The production of brooms from the aerial parts of the *Xeranthemum annuum* L. plant is noteworthy in the area (13 URs) (Figure 6).

Figure 6. Broom made from *Xeranthemum annuum* (G. Emre, 2022).

An interview with a family of musicians in Sarıuşağı Village revealed that they utilized some plants to make musical instruments. These plants are *J. regia*, *Lagenaria siceraria* (Mol.) Standl., and *Morus alba* L. The instrument crafted from *L. siceraria* is commonly referred to as a 'kabak keman' (gourd violin). *L. siceraria* is also utilized as an ornamental plant in the region (Figure 7).

Figure 7. Musical instrument and ornament made from *Lagenaria siceraria* (İ. Yılmaz, 2022).

2.4. Plant Names

The survey also inquired about the local names of therapeutic plants. The adoption of the same vernacular name for multiple plant species in a given location might lead to confusion. Documented instances of multiple namings are provided in Table 2. Since some of the

people we interviewed remembered the Kurdish names of some plants, we recorded these names. These are: *Crocus chrysanthus* (Herbert) Herbert -Bivangk, Bivongk, *Descurainia sophia* (L.) Webb ex Prantl-Şıjıng, *E. angustifolia*- Dara bi, *E. macroclada*-Xaşule, *Gundelia tournefortii*-Gareng, *M. neglecta*-Toluk, *Mentha longifolia* (L.) Hudson subsp. *typhoides* (Briq.) Harley-*M.* x *piperita* L. Pung, Pungha and, *Rumex cristatus* DC.-Sımask. In the course of our research, we discovered plants that serve no purpose other than being referred to by their local name. These are the following *Delphinium ajacis* L. (MARE 22814)-Keloğlan, Mor menekşe, *Reseda lutea* L. (MARE 22809)-Eşek turpu, and *Phlomis armeniaca* Willd. (MARE 22740)-Susam otu.

Table 2. List of same vernacular plant names used for multiple taxa.

Local Name	Botanical Names, Family and Specimen Numbers			
Sıçan otu	*Achillea arabica*	*Achillea wilhelmsii*		
Papatya	*Matricaria chamomilla* var. *recutita*	*Tripleurospermum parviflorum*		
Pung	*Mentha longifolia* subsp. *typhoides* var. *typhoides*	*Mentha* x *piperita*		
Gelincik	*Glaucium grandiflorum*	*Papaver argemone*	*Papaver pilosum*	*Papaver rhoeas*
Kırksinir	*Plantago lagopus*	*Plantago major* subsp. *intermedia*		
Ahlat, Çördük	*Pyrus elaeagnifolia* subsp. *elaeagnifolia*	*Pyrus elaeagnifolia* subsp. *kotschyana*		
Ekşimen, Kuzukulağı	*Rumex cristatus*	*Rumex tuberosus*		
Kekik	*Thymus longicaulis* subsp. *longicaulis*	*Thymus sipyleus*		

2.5. Animal Usages

There is recorded information regarding the utilization of animal-derived products for several purposes throughout the region. Among these purposes, the quantity of therapeutic applications is particularly notable. Tuberculosis is the most common disease for these applications. As an instance, patients consumed cooked hedgehog and puppy meat, as well as donkey milk and turtle blood. Hedgehog meat is also utilized to treat hemorrhoids and rheumatism, and as an analgesic. Donkey blood is administered internally to treat eczema. Cooked turtle meat is consumed as food and is also utilized to treat warts. Rabbit fat applied to the ear is used to alleviate earaches. Prepared beef tongue is used to treat youngsters with delayed speech development. There are further data regarding the utilization of animal-derived resources for many other purposes in the area. Boiled turkey excrement is used in a poultice to alleviate irritated wounds. Buffalo horns are commonly used as containers to store oil. Catfish skin is used to make the body of the 'kabak keman' by cutting the *L. siceraria* fruit lengthwise, emptying it and drying it, and then stretching it. Horsehair is used in the production of traps and violin bows.

3. Materials and Methods

3.1. Study Area

Kırşehir is a province in Central Anatolia, located at a latitude of 39°19′ N and a longitude of 34°8′ E, covering an area of 6584 km^2. Its elevation is 985 m a.s.l. It borders Nevşehir to the east and southeast, Aksaray to the south, Kırıkkale to the west, Ankara to the southeast, and Yozgat to the north and northeast. It has a total of seven districts and 252 villages. These districts are Akçakent, Akpınar, Boztepe, Çiçekdağı, Kaman, Center, and Mucur (Figure 8).

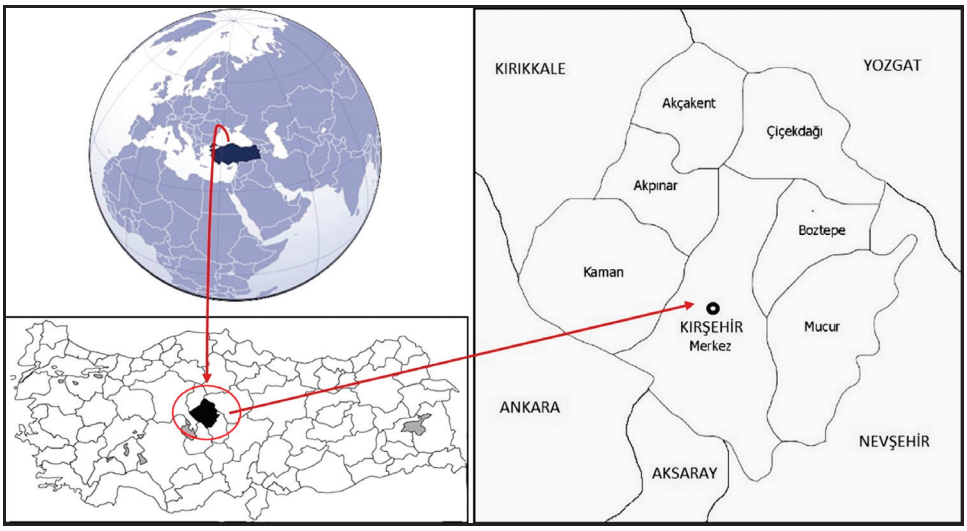


Figure 8. Map of Kırşehir.

The Kırşehir Massif, also referred to as a plateau, is surrounded by mountain ranges. Lake Seyfe is located on this plateau. The province is 65% plateaus, 17% mountains, and 18% plains (Figure 9).

General view of Kırşehir

A view of Seyfe Lake

A view of Çiçekdağı and its surrondings

A general view of Körpınar

Figure 9. General views of Kırşehir and its surroundings (İ. Yılmaz, 2021).

The Kızılırmak, Delice, Kılıçözü, and Kaman rivers, as well as the Seyfe, Kesikköprü, and Çuğun reservoirs, are significant water sources in the region. The Central Anatolian region of Kırşehir experiences a typical continental climate. Winters exhibit low temperatures and frequent rainfall, while summers exhibit high temperatures and aridity. The mean annual precipitation is 383.3 mm [53].

Kırşehir has the effect of the Iran-Turan Flora region and is dominated by plant elements belonging to annual or perennial herbaceous steppe vegetation. Steppe areas have been formed due to the use of trees in some forests as fuel by humans. Most species of the Asteraceae, Fabaceae, Lamiaceae, and Poaceae families are found in steppe areas. The most common genera in steppe areas are the thorny *Astragalus* L. and *Eryngium* L. Kırşehir also has forest vegetation, to a lesser extent. Although *Quercus* L. trees are naturally

distributed in forest vegetation areas, *Pinus* L. and *Cedrus* Trew trees have been grown as plantations. In addition, species belonging to the genus *Salix* L., *Populus* L. and *Tamarix* L. are distributed along the streams [54–56].

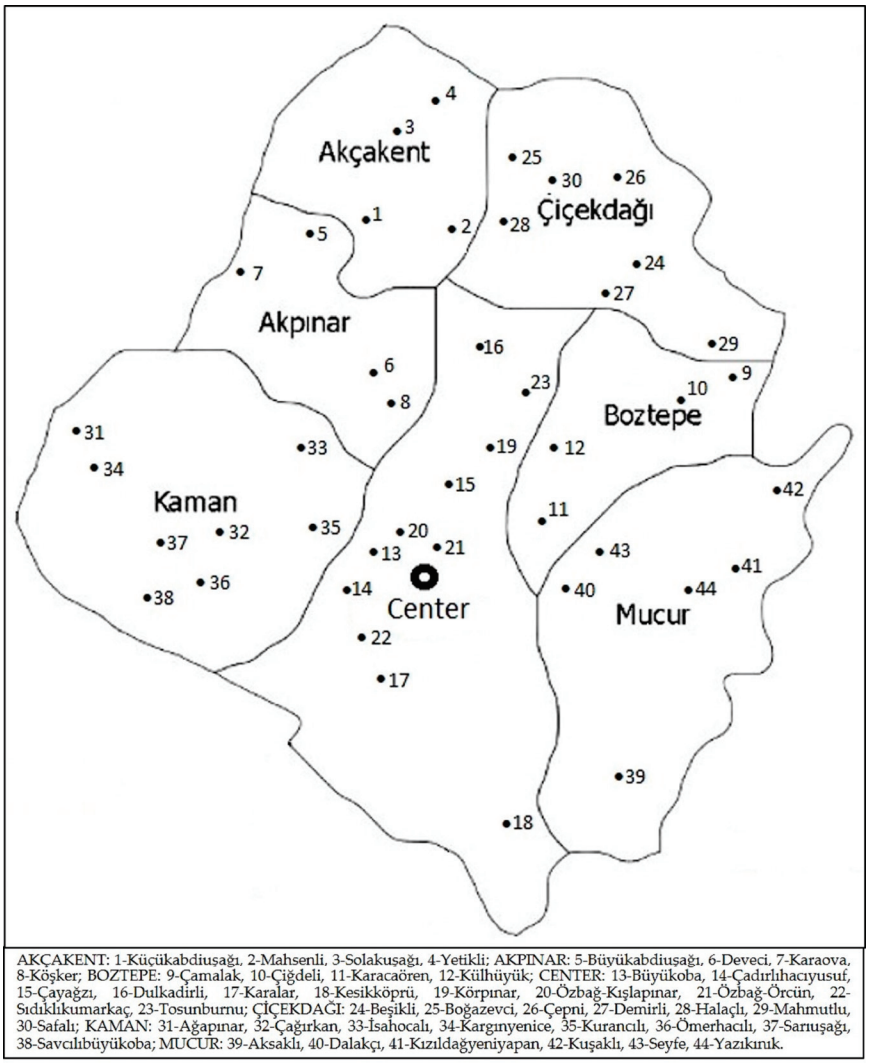
Some plants in Kırşehir are endemic to Türkiye, e.g., *Achillea lycaonica* Boiss. et Heldr., *Astragalus densifolius* Lam., *Astragalus condensatus* Ledeb., *Centaurea kotschyi* (Boiss. et Heldr.) Hayek var. *kotschyi*, *Cousinia halysensis* Hub.-Mor., *Dianthus anatolicus* Boiss., *Eryngium bithynicum* Boiss, *Glaucium grandiflorum* Boiss. et Huet var. *torquatum* Cullen, *Onopordum turcicum* Danin, *Phlomis nissolii* L., and *Salvia virgata* Jacq. (Figures 10 and 11).

Figure 10. *Achillea lycaonica* (O. Tugay, 2021).

Figure 11. *Eryngium bithynicum* (O. Tugay, 2021).

3.2. Field Study

The study was conducted in accordance with the ethical guidelines set forth by the American Anthropological Association Code of Ethics and the International Society of Ethnobiology Code of Ethics [57,58]. Data were mostly gathered utilizing the free listing technique, supplemented by strolls with chosen key informants, from June 2021 to June 2022, predominantly during the spring. The duration of our field trip was 44 days, during which we visited a total of 44 villages (Figure 12). We applied a snowball sampling approach, asking the informants to indicate further people experienced in traditional plant use. All interviews in all settlements were conducted in Turkish.



AKÇAKENT: 1-Küçükabdiuşağı, 2-Mahsenli, 3-Solakuşağı, 4-Yetikli; AKPINAR: 5-Büyükabdiuşağı, 6-Deveci, 7-Karaova, 8-Köşker; BOZTEPE: 9-Çamalak, 10-Çiğdeli, 11-Karacaören, 12-Külhüyük; CENTER: 13-Büyükoba, 14-Çadırlıhacıyusuf, 15-Çayağzı, 16-Dulkadirli, 17-Karalar, 18-Kesikköprü, 19-Körpınar, 20-Özbağ-Kışlapınar, 21-Özbağ-Örcün, 22-Sıdıklıkumarkaç, 23-Tosunburnu; ÇİÇEKDAĞI: 24-Beşikli, 25-Boğazevci, 26-Çepni, 27-Demirli, 28-Halaçlı, 29-Mahmutlu, 30-Safalı; KAMAN: 31-Ağapınar, 32-Çağırkan, 33-İsahocalı, 34-Kargınyenice, 35-Kuranclı, 36-Ömerhacılı, 37-Sarıuşağı, 38-Savcılıbüyükoba; MUCUR: 39-Aksaklı, 40-Dalakçı, 41-Kızıldağyeniyapan, 42-Kuşaklı, 43-Seyfe, 44-Yazıkınık.

Figure 12. Map of villages visited.

The informants had various occupations: farmers, housewives, shepherds, mukhtar (village headmen), and laborers (forestry workers). Interviews were conducted in coffee houses, gardens, houses, fields, etc. The sources of information and data included knowledgeable adults and patients. They provided details such as local names, specific parts of plants utilized, diseases treated, therapeutic effects, methods of preparation, methods of administration, and other plant usages (Appendix A). Throughout this research, with the assistance of our veterinarian colleague, our team also documented certain ancestral knowledge pertaining to animals.

When the villages or localities where fieldwork was conducted were evaluated from a socio-economic perspective, it was observed that agriculture and animal husbandry were important in terms of livelihood. It is possible to make the two following demographic observations about Kırşehir Province. As in Türkiye in general, the population in some villages is elderly. Although the majority of the population are literate, most were not educated beyond primary school. In order to access traditional knowledge, elderly individuals were favored as resource people.

The field study was designed to take into account the ethnic structure of Kırşehir. Of the communities examined in the field study, 28 are Turkmen or Yoruk settlements. Four settlements are predominantly Kurdish, and two of these are inhabited by the Abdal, who are of Çepni Turkish descent. Four settlements are Tatar. Diverse ethnic groups coexist in six settlements.

From a total of 99 people interviewed in the settlements during the field studies, 63 of these people (Table 3) were aged 50–70. It was observed that 25 people were aged 70 and over and constituted the second largest group. The ratio of women to men in this age group was approximately 1:2. As observed during the fieldwork, individuals over age 50 have more traditional knowledge than younger individuals. These people have knowledge of how their elders benefit from plants, even if they do not use them themselves. It is understood from field experience that interest in traditional knowledge has decreased, especially since the 2000s. Macro-level social changes, the rate of urbanization, the increase in transportation facilities, the proliferation of communication channels, and the socialization of medicine can be considered as factors contributing to the decreasing interest in traditional knowledge. However, some of the participants think that the knowledge they learned from past generations is very important now, especially due to recent increased interest in plants.

Table 3. Educational status of participants [W = Women, M = Men].

Age Range						
Education Status	<19–49		50–70		>70	
	W	M	W	M	W	M
Illiterate	0	0	0	0	6	2
Literate	1	0	3	6	4	4
Primary school graduate	1	1	20	19	0	7
Secondary School Graduate	1	1	0	9	0	2
High school graduate	1	2	0	4	0	0
Graduated from a University	1	2	0	2	0	0
	11		63		25	
Total	99					

W = Women, M = Men.

When we look at the gender distribution of the field studies' informants, we see that there are more male (62 males–62.6%) than female participants (37 females–37.4%) (Figure 13).

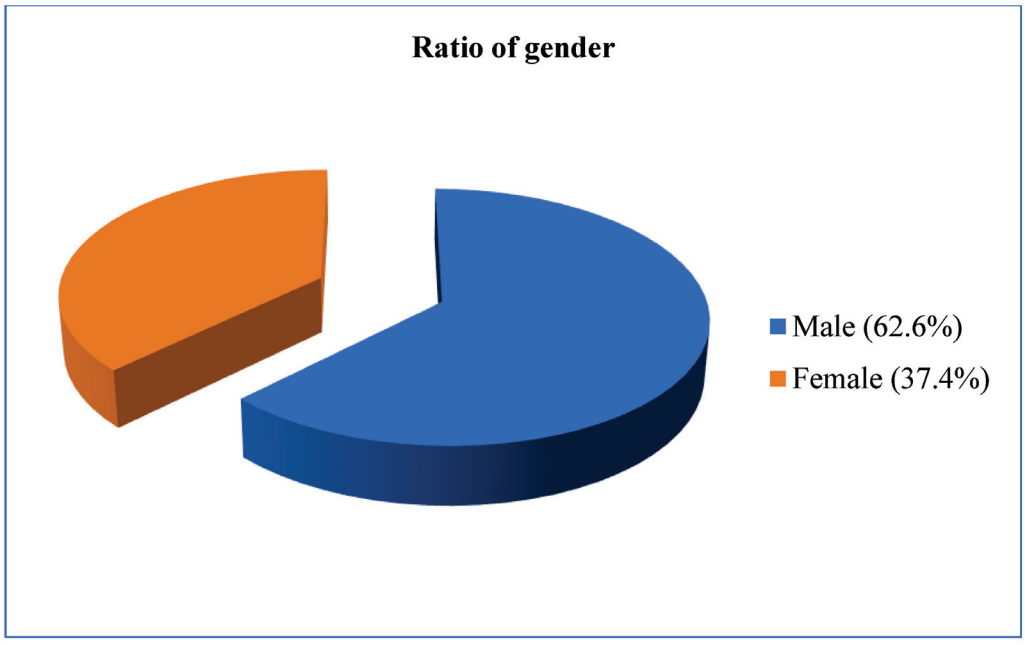


Figure 13. Gender features of informants.

The collected plants were identified by the authors (G.E., I.S.), using *The Flora of Türkiye and the East Aegean Islands* [54–56] and *Illustrated Flora of Türkiye Vol 2* [59]. Voucher specimens were deposited at the Herbarium of the Faculty of Pharmacy, Marmara University (MARE). Taxonomic changes according to Plants of the World Online [60] are shown in parentheses with scientific names in Table 1.

As stated by Heinrich et al. [61,62], our results include only primary data. These data consist of the total number of use reports (URs), which represents the number of individual citations of a plant taxon. We established a database that encompasses the taxon (including family), local name, parts utilized, preparation method, administration technique, documented usage, and overall count of URs. In order to classify the ailments treated with plants mentioned in the interviews, we utilized a symptom-based nosological approach, which is a regularly used method in ethnobotanical research [2].

4. Conclusions

This study presents a thorough examination of ethnobotanical knowledge in Kırşehir, showcasing the wide range of ways in which plant species are used for medicinal, food, and other purposes. The traditional applications of these plants exemplify their deep-rooted cultural legacy and fundamental significance in the lives of the local cultures. The documenting of recent ethnobotanical discoveries enhances our comprehension of traditional plant utilization in this area, underscoring the significance of safeguarding and advocating for this invaluable knowledge for future generations. The information documented in these ethnobotanical studies increases our scientific knowledge and understanding, helps prepare a foundation for the sustained and widespread utilization of beneficial but heretofore overlooked plant species, and identifies plant species which may have the potential—great or small—to improve our nutrition and health care.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Questionnaire Form

1. Name and surname of participant.
2. Age and gender of participant.
3. Telephone and address of participant.
4. Educational level of participant.
5. Date of interview.
6. Participant's place of residence.
7. Duration of the participant's stay at the current residance.
8. Local name of plant.
9. Human health or Animal health.
10. Ailments treated/therapeutic effect.

11. Plant part used.
12. Preparation.
13. Administration.
14. Dosage.
15. Duration of treatment.
16. Age group of patients (baby, child, adult).
17. Side effects.
18. Different ethnobotanical use.

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Ethnobotanical Inventory of Plants Used by Mountainous Rural Communities in NW Portugal

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Abstract: Mountains matter. Rural subsistence communities living in areas with high biodiversity, such as mountains, are hotspots of ecological knowledge. However, modern lifestyles may threaten this unique cultural heritage. Our study aimed to document and analyze information on plants used to fulfill the everyday needs of the people in three rural communities in NW Portugal. Fieldwork was carried out for a period of one year and information was collected through face-to-face semi-structured interviews. A total of 98 species, belonging to 46 families, were identified, and 142 vernacular names were recorded. Ethnobotanical richness was similar among the studied communities. The five most frequently cited species were: *Pterospartum tridentatum*, *Erica arborea*, *Ruta graveolens*, *Zea mays* and *Chamaemelum nobile*. Phanerophytes and hemicryptophytes comprise nearly 81% of the list. The top three uses categories (total 14) were: medicine, fuel and ritual. Digestive, skin and respiratory symptoms were the most often conditions treated with plants. Medicinal plants were used fresh and dried, mostly as infusions. The insights gathered here are important for the preservation of the cultural heritage of the local communities. Moreover, the data are of considerable scientific interest because it provides the fundaments for future studies that aim to validate/invalidate specific uses.

Keywords: Alto Minho; Portugal; NW Iberia Peninsula; local knowledge systems; utilitarian plants; ethnobotany

1. Introduction

Ecological knowledge plays a crucial role in understanding the interactions between humans and the natural world. However, there has been an increasing separation between people and nature [1,2], which, in turn, contributes to the loss of local ecological knowledge. It is acknowledged that modern lifestyle has shaped the degree and depth of knowledge about wildlife. Factors such as the systems of formal education implemented at national levels, migration, land use change and urbanization are associated with the loss of the ability to recognize, name and use biological resources [3–5]. The cumulative body of knowledge, practices and beliefs, evolving by adaptive processes and passed through generations by cultural transmission, is known as local traditional knowledge [6] and includes ecological knowledge. This may include information such as the harvest period of

a particular resource, the best storage methods and harvesting tools, and complex belief systems, all fundamental for people's livelihood and health. The value of local knowledge is internationally recognized as a way of protecting and ensuring the sustainable use of ecosystems and a source of information related to resilience and adaptation to the environment. In 2003, UNESCO deemed local ecological knowledge worthy of protection through the Convention for the Safeguarding of the Intangible Cultural Heritage [7] and further recognized "that respect for Indigenous knowledge, cultures and traditional practices contributes to sustainable and equitable development and proper management of the environment" in the UN Declaration on the Rights of Indigenous Peoples [8].

In recent decades, the ecological knowledge of rural communities has become the object of scientific studies [6,9], with the argument that it is fundamental to ensure sustainable socio-ecological systems in high biodiversity areas [10–12]. This is particularly relevant in mountain socio-ecological systems (MSESs) because the ecosystem services they provide depend largely on land use shaped by the long-term interaction of humans with nature [13]. While MSES are ecological knowledge hotspots due to their high botanical diversity and cultural diversity [14], they are also regarded as highly vulnerable. Mountain rural communities are currently facing unprecedented rates of societal and environmental changes, namely a decline in local knowledge heritage [5,15–17] and the impacts of climate change on biodiversity [18].

In Portugal, MSESs are also iconic and host economic activities relevant at the national and regional levels. Concomitantly, most mountains (18% country's territory) are classified as protected areas (national or international legal protection) for their high biological diversity and because they host unique cultural heritages bound to nature, particularly plants, which have always been a crucial resource. Despite all these, the documentation of local knowledge associated with plants is still scarce. The beginning of the country's systematic ethnobotanical inventories (to address the relationships between humans and plants) in MSESs was sponsored by the national conservation authority (Instituto para Conservação da Natureza—ICN) in the late 1990s. Since then, and despite the increasing interest and efforts towards documentation of plant uses (e.g., Refs. [19–22]), to the best of our knowledge, no study has been devoted to the peculiar socio-ecological systems in NW Portugal, where livelihoods are based on agro-silvo-pastoralism in areas with high biological diversity (e.g., Peneda-Gerês National Park and Natura 2000 Special Area of Conservation Serra d'Arga) at the southern edge of the Atlantic biogeographical region.

To address this knowledge gap, we set out to document and evaluate the diversity of knowledge associated with plants—ethnobotanical inventory—in the rural communities of NW mountains of Portugal, with the rationale of contributing to biocultural heritage preservation in areas relevant to biodiversity conservation. The aims of this study were as follows: (i) to record the ethnobotanical knowledge of the MSES of Alto Minho; (ii) to highlight local plant resources of particular interest for medicinal purposes and (iii) to provide knowledge that can support sustainable economic activities in communities that are currently struggling with depopulation. Systematic ethnobotanical studies are of paramount importance to assess and mitigate the potential loss of valuable local knowledge and practices in areas that are succumbing to rural abandonment, changes in land use and the breakdown in transmission to younger generations.

2. Results

2.1. Diversity of Utilitarian Plants

We interviewed forty-four informants (thirty-eight females and seven males) whose ages ranged from 50 to 94 years, with seventeen from Castro Laboreiro, sixteen from Serra d'Arga and eleven from Soajo. Our study revealed that 106 plant species and two lichens (two genera from two families) had utilitarian purposes. From all botanical references, one citation was for Bryophyta (general designation used) and eight were for Tracheophyta, for which we could not ascertain the species; hence, 98 were plants identified to the species level (Supplementary Materials Table S1).

Across all informants, we collected 641 use reports for the 98 vascular plant species: 257, 189 and 190 reports for Castro Laboreiro, Serra d'Arga and Soajo, respectively. The mean informant report was 14 citations ± 10 (range 1–44). We found no significant effect of locality on the number of citations per species (Kruskal–Wallis Chi-squared = 1.001, df = 2, $p = 0.606$). Twenty-three species were used in the three communities and thirty were shared between pairs (Supplementary Materials Figure S1).

Given the above information, we proceeded with the analyses, lumping the three mountain communities and accounting exclusively for the plants to which species-level identification was unambiguous (97 species).

2.1.1. Use Categories

A total of 14 use categories were defined and the use category with most references ($n = 220$) was human medicine, followed by ritual ($n = 63$) and fuel ($n = 59$) (Figure 1A). In terms of plant species, these correspond to 53, 12 and 13 species, respectively. The category with fewer mentions ($n = 2$) was dye, with two species identified. The five most frequently cited species were *Pterospartum tridentatum* (L.) Willk. (45 use reports), *Erica arborea* L. (27 use reports), *Ruta graveolens* L. (23 use reports), *Zea mays* L. (23 use reports) and *Chamaemelum nobile* L. (20 use reports). *P. tridentatum* was mentioned as medicine and fuel, twenty and six times, respectively. Maize is the most often reported plant within the human food category; yet it was also used for medicinal purposes (five reports). Tree heather (*E. arborea*) was mainly used as fuel either for cooking or house heating, and rue (*R. graveolens*) was used in ritual practices.

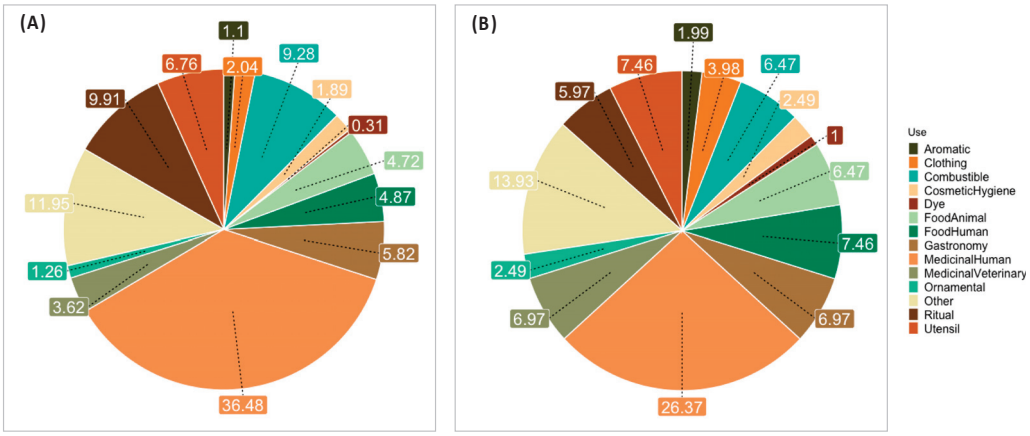

Figure 1. Uses for all plants mentioned and identified to the species level (98 species) as categorized into 14 classes. (**A**) Proportion of reports per category. (**B**) Proportion of species per category. Medicinal purpose was the most frequently cited (36.48%, 232 mentions) and the most species-diverse category (26.37%, 53 species).

2.1.2. Plant Families, Origin and Life Form

We identified 47 families, all vascular plants, and two lichens (Umbilicariaceae and Parmeliaceae). However, discarding the taxa in which a species-level identification could not be achieved, we were left with 46 families of vascular plants (Figure 2A). Lamiaceae was the most frequent with fifteen species, followed by Fabaceae and Ericaceae with nine and eight species, respectively.

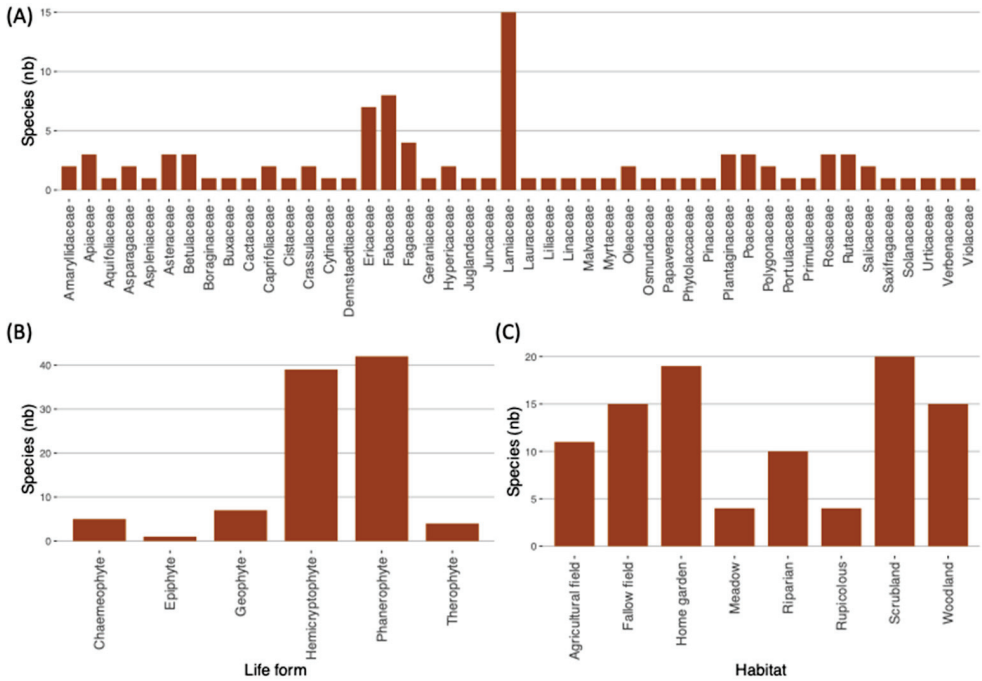

Figure 2. Details about the ethnobotanical resources exploited by three studies communities of NW Portugal: (**A**) plant families, (**B**) life form and (**C**) broad habitat groups where harvested.

According to the species life form (sensu Raunkiær; see Materials and Methods for details), the mentioned vascular plants were as follows: forty-two phanerophytes (trees and shrubs), thirty-nine hemicryptophytes (die back each year), seven geophytes (with underground storage organs), five chamaephytes (small shrubs and herbs), four therophytes (annuals), and one epiphyte (Figure 2B and Table S1). Nearly 70% of the species used were sourced from the wild (Figure 2C): mainly, scrubland (*n* = 20), woodland (*n* = 15) and riparian (*n* = 10). The remaining ethnobotanical resources (30%) were assigned to anthropogenic environments, such as agricultural fields and home gardens (Figure 2C and Supplementary Materials Table S1).

2.1.3. Utilized Parts

We collected information on 16 parts of plants used for different purposes: trunk, stem, leaf, flower, stigma, seed, fruit, peduncle, root, rhizome, tuber, bulb, latex, sap, bark and gall. Shoots, i.e., leaves and stems, were the most frequently mentioned plant part (39%); leaves and flowers accounted for 18% and 8%, respectively. Yet, it was frequent to use stems with leaves and flowers together (2%). The less commonly used parts were peduncle and sap (0.15%; one use report each).

2.2. Quantitative Analysis of Useful Plants: Ethnobotanical Indices

The number of different plant species used by the communities, i.e., ethnobotanical richness (R) was 98. The relative frequency of citation (RFC) of the reported species ranged from 0.02 to 0.55, with *P. tridentatum*, *E. arborea*, *R. graveolens*, *Laurus nobilis* L. and *Secale cereale* L. being the top five taxa with the highest RFC. The cultural importance index ranged from 0.02 to 1.05, and the most culturally significant species were, by descending order, *P. tridentatum*, *S. cereale*, *Zea mays*, *E. arborea* and *R. graveolens*. *P. tridentatum* was mainly used as medicine, but was also mentioned as relevant for fuel, condiment and ornamental. Rye, *Secale cereale*, was grown for human (seed) and animal food (straw) and for thatching roofs (straw). *Erica arborea* was chopped for use as a combustible, animal food and for utensils craft (brooms for cleaning the wood-fired oven used for bread baking). Rue, *Ruta graveolens*, was kept in home gardens for its magical purposes, but there were also mentions of medicinal uses as abortive and painkiller. Laurel, *L. nobilis*, like rue, was used in religious

ceremonies—blessed on Palm Sunday—in addition to its main use as an aromatic and fuel. Regarding the informant consensus factor (ICF), the highest values were recorded for ritual (ICF = 0.82), followed by fuel (ICF = 0.79) and human medicine plants (ICF = 0.77) (Table 1).

Table 1. Informant consensus factor (ICF). The factor was calculated (Nur − Nt)/(Nur − 1). Values range from 0 to 1, and the larger the factor, the better the agreement among informants.

Category	Nur	Nt	ICF
Aromatic	7	4	0.50
Clothing	12	8	0.36
Fuel	59	13	0.79
Cosmetic/Hygiene	12	5	0.64
Dye	2	2	0.00
Food Animal	30	13	0.59
Food Human	31	15	0.53
Gastronomy	37	14	0.64
Medicinal Human	232	52	0.77
Medicinal Veterinary	23	14	0.41
Ornamental	8	5	0.43
Other	76	28	0.64
Ritual	63	12	0.82
Utensil	44	15	0.67

We found a total of 142 vernacular names to designate the 98 species. Nearly 36% of the species had more than one common name, and the phytonym linguistic diversity index was 1.50 (mean number of vernacular names per species). Frequently known in the communities by two names were twenty-two species; thirteen had three local designations and one species had as much as five vernacular names. Overall, the botanical linguistic richness (BLR) was 1.44. The estimation per locality was similar: Castro Laboreiro = 1.20, Serra d'Arga = 1.16 and Soajo = 1.12. BLR values larger than one (1) indicate that taxonomic entities have multiple vernacular designation, which expresses the linguistic richness of the community.

2.3. Local Medicinal Species

This was the largest class of use with sixty-three plants: fifty-three species (thirty-two families) used to treat humans and fourteen for animal afflictions (nine families), with five serving both purposes. Lamiaceae was the family with more species (n = 10) followed by Apiaceae, Asteraceae and Rutaceae (n = 3). Ninety-two percent of the plants used for human medicine purposes are perennials that keep their growth point above the surface of the ground during the unfavorable season (twenty-seven hemicrytophytes, sixteen phanerophytes and five chamaephytes). Commonly used plant parts were aerial parts (shoot and leaves; n = 44), reproductive organs (flowers, stigma, fruit and seed; n = 12) and underground organs (rhizome, bulbs, root, tuber; n = 7). Latex and sap were mentioned for a single species, *Chelidonium majus* L. and *Opuntia ficus-indica* (L.) Mill., respectively. We note that for some species (n = 14), multiple organs were used.

2.3.1. Local Therapeutic Categories

Plants were used to treat human diseases linked to 17 ICPC-2 categories. The three most frequent uses concern the digestive system (n = 26; ICF = 69%), skin (n = 13, ICF = 70%) and respiratory system (n = 12; ICF = 62%) (Figure 3A). Other references included "general unspecified" disorders (six species), meaning the plant was used as a panacea; in addition, informants attributed medicinal interest for four species, yet could not recall the specific

disease treated (labeled as "UNK"; Figure 3A). A remarkably high percentage of plants (74%) were used as multi-contextual remedies for several disorders (2–5 categories); only five species had a single medicinal purpose. The synergistic uses of plants for therapeutic purposes were rarely mentioned. By applying the same ICP2 categories to animal medicine, we found four categories of afflictions for which plants were used: "digestive" was the most mentioned with 11 species indicated; "urological", "musculoskeletal" and "skin" were treated with one species each.

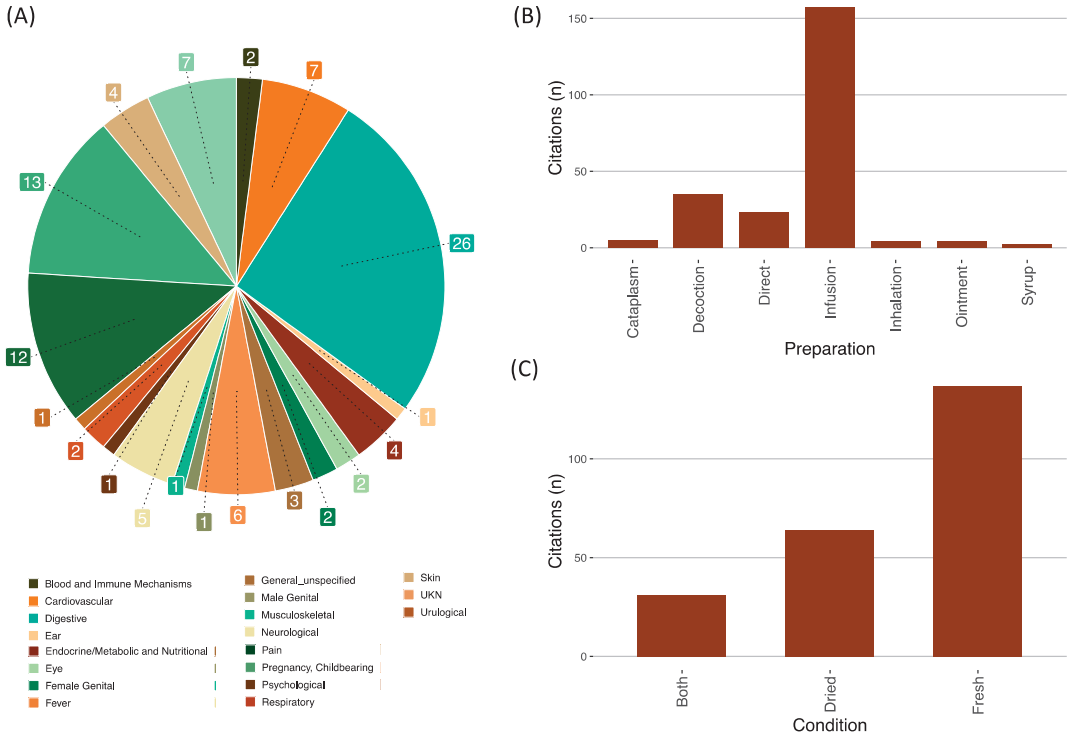

Figure 3. Details about human health afflictions treated with local plants. (**A**) Health disorders reported as categorized according to ICPC2. (**B**) Preparation mode of remedies. (**C**) Plant condition (fresh or dried) when preparing the remedy. General unspecified—all ills; UNK—specific illness unidentified.

2.3.2. Mode of Preparation and Administration in Human Medicine

The methods reported for internal use were infusion, decoction and syrup. The methods documented for external use included decoction (for washes and bath sitz), cataplasm, ointment and squeezing for the direct application of fresh material. Overall, the preferred form of using the species as medication was infusion (157 citations for thirty-three species; Figure 3B), followed by decoction (35 mentions for sixteen species; Figure 3B), and direct use (22 references for four species; Figure 3B). While the decoctions consisted of a heavy extraction in rolling boil water for harder plant parts (rhizome, whole plant), the infusions were used with softer parts (leaves, flowers, stigma) left to steep in very hot (not boiling) water. There were also reported instances of inhalations (respiratory; *Eucalyptus globus* Labill. and *Allium cepa* L.), cataplasms (e.g., *Plantago major* L.) and ointments (e.g., *Umbilicus rupestris* Salisb.), both applied for skin problems. Several species were used in different preparations; four species had three different modes of preparing the medicine pending the disease to be treated. The plants with medicinal purposes were harvested for immediate use (fresh; 27 species with 128 citations; Figure 3C), solely dried for preservation to use later (10 species mentioned 72 times; Figure 3C) or used in both conditions (32 references for 16 species; Figure 3C); for instance, *C. nobile*, *P. tridentatum*, *Plantago coronopus* L. and *Sambucus nigra* L. were used either fresh or dried; *A. cepa*, *E.*

globulus and *U. rupestris* were used exclusively fresh; and *Hypericum androsaemum* L., *Hypericum perforatum* L. and *Calluna vulgaris* (L.) Hull were dried for later use.

2.4. Association of Use Values (Ethnobotanical Indices) with Plant's Ecological Features

Our results show that the number of uses, citation frequency, cultural importance, or number of vernacular names is not determined by plant origin, life form, or habitat of harvesting (Table 2). The same results held for the number of medicinal uses (MU) (Table 2). Overall, this suggests the studied communities harvest ethnobotanical resources regardless of the life forms and exploit all types of habitats.

Table 2. Summary of the Chi-squared tests (χ^2) of independence for number of uses (NU), relative frequency of citation (RFC), cultural importance (CI), number of vernacular names (VN) and number of medicinal uses (MU). Dependent and explanatory variables are numeric and categorial, respectively.

	NU	**RFCs**	**CI**	**VN**	**MU**
Origin (2 categories)	$\chi^2 = 5.79$ $p = 0.93$ $V_{Cramer} = 0.00$	$\chi^2 = 32.59$ $p = 0.44$ $VC_{ramer} = 0.04$	$\chi^2 = 44.14$ $p = 0.38$ $VC_{ramer} = 0.09$	$\chi^2 = 7.31$ $p = 0.29$ $V_{Cramer} = 0.08$	$\chi^2 = 13.61$ $p = 0.19$ $V_{Cramer} = 0.18$
Life form (6 categories)	$\chi^2 = 25.28$ $p = 0.71$ $V_{Cramer} = 0.00$	$\chi^2 = 83.22$ $p = 0.38$ $V_{Cramer} = 0.07$	$\chi^2 = 117.24$ $p = 0.20$ $V_{Cramer} = 0.15$	$\chi^2 = 8.97$ $p = 0.88$ $V_{Cramer} = 0.00$	$\chi^2 = 13.10$ $p = 0.87$ $V_{Cramer} = 0.00$
Habitat (8 categories)	$\chi^2 = 36.38$ $p = 0.72$ $V_{Cramer} = 0.00$	$\chi^2 = 110.58$ $p = 0.52$ $V_{Cramer} = 0.00$	$\chi^2 = 139.60$ $p = 0.66$ $V_{Cramer} = 0.00$	$\chi^2 = 27.71$ $p = 0.15$ $V_{Cramer} = 0.15$	$\chi^2 = 22.73$ $p = 0.83$ $V_{Cramer} = 0.00$

V_{Cramer} [0.10–0.20] indicates a weak association.

3. Discussion

Integrative research exploring the relationship between biological and cultural diversity can provide solid ground for developing conservation strategies for biocultural diversity. Our study reveals, for the first time, the many fascinating uses of plants in MSES of NW Portugal. Ethnobotanical resources were multifunctional, i.e., the same species with different purposes and distinct parts of the plant with different uses, which support the idea of a large biocultural diversity. In the absence of any major geographical barrier separating plant assemblages, the ethnobotanical heritage is transmitted between similar MSES, as indicated by the lack of difference in ethnobotanical richness across the studied geographical territories. The shared species utilitarian species (24 species) and the consistency in the cultural dominance of some species—*P. tridentatum*, *Z. mays*, *E. arborea* and *R. graveolens*—also denotes territorial continuity.

As expected, medicinal use was the most often cited category. However, we did not anticipate the relevance of plants for fuel, less so its strong cultural role for ritualistic and superstitious purposes (Figure 1A,B). The high frequency of citation and the high consensus among informants regarding plant species used for medicine, fuel and rituals indicate that knowledge about these botanical resources, with (i) medicinal proprieties relevant for treating common human health symptoms, (ii) best combustible proprieties for cooking and warming, and (iii) attributed religiousness and magic power, are crucial for the livelihoods in these MSESs.

With this study, we aspire to help preserve local knowledge in its entirety. As such, our approach was based on curiosity rather than judgment, which led us to inquire about rituals (religious, magic, or superstitions). We discovered that a relevant portion of plants (10% of use reports, 6% of species) was used for religious and magical/sorcery purposes, with the most cited species being *Ruta graveolens*. The use of rue as a human and animal protector against misfortune and "evil eye" is still a current practice in the studied communities and is kept handy at home gardens, along with *Salvia rosmarinus* Spenn. and *Salvia officinalis* L. The ritualistic use of plants for religious or pagan ceremonies/beliefs is an important

body of knowledge that should not be overlooked in studies aimed at the protection of biocultural heritage.

3.1. Biocultural Heritage—Biodiversity and Cultural Preservation

It is of utmost importance, and a worldwide quest, to document biocultural diversity before its extinction [23]. An essential portion of the biocultural heritage is the knowledge and practices associated with the use of wild plant species for various purposes. At the brink of a biological and cultural diversity crisis, ethnobotany is a topic of increasing interest Refs. [9,24]. Ethnobotany can simultaneously support the preservation of biocultural heritage and shrinking rural communities and contribute to biodiversity conservation in SCI-Rede Natura 2000 areas by supporting policies to protect plants (e.g., Refs. [25,26]) and the local knowledge inheriting/transmission system (e.g., Ref. [27]). In rural subsistence communities, local knowledge is pivotal for supporting the ecosystems' regenerative capacity, which in turn provides a variety of services, including fuel, medicine and food. The prevalence of wild phanerophytes (trees and shrubs; 43%) and hemicryptophytes (perennials; 38%) as utilitarian plants translates the ecological knowledge about the ability of these life forms to cope with the harsh climatic conditions of higher elevations with increasing precipitation and decreasing temperature. The local reliance on predictable resources, for fulfilling the everyday needs regarding cultural and practical purposes, is consistent with altitudinal gradients in Southern Europe, where phanerophytes outcompete other plant life forms under mild conditions of intermediate elevations, causing hemicryptophytes to assume the dominant role in higher elevations [28–30]. With nearly 70% of the botanical resources collected in the wild and many (35 species) harvested in woodlands (oak and riparian forests), the impacts of global change on ethnobotanical diversity in mountain regions of NW Iberia should be a concern. These territories are also vulnerable to climate change, which may affect plant metabolomes and increase the risk of species extinction [31], and ultimately impact local ethnobotanical richness.

3.2. Ethnomedicine in Southern European Countries

In the Iberian and Italian peninsulas, the main focus of ethnobotany has been traditional medicine (e.g., Portugal [19–21,32]; Spain [33–36] and Italy [15,16]. Therefore, we here place our results in the perspective of other studies developed in Southern European countries. Ethnomedicine richness in the studied communities (53 species) was smaller in comparison to other Portuguese rural mountain communities: NE (88 species [20]), central (124 [32]), SW (105 [21]) and SE (150 [19]). Despite the lower richness, there was a good consensus regarding the use of medicinal plants (ICF = 0.78) when compared to ICF in other published studies in the Iberian Peninsula: Portugal (0.90 [21]; 0.85 [19]; 0.48 [20]), Spain (0.65 [34]; 0.71 [37]; 0.86 [36]). The plants used to treat stomach- and skin-related ailments had the highest agreement among the participants (ICF ~ 70%), indicating that these plants are well known in the community and further suggest their possible efficacy for these specific uses. The most frequently treated human health symptoms coincide with results obtained in works carried out in Iberia [19,21,35,38,39]. Likewise, in NW Portugal, plants in families Lamiaceae and Asteracea were the most employed to treat human afflictions. Our results provide basic and important data for further research aimed at pharmacological studies, and, especially, the ICF estimates can be useful for prioritizing plants for further pharmacological studies [40]. In fact, we are already exploring some of the plants documented.

3.3. Study Caveats

The current socio-demographic context of the communities (shrinking and aging) posed some challenges: the engagement of the informants in the sample is biased towards elders. Regarding this skew, the elderly population is expected to be the custodians of traditional knowledge, so the a priori bias towards elders was inescapable. However, to overcome that, we interviewed locals with <65 years (30% of informants). Pertaining

the engagement, despite our effort to build a relationship of trust with constant visits to the community, some people were still very reluctant to spend time sharing information with us—allegedly busy with their affairs. We also suspect, from our conversations with people, that the ridicule of local knowledge has played a role in refraining some people from even discussing it. Our study was based on all plants reported, including the species only reported by one or two independent informants. In general, uses cited by least three independent informants is the threshold applied (e.g., Refs. [21,32,35]) to ensure reliability for future pharmacological prospects. Because we set out to document and analyze local knowledge and practices, we decided to report single and dual reports, as these may demonstrate the process of knowledge erosion.

3.4. Halting Local Knowledge Erosion

Several lines of evidence point to the idea of local knowledge erosion: the relatively low number of utilitarian species documented (n = 98 species), the ethnobotanical multifunctionality reported but mostly no longer in practice, the linguistic richness relatively lower (1.50) to other mountainous localities in the Iberian Peninsula (2.90 in Serra de Montejunto [21]; 1.72 in Serra de Montesinho [21,38]; 1.94 in l'Alt Empordà [33]) and the depopulation and aging of the MSES located at the southern edge of the Atlantic bioregion. Although we have no quantitative assessment of the loss, due to the lack of previous studies, to perform an explicit comparative analysis, all these elements, together with informant comments such as "you are 20 years late. . . the wisdom and actual users are already gone", suggests that the wealth of local knowledge and practices failed to be transmitted over the last generations. The key to halting erosion will be to build awareness, especially among the younger generations, of the importance of this intangible cultural heritage and its safeguarding. There is a need to communicate results from studies like this. Besides the evident relevance of ethnomedicine through the search for phytochemicals with therapeutic proprieties, local knowledge and practices associated with botanical resources can be a source of information for (i) policy stakeholders to implement strategies for preservation of precious local knowledge that risks being lost due to modern standards, (ii) conservation authorities to ensure the sustainable use plant resources, (iii) other scientific endeavors and (iv) the economic sector to develop activities (gastronomy, eco-tourism) that can sustain local communities. Ultimately, this can revitalize the human–nature nexus and help preserve the local biocultural heritage in Alto Minho.

4. Materials and Methods

4.1. Characterization of the Study Area and Communities

Our study was conducted in three rural communities located in the mountains of Alto Minho region, NW Portugal (Castro Laboreiro, Serra d'Arga and Soajo; Figure 4). Alto Minho region hosts an incredibly rich cultural, linguistic and biological diversity; nearly 40% of this territory belongs to the Natura 2000 Network and the National Network of Protected Areas (RNAP). The study communities were selected according to four major criteria: (i) rural communities highly dependent on biological resources, i.e., socio-ecological systems, (ii) embedded in areas relevant for biological conservation, such as Special Areas of Conservation (SAC) in Natura 2000 network, with a wide topographical range which increases habitat diversity and hence plant richness (Table 3); (iii) peripheral territories, where the lack of opportunities and resources may facilitate the possibility of harboring deep-rooted customs and local peculiarities lessening the impacts of globalization; and (iv) strong demographic regression with high aging index, where, in the last decade, communities lost > 20% of the population and there are 10 times more elders than young people, contributing to a high risk of transmission break (Table 3).

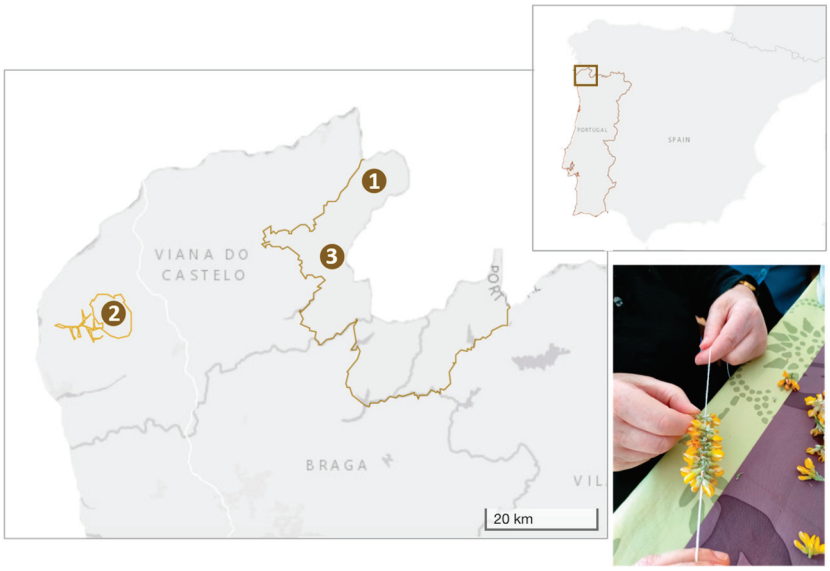

Figure 4. Geographic location of the three studied communities in NW Portugal: 1. Castro Laboreiro, 2. Serra d'Arga, 3. Soajo. Inset shows placement in the Iberian Peninsula. Photography of one informant teaching us how to use *Pterospartum tridentatum* flowers to make adornments.

Table 3. Relevant ecological and social features: conservation, plant biodiversity, altitude and demographic trends in the studied communities.

	Castro Laboreiro	Serra d'Arga	Soajo
Conservation interest	SAC—PTCON0001 Peneda-Gerês National Park Gerês-Xurés Biosphere Reserve	SAC—PTCON0039	SAC—PTCON0001 Peneda-Gerês National Park Gerês-Xurés Biosphere Reserve
Vascular flora (nb species)	817	546	817
Topographical range (m)	600–1300	250–800	200–1400
Demographic trend 2011–2021 § (%)	−23.4%	−23%	−32%
Aging Index ¥	2079	1800	989

estimation for the Peneda-Gerês National Park; § INE—statistics Portugal, CENSOS 2021; ¥ AI = (n ind. ≥ 65 yo/ n ind. (0–14 yo) × 100).

4.2. Data Collection—Ethnobotanical Survey

We interviewed locals, both natural residents or long-time members of the community, by applying a snowball sampling approach, i.e., asking the informants to suggest further people with experience in traditional plant use [41]. Interviews were conducted between June 2022 and July 2023 using both semi-structured methods. Semi-structured interviews involved open-ended questions prepared in advance, allowing the interviewee to provide spontaneous and detailed responses. The questionnaire consisted of two parts: the first centered on the socio-demographic characteristics of the participant (age, educational level, profession/occupation and place of residence), and the second focused on the plant species used by the local community. For this second part, we collected vernacular names, folk uses, plant parts used (e.g., root, shoot, leaves, flowers), plant condition when used (fresh, dried, both), time of collection (month/season) and habitat of harvest (8 categories). When reported for medicinal purposes, the informants were also asked to identify the diseases the plant treated, the remedy preparation (e.g., infusion, decoction, cataplasm) and application method (e.g., internal, external).

Due to the socio-demographic context of the communities most informants were elderly and many with mobility limitations for outings in the field to identify plants. To circumvent this issue, we adapted our approach and opted for a visual identification either

of plants collected by us in the field or through photographs in guides and databases, namely Flora-on (https://flora-on.pt/ accessed 2022–2023) from the Portuguese Botanical Society. In cases of ambiguity (several), we discarded the reference.

Data were recorded using two methods: on paper and audio recordings, mostly simultaneously. All information was registered, transcribed and introduced into a database. As a general procedure in ethnobotanical surveys, the information was organized in use reports and use categories (Table 4): human medicinal, veterinary medicinal, human food, animal food, rituals, cosmetics/hygiene, utensils, ornamental, gastronomy, aromatic, fuel, dyes, clothing, and others (for uses that did not fit into any of the previous). For medicinal uses, we categorized the diseases treated with medicinal plants according to the International Classification of Primary Care (ICPC) 2nd edition, which is accepted by the United Nations' World Health Organization (WHO). The ICPC2 categories are as follows: blood, blood-forming organs and immune mechanisms; digestive; eye; ear; cardiovascular; musculoskeletal; neurological; psychological; respiratory; skin; endocrine/metabolic and nutritional; urological; pregnancy, childbearing, family planning; female genital; and male genital. When multiple and unspecified diseases were mentioned, we grouped those into "global unspecified". In a few cases, the informant knew that the plant had medicinal uses, yet could not recall which, hence we created the category "unknown".

Table 4. Use categories (14) considered in this study when collecting field data.

Use Category	Description
Human Medicinal	medicinal proprieties for humans
Veterinary Medicinal	medicinal proprieties for livestock
Human Food	direct human consumption
Animal Food	livestock feeding
Rituals	religious ceremonies and magical purposes
Gastronomy	transformed by cultural practices for human consumption
Cosmetics/Hygiene	body care and beauty products
Utensils	manufacture household and agricultural utensils
Ornamental	adornment of objects, houses and patio
Aromatic	food flavoring and condiment
Fuel	heating, cooking and smoking/curing food
Dyes	textile coloring
Clothing	manufacture of clothes
Others	purposes not fitting any of other use category

4.3. Botanical Identification, Ecology and Conservation Status

Plant nomenclature followed the Flora Iberica [42], Nova Flora de Portugal [43]. Voucher specimens were prepared and deposited at the Herbarium of the Natural History and Science Museum of the University of Porto (PO; Portugal; numbers PO-V72999 to PO-V73023; Supplementary Materials Table S1) and scientific names and families were verified. We categorized the mentioned plants according to life form sensu Raunkiær (1934), which classifies plants according to the place where the growth point is located during the less favorable season: phanerophyte (growth point projects into the air, e.g., trees and bushes), chamaephyte (growth point at or near the soil surface; many perennial herbaceous plants), hemicryptophyte (growth point at the ground level protected by withered leaves and soil), geophytes (growth point below ground level; tuber, rhizome, bulbs), therophyte (survive unfavorable period as seeds) and epiphyte (grow on or is attached to other living

plants). In addition, we also collected information regarding its origin (native vs. exotic) and the conservation status in Portugal according to the current Red List [44].

4.4. Quantitative Ethnobotanical Indexes

To summarize the ethnobotanical information collected and later compare it with similar studies, we estimated the indices described below. But first, we converted the data into a "use report" (UR), where each UR corresponds to an event where an informant reported a utilitarian species to a particular category of use. The number of useful botanical species was estimated as Ethnobotanical Richness (R [45]). The Relative Frequency Citation (RFC [46]) was calculated by dividing the number of informants who claim to have used/used the plant species (*FC*) by the total number of informants in the survey (*N*). The formula is RFC = *FC*/*N*, with *FC* (frequency of citation) being the total number of informants that referred to the taxon and *N* being the total number of informants in the survey. The cultural importance index (CI [46]) is used to evaluate the extent to which each species is present in the local culture and the memory of the informants. The index is estimated as CI = *UR*/N, where *UR* is the number of different uses mentioned for each taxon and *N* is the total number of informants interviewed during the ethnobotanical survey.

To determine whether there is agreement among respondents in the use of plant species in each category, we estimated the informant consensus factor (ICF [47]). ICF was calculated as $(Nur - Nt)/(Nur - 1)$, where Nur is the number of use reports in each use category and Nt is the number of species used in the same category by all informants. ICF values range from 0 to 1, and the larger the index, the better the agreement among respondents, and hence an indication of well-established criteria for the use of plant species.

The names of plants, phytonyms, are an important proxy of cultural heritage and an indicator of the erosion of traditional knowledge about biodiversity. Hence, the diversity in phytonym was assessed using (i) linguistic diversity index [33], which is the mean number of folk names for the plants recorded during the study, and (ii) botanical linguistic richness (BLR), which is calculated as the ratio between the number of vernacular names and the number of species scientific name. BLR > 1 indicates that taxonomic entities have multiple vernacular designations, which translates the linguistic richness within the community.

4.5. Statistic Analyses: Sampling Assessment and Ecological Effects on Ethnobotanical Information

To assess the level of plant documentation, i.e., adequate sampling, we used accumulation curves based on the number of citations associated with each plant. The accumulation curve with 95% confidence intervals suggests that our inventory is nearly complete. We reached 98 species with 44 informants; however, if we were to continue with fieldwork, it would be likely that we have added a few other reports of less used plants (bootstrap mean number of species = 109, SE = 4; Supplementary Materials Figure S2). Therefore, given the absence of earlier reports and the socio-demographic context (see Section 4.1), we contend that our data allows for the first grasp of the ethnobotany of the studied communities.

Before formal tests, we assessed data normality using quantile–quantile plots and Tukey's test. Because variables were non-normal, we used non-parametric Kruskal–Wallis tests to evaluate whether (i) the number of plant citations varied significantly with locality and (ii) to compare use values among ecological features of plants. Specifically, we tested whether there was an association between plant life form, origin (wild vs. cultivated), habitat of collection and plant condition when used (fresh or dried) with the number of citations, relative frequency of citation, cultural importance, number of medicinal uses and number of vernacular names. We report χ^2 values and p-values < 0.05 were considered statistically significant. All statistical analyses were performed using R (version 4.2.3) and R Studio (version 2022.02.3+492) with packages vegan, ggplot2 and ggstatsplot.

4.6. Ethical Considerations

While conducting the questionnaires, we adhered to ethical principles as follows: (i) full disclosure—the informants were fully acquainted with the scope and goal of the

research; (ii) prior informed voluntary consent—all informants agreed to the terms of the research and provided oral and/or written consent; (iii) and confidentiality—we ensured the anonymity and privacy of the respondents. The study was conducted following the Declaration of Helsinki and approved by the Ethics Committee for Social, Life and Health Sciences of the Polytechnic Institute of Viana do Castelo (CECSVS2023/09/ii). In addition, we observed the International Society of Ethnobiology Code of Ethics. The plant vouchers were collected considering the permit issued by the national authority (ICNF, Licenses REC546-2022 and REC29-2023).

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/plants13192824/s1, Table S1: Details about the 98 plant species reported. Figure S1: Number of shared and unique plants species documented in the three study communities. Figure S2: Accumulation curve based on number of species documented as new informants were incorporated in the study.

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Data Availability Statement: We have included all data related to this study either in the main text or as Supplementary Materials.

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plants

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Article

Ethnobotany around the Virovitica Area in NW Slavonia (Continental Croatia)—Record of Rare Edible Use of Fungus *Sarccoscypha coccinea*

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Abstract: Slavonia is the most developed agricultural region in Croatia. With rich and fertile soils that have enabled the cultivation of a wide variety of fruits, vegetables, and cereals, Slavonia has always met the food needs of its population. Today, the biocultural diversity of local varieties and semi-natural vegetation has irretrievably disappeared. Our aim was to document the remaining local knowledge of plant use in this area through in-depth semi-structured interviews, which were conducted in 2022–2023. All possible aspects of the use of plants and fungi were recorded as food, animal feed, medicine, construction, jewelry, rituals and ceremonies, dyes, etc. The names and uses of local plant varieties were also recorded. The results show 1702 entries—a total of 296 plant taxa from 76 families and 28 fungi from 16 families. The most frequently named plants were: *Urtica dioica*, *Robinia pseudoacacia*, *Rosa canina*, and *Sambucus nigra*. The plants with the greatest variety of uses were *Morus alba*, *Rosmarinus officinalis*, *Triticum aestivum*, and *Zea mays*. Interesting uses were identified. The leaves of the ornamental plant *Hosta sieboldiana* are still used today as food for wrapping meat with rice, the aquatic plant *Trapa natans* is eaten like chestnuts, and *Pteridium aquilinum* was once consumed as a vegetable. In addition, *Ambrosia artemisiifolia* and *Sambucus ebulus* were given to horses to prevent and avoid blood poisoning. Some forest species had a special significance and were revered or favored. The most frequently mentioned edible fungi were *Boletus* sp., *Cantharellus cibarius*, and *Lactarius piperatus*. *Auricularia auricula-judae* is the only species stated to have been used exclusively as a raw snack. Evidence of edible use of *Sarccoscypha coccinea*, which was reported as traditionally consumed in the past, was of particular interest. Despite the modernization and agricultural nature of the region, many interesting uses of plants and fungi were identified. Further efforts should be directed towards documenting this knowledge to facilitate its dissemination in the communities that possess it, or at least to preserve it for future generations.

Keywords: ethnobotanical knowledge; edible wild mushrooms; wild edible plants; medicinal plants; traditional uses of plants

1. Introduction

Due to its ecological and socio-economic conditions, Slavonia is the most developed agricultural area in Croatia. It has always met the food needs of its population, and its rich and fertile soils have enabled the cultivation of a wide variety of fruits, vegetables, and cereals. For this reason, the use of wild plants in the diet of the people of Slavonia is generally not greatly pronounced, as is common for peasants from Slavic countries, who used to resort to several of the most common wild greens, ignoring other species [1]. In contrast to Slavonia, the region of Dalmatia in Croatia is ethnobotanically very interesting,

with the combination of Slavic and Mediterranean influence positively affecting the number of wild plants used in everyday life [2].

In the last century, the records of traditional foraging practices are derived from travelogues, historical ethnographic papers, and accounts of famines, which have impacted nearly every country on Earth [3–6]. In most European countries, wild plant use intensified in times of famine and war [3]. When the population of Slavonia underwent mass starvation, especially during Ottoman rule (16th and 17th centuries), chestnuts (*Castanea sativa* Mill.) were added to wheat flour to bake bread. Remarkably, there has been no major famine in Slavonia for about 175 years, since the mid-19th century, not even during the First and Second World Wars. The widespread use of acorns (*Quercus* sp.) as a raw material for bread making was also not recorded [7]. However, the feeding of acorns to animals was widespread and is used today in organic pig farming [8].

Due to the rich and fertile soils of the Pannonian Plain, the area of Slavonia was colonized several times in the 19th century by settlers from other parts of the former Austro-Hungarian monarchy [9]. After the First World War, during the Kingdom of Yugoslavia, and then after the Second World War, at the beginning of the former socialist Yugoslavia, the population was resettled to Slavonia from the poor regions of the country, such as Herzegovina, the Dalmatian hinterland, Bosnia and Montenegro. As a result, Slavonia saw the assimilation and mixing of Slavic and Germanic peoples and, to a lesser extent, the Hungarians who lived along the natural border of the Drava River.

The different peoples brought with them knowledge of plant cultivation and various crafts. They had little need to use wild plants as food. In the 19th and first half of the 20th century, forestry and hunting of wild animals were important economic activities in addition to agriculture [10]. All this is reflected in the traditional continental cuisine of Slavonia, which is based on pork meat and river fish, a variety of cereals, paprika, suet, browned flour, pork fat, roasts, cultivated fruits (quince, currant, gooseberry, plum, apricot, etc.) and naturalized fruits planted by the order of Empress Maria Theresa (e.g., white and black mulberry, *Morus alba* and *M. nigra*) [11,12].

In 2008 Ivan Šugar [13] published a systematic collection of Croatian plant names "Hrvatski biljni imenoslov", which was created on the basis of the author's many years of fieldwork on the collection of vernacular names for plants throughout Croatia. Between 1962 and 1986, the Yugoslav Army conducted a project in which Josip Bakić from the Institute for Naval Medicine of the Yugoslav Navy in Split documented traditional knowledge of wild foods and analyzed their chemical composition. He trained army personnel, developed survival tactics, organized survival expeditions, and shared the results of his studies and experiments with the general public [14–19]. Thorough systematic ethnobotanical research in Croatia started over a decade ago, on the Adriatic coast, with two authors of this paper, in the regions of Dalmatia [2,11], Primorje, Istria [20–22], then Inland Dalmatia [23] and Lika [24]. Continental Croatia has only been explored recently, and only partially so, e.g., around Varaždin [25–27]. No ethnobotanical research has been conducted in Northwest Slavonia. The closest region to have been the subject of research was Northeast Pannonia [28], where medicinal plant use was recorded.

Presently, traditional knowledge is being forgotten due to changes in lifestyle, migration, depopulation, and the transition to a "modern way of life", without coexistence with nature. Łuczaj [29] emphasizes that biocultural biodiversity is irretrievably disappearing, and hence the main goal and absolute priority of ethnobiological research is to document disappearing traditional knowledge. Given this context, the aim of the present paper is to document and highlight the persistence of local ethnobotanical knowledge of people living in NW Slavonia, a continental part of Croatia.

2. Results and Discussion

In the survey conducted between July 2022 and September 2023, 1702 data records on plants known to the respondents were collected. A total of 296 plant taxa from 76 families

and 28 fungi from 16 families were recorded (Table 1). Of the total of 296 plant taxa, 36 were only named by one informant.

In the interviews conducted, the average number of plant taxa mentioned per respondent was 44.6, ranging from 16 to 98 (SD = ±18.7). Fungi were mentioned in 30 surveys, with an average of 4.3 fungal species per respondent. The largest number of plant taxa belongs to the families Rosaceae (64), Vitaceae (27), and Asteraceae (20). Certain families are characterized by a high number of mentions of a single plant taxon, such as the families Urticaceae (*Urtica dioica*, 34 times) and Viburnaceae (*Sambucus nigra*, 28 times).

Among 296 plant taxa, the 5 mentioned most frequently are *Urtica dioica* (34), *Sambucus nigra* (28), *Rosa canina* (26), *Robinia pseudoacacia* (26), and *Taraxacum* spp. (25). A total of 12 out of 296 plant taxa have a frequency of more than 20, and 43 of them are mentioned more than 10 times. *Vitis vinifera*, *Malus domestica*, and *Pyrus communis* are the plant species with the most recorded local varieties (25, 19, and 10, respectively) (Table 1).

While the number of plant varieties mentioned is larger in reality, they are not listed in the table because their cultivation and use are widespread today, and no specific application was recorded. Moreover, according to the interviewees, the great genetic diversity of the varieties has been lost with the advent of seed companies.

The social, economic, and cultural importance of a plant for an area can be judged by the type and frequency of its use. Plants in the study area are used for food, beverages, cosmetics, alcoholic beverages, animal feed, tools and equipment, building and construction, ceremonial purposes, medicine, and other unspecified uses. The most common use category is food (846 entries), followed by medicine (217 entries), other unspecified uses (214 entries), and beverages (188 entries). The least frequently mentioned uses are ceremonial (48 entries), building and construction (35), and cosmetics (21). The greatest variety of plants is found in the use category food (210 plant taxa), followed by other uses (102 plant taxa) and medicine (95 plant taxa). For the purpose of data presentation, we narrowed the use categories from 10 to 6 in Figure 1.

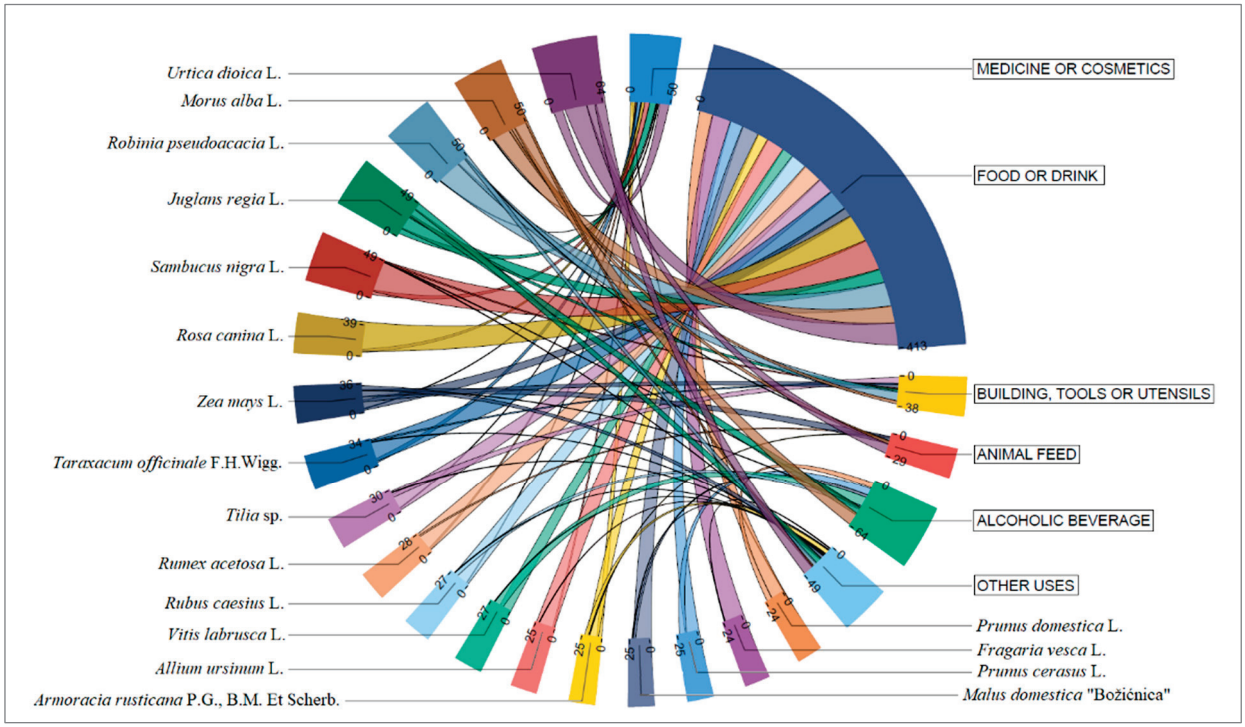

Figure 1. The most used plants in NW Slavonia area according to use categories.

Table 1. List of documented wild and cultivated plant taxa used in Northwest Slavonia (Croatia).

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Abies alba Mill., Pinaceae	jela	4	N	FO, TL, CON	sh, tk	cough syrup; building wood; furniture material	[24]
Acer campestre L., Sapindaceae, ZAGR78836	javor	2	N	TL	fr, sd, st	making musical instruments (guitar and "tamburica") and sleds	
Achillea millefolium L., Asteraceae, ZAGR78837	jezičac, purija trava, hajdučica, hiljadarka, stolisnik	10	N	DR, AF, MD, OT	ap, fl, fr, lf, sd, st, wh	tea against menstrual discomfort and stomach problems; purulent wound treatment; tea; for sale; poultry feed; fertilizer	[22,24–26,28,30]
Aesculus hippocastanum L., Sapindaceae, ZAGR78838	divlji kesten, okrugli kesten	10	C	COS, MD, OT	fr, lf, pj, sd, st	for repelling pests around livestock; macerate against rheumatism and hemorrhoids; poultice against rheumatism; for massage; knee pain reliever (in "rakija"); tincture for varicose veins; stomach pain reliever	[24,25,28]
Alcea rosea L., Malvaceae, ZAGR78839	sljez	4	N	FO, DR, MD, OT	fr, lf, sd	against menstrual pain (root steeped in brandy); tea; sold to companies	[22]
Allium ascalonicum L., Amaryllidaceae, ZAGR79004	luk kozjak	2	C	FO	fr	cooked as vegetable; against menstrual pain (root in brandy); tea; for sale	[25]
Allium cepa L., Amaryllidaceae, ZAGR79005	crveni luk, luk, luk 'Srebrnjak', vječno mladi luk	12	C	FO, DR, TL, CE, MD, OT	fr, lf, sd, st	raw; fried or cooked for food; for treating purulent wounds and ulcers; dry scaly leaves for dyeing Easter eggs	[24–26,30]
Allium sativum L., Amaryllidaceae, ZAGR79006	bijeli luk, češnjak	5	C	FO, TL, CE, MD	fl, fr, rt, sd	raw; fried or cooked as food; against spells (in the past: placed under children's heads); poultry feed; tincture against hypertension; stomach pain reliever	[25,26]
Allium schoenoprasum L., Amaryllidaceae, ZAGR78840	vlasac	5	N / C	FO	ap, fr, lf, rt, sd, st	condiment for salad and stew	[25,26]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Allium ursinum L., Amaryllidaceae, ZAGR78841	crijemuš, divlji luk, medvjeđi luk, srijemuš	21	N	FO, MD, OT	ap, bch, bk, fl, fr, in, lf, rt, sd, sh, st, tb, wh	raw salad; mixed with fresh cheese; cooked; blood detox tincture; for sale	[22,25,26,28]
Alnus glutinosa (L.) Gaertn., Betulaceae, ZAGR78842	joha	2	N	TL, CON, OT	fr	construction wood for traditional houses; water troughs and garden stakes	
Aloe barbadensis (L.) Burm.f., Asphodelaceae	aloa, aloe vera	2	C	FO, COS, MD	fr, lf	eaten raw; medicinal cream; mixed with honeycomb	
Alopecurus myosuroides Huds., Poaceae, ZAGR78843	mišji rep, mišji repak	2	N	AF	fr	poultry and other animals' feed	
Althaea officinalis L., *Malvaceae*	bijeli sljez, sljez	2	N / C	DR, MD, OT	fr	tea; drops for stuffy nose; for sale	[22,25]
Amaranthus retroflexus L., *Amaranthaceae*, ZAGR78845	štir	3	N	FO	fr, hu, in, lf, sd, sty	leaf and seed for stew	[2,22,25]
Ambrosia artemisiifolia L., Asteraceae, ZAGR78846	ambrozija	4	N	MD, OT	fr, in, sd, st, wh	for strengthening blood in horses; came to the region with USA aid after World War II; in the past: for sale	
Anethum graveolens L., Apiaceae, ZAGR78847	kopar	11	C	FO	bch, fl, fr, in, lf, sd, tk	sauces; condiment for pickles	[2,26]
Anthemis arvensis L., Asteraceae	divlja kamilica, kamilica, samonikla kamilica	16	N	DR, MD	ap, bch, fl, fr, in, lf, sd	tea against cold; inhalation; poultice against pain	[25]
Anthoxanthum odoratum L., Poaceae	mirisavka	1	N	MD	fr	poultice against hemorrhoids	
Arctium lappa L., Asteraceae, ZAGR79007	čičak	5	N	DR, TL, MD, OT	bch, fr, lf, sd, tk	raw leaf for treating wounds; ulcers and acne; hair growth oil; root tea; children's toys and playthings (bad if thrown into hair); decoration	[22,24,28]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Armoracia rusticana P. Gaertn., B. Mey. et Scherb., Brassicaceae, ZAGR79008	hren	15	N	FO, AF, CE, MD, OT	bch, fr, in, lf, rt, st, tk, tr	raw; freshly grated root for sauce (plenty at Easter); preservative for pickling; leaf tea against headache	[25,28]
Artemisia absinthium L., Asteraceae, ZAGR79009	pelin	5	N / C	DR, AL, AF, MD, OT	fr, lf, rt, st, tk	for "pelinkovac" liqueur (good for the stomach; mixed with other species); tea against stomach problems; anthelmintic for animals (leaf; tea); insecticide against aphids	[24–26,30]
Arum maculatum L., Araceae, ZAGR79010	kozlac	2	N	AF	fr	boiled for pig feed	[24]
Asarum europaeum L., Aristolochiaceae	kopitnjak	2	N	OT	hu	sold to the pharmaceutical industry	[31]
Asparagus densiflorus (Kunth) Jessop, Asparagaceae, ZAGR79011	asparabus, ukrasna šparoga	1	C	OT	fr	wedding decorations; bouquets	
Asparagus officinalis L., Asparagaceae, ZAGR79012	kultivirana šparoga, uzgojena šparoga	2	C		st	soup and risotto; used to be sown (cultivated) extensively	[2,22]
Avena sativa L., Poaceae	zob	4	N	FO, AF, TL, CON	ap, fr, lf, rt	food (flour); feed (straw and chaff for cattle; horses); woven baskets and slippers; in the past: mattress filling ("stroža"); roof covering	[24–26]
Balsamita major Desf., Asteraceae, ZAGR79013	kaloper	4	N / C	MD, OT	fr, lf	kept in vases around the house for the smell; worn behind women's ears for the smell; tea against laryngitis; tincture and tea against male infertility	
Bellis perennis L., Asteraceae, ZAGR79014	tratinčica	3	N	FO, DR, CE, OT	ap, fr	stomach upset tea; flower necklace and decoration; ceremonial face wash on Palm Sunday	[22,24,25,28,30]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Beta vulgaris L., Amaranthaceae, ZAGR79015	cikla	3	C	FO, MD, OT	ap, fl, fr, lf	fully cooked and pickled; dyeing fabric and Easter eggs; a piece of beetroot on the heel against fever	[24–26]
Beta vulgaris L. ssp. *vulgaris* var. *saccharifera* Alef., Amaranthaceae,	šećerna repa	5	C	FO, AF	ap, fr, wh	sugar production; in the past: jam used as sweetener; leaves for food	[25]
Betula pendula Roth, Betulaceae, ZAGR79016	breza	9	N	FO, DR, TL, CON, MD, OT	ap, bch, fr, in, lf, sd	bark tea against urological problems; for kidneys; detox; sap rich in minerals collected in early spring; traditional construction material and for furniture; rough brooms	[24,26,28]
Boswellia sacra Flueck, Burseraceae	tamjan	2	C	CE	fr, in, sd	protection from evil forces and spells	
Brassica napus L. (syn. *Brassica napus* L. ssp. *oleifera* (DC.) Janch.), Brassicaceae, ZAGR79017	uljana repica	2	N	FO	fr, lf	oil production; good bee pastures	[25]
Brassica napus ssp. *rapifera* J. Metzg., Brassicaceae	žuta koraba	2	N		hy	raw; cooked in stew	
Brassica oleracea L. ssp. *acephala* (DC.) O. Schwarz, Brassicaceae	stočni kelj	2	C	AF	fr	for feeding livestock in winter (cattle; pigs; poultry)	[25]
Brassica oleracea ssp. *capitata* (L.) Duchesne, Brassicaceae	kupus, kupus 'Varaždinac', zelje	12	C	FO, MD	ap, fr, in, lf, sd, st, tk	raw; cooked; base for baking bread; pickled for stuffed leaves with minced meat (sarma); poultice from the leaves used against fever or mastitis; reduces inflammation; helps with sprains; oiled leaves placed on burns	[24–26]
Brassica rapa L., Brassicaceae	bijela repa, crvena repa, repa, žuta repa	10	N/C	FO, AF	fr, lf, sd, st, tk	cooked food; pickled; filling for strudel; feed	[25,26]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Briza media L., Poaceae	majčine suzice	2	N	DR, OT	ap, sd	tea against diarrhea; decoration	
Buxus sempervirens L., Buxaceae, ZAGR79018	bušpan	2	C	CE, OT	sd, tk	decorative fence or hedge; for graves for All Saints Day	[31]
Calendula officinalis L., Asteraceae, ZAGR79019	neven	5	N / C	DR, COS, MD, OT	ap, bch, fr, lf, tk	petals used in medicinal ointment for skin (acne) and varicose veins; against moles; tea against hypertension (with nettle leaf); tincture against heart problems	[22,24–26,30,32]
Cannabis sativa L., Cannabaceae, ZAGR79218	konoplja, kudelja konoplja	16	C	FO, TL, CON, OT	fl, fr, in, lf, sd, st, tk, wh	for ropes; linen; sacks and blankets; filling for traditional mattress "strože", seed oil; for sale	[22,24–26]
Capsella bursa-pastoris (L.) Medik., Brassicaceae, ZAGR79020	rusomača	2	N	MD, OT	fl, fr, pj	tea against urological and menstrual problems; the fruit is balanced on the thumb as a game	[28]
Capsicum annuum L., Solanaceae, ZAGR79117	paprika ljuta, feferona	4	C	FO, TL	ap, fl, in, sd	raw; cooked; condiment	[25,26]
Capsicum annuum 'Babura', Solanaceae, ZAGR79156	paprika 'Babura'	2	C	FO	fl, in	raw; pickled	
Capsicum annuum 'Paradajzerica', Solanaceae, ZAGR79216	paprika 'Paradajzerica'	2	C	FO	fl, fr	raw; pickled	
Capsicum annuum 'Rog', Solanaceae, ZAGR79217	paprika 'Rog'	3	C	FO	fl, fr, lf	raw; "ajvar" ingredient	
Carpinus betulus L., Betulaceae, ZAGR79021	grab, grab majpan	9	N	AF, TL, CE, OT	fl, fr, lf, pj	for the celebration of May 1st ("majpan"); firewood; tool handles; litter; sawdust for smoking; toys	[31,33]
Carum carvi L., Apiaceae	kim	4	N / C	FO, MD	fr, lf, pj, rh, wh	condiment; against flatulence	[22,24–26]
Castanea sativa Mill., Fagaceae, ZAGR79022	kesten, kresten, pitomi kesten	18	N / C	FO, TL, CON, OT	bch, fr, hy, in, lf, sd, st, tb, tk	boiled or baked; flour; leaves as a baking mat; poles; building wood; for sale	[7,22,25,26]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Centaurium erythraea Rafn, Gentianaceae	kičica	1	N	MD	lf	tea against stomach problems	[22,28]
Chamomilla recutita (L.) Rauschert, Asteraceae, ZAGR79023	kamilica	4	C	DR, MD	bk, fl, fr, lf, pj, sd	calming tea; tea and macerate for stomach; health and immunity; poultice for cleaning eyes; hair wash	[22,24–26,28,30]
Chelidonium majus L., Papaveraceae, ZAGR79024	cimbola, rosopas	5	N	MD, OT	bd, fl, hu, lf, st	cell sap against warts; for sale	[22,25,28]
Chenopodium album L., Amaranthaceae, ZAGR79025	loboda	16	N / C	FO, AF, OT	bch, fr, hy, in, lf, rt, sd, st	cooked (stew; strudel) or prepared as spinach; feed (with potato peel); insecticide against aphids and potato beetle; in the past: sown	[2,22,25]
Chrysanthemum x *morifolium* (Ramat.) Hemsl., Asteraceae, ZAGR78923	krizantema	2	C	CE	fr	graveyard decoration (All Saints Day)	[30]
Cichorium endivia L., Asteraceae	andivija, endivija	2	C	FO	fr, lf	raw salad	
Cichorium intybus L., Asteraceae, ZAGR79026	cikorija, vodopija	11	N / C	FO, DR, MD	bl, fl, fr, in, st, tb	raw (young leaves) with pork fat; or cooked (stew with potato); coffee substitute	[2,22,28]
Colchicum autumnale L., Colchicaceae, ZAGR79027	mrazovac	14	N	MD, OT	bch, fl, fr, in, lf, sd	dried for sale; or decoration in pots	[25]
Cornus mas L., Cornaceae	drenak, drijen	3	N	FO, DR, AL, CE, OT	fl, lf, tb, tk	for distillation (“rakija”) or brandy flavoring; liqueurs; tea; jam; flower branch for blessing on Palm Sunday in the church	[22,24–26]
Cornus sanguinea L., Cornaceae, ZAGR79028	svib	1	N	TL	fr, lf	slingshot making (children)	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Corylus avellana L., Betulaceae, ZAGR79029	divlji lješnjak, lijeska, lješnjak, šumski lješnjak	14	N / C	FO, TL, CON, OT	ap, bch, fl, fr, lf, rt, sd, st, wh	raw fruit; cake; building of traditional houses; farming utensils (three-horn hay fork); fishing rod; stick; handles; garden stalks; wicker fence (with ivy); branches for woven baskets; bows and arrows for children; whistles; in the past: twigs for punishing children; for sale	[24–26]
Crataegus monogyna Jacq., Rosaceae, ZAGR79030	bijeli glog, glog	10	N	FO, DR, AL, TL, MD	ap, bch, fl, fr, hy, lf, rt, st, wh	raw; tea against hypertension and insomnia; tincture for the treatment of heart disease; for distillation (“rakija”); liqueurs; slingshot	[24–26,28]
Crataegus nigra Waldst. et Kit., Rosaceae	crni glog, glog	2	N	MD, OT	ap, sd	tea against hypertension	
Cucurbita pepo L., Cucurbitaceae, ZAGR79119	buča, bundeva, mesirka, misirka, turkinja (bundeva), valjanka	15	C			baked or in stew; especially on Christmas Eve and in periods of fasting; roasted seeds for snacking; a highly valued oil; feed (“pogača”) for cattle and pigs; custom: expressing love by carving a name on the fruit	[26]
Cucurbita pepo L. ‘Mađerka’, Cucurbitaceae	mesirka ‘Mađerka’	1	C	FO	lf	soup or baked	
Cucurbita pepo L. ‘Turkinja’, Cucurbitaceae	bundeva ‘Turkinja’, mesirka ‘Turkinja’	2	C	FO, AF	ap	tsew; oven baked; feed (pig and cattle); roasted seeds for snacking	
Cyclamen purpurascens Mill., Primulaceae	košutica, šumska ciklama	2	N / C	OT	bl, fr	decoration in house and garden	[30]
Cydonia oblonga Mill., Rosaceae, ZAGR79031	dunja	17	C	FO, DR, AL, MD, OT	ap, bl, fl, fr, in, lf, sd, st, tb, wh	compote; jam; quince cheese or paste (“kitnikez”); for distillation (“brandy”); liqueurs; anti-diarrhea and anti-dysentery tea leaf; kept in wardrobes throughout the winter for fragrance	[24–26]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Daucus carota L. ssp. *sativus* (Hoffm.) Arcang., Apiaceae, ZAGR79032	mrkva	1	C	FO	st	raw; cooked; condiment; was sown	[25,26]
Dryopteris filix-mas (L.) Schott, Dryopteridaceae, ZAGR79033	paprat muška, paprat	4	N	MD, OT	fr, in, lf, pj, st	agent against red mites; ticks; fleas and lice; honeybee protection against varroa; decoration; for sale	[31,34]
Elymus repens (L.) Gould, Poaceae, ZAGR79034	pirika	5	N	DR, MD	ap, fr, pj, rt	pain reliever tea; against lung problems; fertilizer; for sale	[22,24]
Equisetum arvense L., Equisetaceae, ZAGR79035	poljska preslica, preslica	8	N	FO, DR, MD, OT	bk, fl, fr, in, lf, lg, rt, sd	tea against urological problems; for prostate; against feet sweating; insecticide against aphids; fertilizer; for sale	[22,25,28]
Fagopyrum esculentum Moench, Polygonaceae	heljda	2	N / C	FO	in, rh	side dish; flour	[25,26]
Fagus sylvatica L., Fagaceae, ZAGR79037	bukva	11	N	AF, TL, CON, MD, OT	bch, fr, in, lf, pj, st, tk, wh	leaf to stop bleeding; leaf for treating ulcers and warts; pig feed; litter for livestock; building wood; for tools; toys and utensils; furniture materials; firewood; sawdust for smoking meat; game: "masličanje" in which a pointed beech pole was to be thrown so that it would land upright in the ground, and the opponent had to knock it over with another pole	[22,24,26]
Festuca pratensis Huds., Poaceae, ZAGR79038	trava, vlasulja	2	N	TL, OT	fr	whistling on leaves	
Ficus carica L., Moraceae, ZAGR79039	smokva	2	C	FO, AL, MD	fl, lf	raw; jam; boiled dry figs for digestion	[30]
Forsythia sp., Oleaceae, ZAGR79040	forzicija	3	C	CE	fl, lf, rt	Palm Sunday ceremony	
Fragaria vesca L., Rosaceae, ZAGR79041	divlja jagoda, jagoda, šumska jagoda	21	N	FO, DR, OT	ap, bch, fl, fr, in, lf, lg, rt, sd	raw; jam; dried leaves for tea; in gift bouquets	[22,24–26,28]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Frangula alnus Mill., Rhamnaceae	krkovina, tušljika	2	N	MD, OT	ap, bch, fr	for sale (pharmaceutical and medical purposes)	[35]
Fraxinus angustifolia Vahl, Oleaceae	jasen	2	N	AF, TL	fr, in	animal feed; furniture making	[36]
Galanthus nivalis L., Amaryllidaceae, ZAGR79042	visibaba	2	N	TL, OT	bl, lf	decoration in the house and garden	[24]
Galium odoratum (L.) Scop., Rubiaceae, ZAGR79210	lazarkinja	2	N	DR, AL, OT	lf	tea; flavoring for brandy ("rakija lazarkinja") and cigarettes	[37]
Glechoma hederacea L., Lamiaceae, ZAGR79043	dobričica	2	N	MD, OT	lf	pain reliever ointment (cooked in pig fat); for sale	[37]
Hedera helix L., Araliaceae, ZAGR79044	bršljan	6	N / C	FO, TL, CON, CE, MD	fr, lf	cough syrup and tea; wicker fence combined with *Corylus avellana*; funeral and Easter decorations	[24,26]
Helianthus annuus L., Asteraceae, ZAGR79120	suncokret	2	C	FO	bch, fl, fr	seeds for snacking; oil; good as bee pasture (in Baranja)	[25]
Helianthus tuberosus L., Asteraceae, ZAGR79045	čičoka, divlji krumpir	5	N / C	FO, DR, AL, AF, MD	ap, fr, in	raw; food for diabetics; feed; horse feed for speed; for distillation (it was poisonous "rakija" to deceive alcoholics); liqueurs	[22,25]
Helichrysum italicum (Roth) G. Don, Asteraceae	smilje	2	C	COS, MD, OT	ap	ointment; garden decoration	[22,30]
Herniaria hirsuta L., Caryophyllaceae	kilavica	2	N	OT	wh	for sale (pharmaceutical and medical purposes)	
Hordeum vulgare L., Poaceae	ječam	6	N	FO, DR, AF, CE	fl, fr, hu, in, sd, tk	bread "for the poor", side dish; barley porridge "geršl", coffee substitute; straw for animal feed; straw mattress protects against groundwater	[24–26]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Hosta sieboldiana (Hook.) Engl., Asparagaceae, ZAGR79046	hosta	2	C	FO	ap, fr	for "sarma" (minced meat with rice wrapped in a leaf); decoration in garden	
Humulus lupulus L., Cannabaceae, ZAGR79047	divlji hmelj, hmelj	5	N	FO, DR, AL	fl, fr, lf, wh	dried for tea; brewing beer; young shoots fried with eggs; in the past: the flower was eaten	[22]
Hyoscyamus niger L., Solanaceae	crna bunika	2	N	OT	fr	boiled fruit (jam) as poison; in the past: hallucinogenic agent	[31,38,39]
Hypericum perforatum L., Hypericaceae, ZAGR78844	gospina trava, kantarion	3	N	DR, MD	ap, fr, in, lf	tea against depression and for regulating menstrual problems; strengthening immunity; red medicinal oil for the treatment of skin diseases (psoriasis and burns)	[24–26,28,30]
Juglans nigra L., Juglandaceae	crni orah	3	C	FO, TL	ap, fr, sd	rifle stock	Not in the region but used for this in N. America [40,41]
Juglans regia 'Koštunac', Juglandaceae, ZAGR79048	orah 'Koštunac'	2	C	FO	fr, lf	raw food for diabetics; cake "orahnjača", brandy "orahovac" for the stomach; liqueur for treating thyroid problems; dyeing fabrics; furniture materials; garden stakes; stock; leaf: insect and moth repellent (put in *Phaseolus vulgaris* with just few grains *Piper nigrum*, it was to expensive); smoked like tobacco; for slingshot and helicopter games	
Juglans regia L., Juglandaceae	crveni orah, orah	24	C	FO, AL, TL, MD, OT	ap, bl, fr, in, lf, rh, sd, st	for "orahnjača" cake	[24–26,28,30]
Juncus effusus L., Juncaceae, ZAGR79049	zukva trava	1	N	TL	fr, lf	against throat pain	
Juniperus communis L., Cupressaceae	borovica	3	N	FO, AL, TL, MD	lf, lg	in brandy against diarrhea; against throat pain; condiment for game meat	[22,24]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Lactuca sativa 'Hrastov list', Asteraceae	salata 'Hrastov list'	2	C	FO	fr, in, sd	raw salad	[25,26]
Lagenaria siceraria (Molina) Standl., Cucurbitaceae, ZAGR79121	tikvica, ukrasna tikvica, ukrasna tikvica 'zug'	5	C	TL	bch, fr, lf	ladle for taking wine out of a barrel; swimming aid; decoration; toy	
Lamium maculatum (L.) L., Lamiaceae, ZAGR79050	pjegava kopriva	2	N	FO	bch, in	nectar from flowers as a raw children's snack	[33]
Laurus nobilis L., Lauraceae, ZAGR79051	lovor	20	N / C	FO, DR, MD, OT	ap, fl, fr, in, lf, sd, st, wh	cough syrup; laurel tea drunk for 14 days against bronchitis; condiment in cooked food and sauerkraut	[22,30]
Lavandula intermedia Emeric ex Loisel., Lamiaceae, ZAGR79061	lavanda	12	C	COS, OT	bch, fl, fr, in, lf, rt, sd, st, tk, wh	dried against moths and flies; relaxing agent for better sleep; in massage oil	[26]
Levisticum officinale W. D. J. Koch, Apiaceae, ZAGR79122	ljupčac, 'magi', 'vegeta' biljka	4	C	FO	fl, fr, in, wh	condiment	[26]
Lilium candidum L., Liliaceae	antunovski ljiljan, bijeli ljiljan sv Ante, bijelo blaženo, ljiljan	9	C	CE, MD	fr, in, pj, sd	ointment against skin burns; bouquets of lilies brought to church on St. Anthony's Day (June 13) and for the rite of baptism	[25,30]
Linum usitatissimum L., Linaceae	lan	9	N / C	FO, AF, TL, OT	ap, fr, in, lf, sd	food; feed (seed and bran digestive agent for cattle); fibers for linen cloth; used to be woven; was cultivated but not extensively	[22,24,25]
Malus domestica (Suckow) Borkh., Rosaceae	jabuka	7	C	FO, DR, AL, TL	fl, fr, lf, st	raw; dried; compote; juice; vinegar; for distillation ("rakija"); roasted on open fire on a stick; stored in cereal grains (or underground storage; a so-called "trap")	[22,24–26]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Malus domestica 'Božićnica', Rosaceae	jabuka 'Božićnica', jabuka 'Koturača', jabuka 'Pogačarka', jabuka 'Tanjurača'	21	C	FO, DR, AL, CE	bch, fl, fr, hy, in, lf, sd, st, wh	raw; juice; compote; dried slices; oven baked; made into vinegar; for distillation "rakija"); blessed on Candlemas	[26]
Malus domestica 'Crveni delišes', Rosaceae	jabuka 'Crveni delišes'	1	C	FO	fr	dried	
Malus domestica 'Debeljara', Rosaceae	jabuka 'Debeljara'	2	C	FO	fr, tk	raw; cakes; juice	
Malus domestica 'Idared', Rosaceae	jabuka 'Idared'	2	C	FO	fr, lf, st, tk	raw; dried	
Malus domestica 'Ivančica', Rosaceae	jabuka 'Ivančica'	1	C	FO	lf, st	raw	
Malus domestica 'Jonagold', Rosaceae	jabuka 'Jonagold'	2	C	FO, AL	lf, rt, st	raw; dried; for distillation ("rakija")	
Malus domestica 'Jonator', Rosaceae	jabuka 'Jonator'	1	C	FO	lg	dried	
Malus domestica 'Kanada', Rosaceae	jabuka 'Kanada', jabuka 'Musavka'	2	C	FO	ap	raw; dried; compote; cake	[26]
Malus domestica 'Katarinčica', Rosaceae	jabuka 'Katarinčica'	1	C	FO	bch	raw	
Malus domestica 'Kožara', Rosaceae	jabuka 'Kožara', jabuka 'Kožnjara'	2	C	FO	fl	raw; compote	
Malus domestica 'Limonka', Rosaceae	jabuka 'Limunka'	2	C	FO	fr, lf, sd	apple vinegar; cake; oven baked	
Malus domestica 'Mašanka', Rosaceae	jabuka 'Mašanka'	2	C	FO	fr, hy	raw; juice; cake	
Malus domestica 'Musavka', Rosaceae	jabuka 'Musavka'	5	C	FO	bch, fr, im, lf, sd, tb	raw; dried; kept in "trap" (traditional underground storage)	
Malus domestica 'Paradija', Rosaceae	jabuka 'Paradija'	2	C	FO	fr	raw; apple vinegar; cake; oven baked	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Malus domestica 'Petrovača', Rosaceae, ZAGR79211	jabuka 'Petrovača', jabuka 'Petrovka'	12	C	FO, DR, AL	bch, fr, hy, lf, sd, wh	raw; grated and dried; juice; compote; cake; for distillation ("rakija"); vinegar	[26]
Malus domestica 'Slavonska srčika', Rosaceae	jabuka 'Srčika'	1	C	FO	fl	raw; kept in "trap" (traditional underground storage)	
Malus domestica 'Starking', Rosaceae	jabuka 'Starking'	1	C	FO	hy	raw	
Malus domestica 'Zelenika', Rosaceae	jabuka 'Zelenika', jabuka 'Zelenjavka'	3	C	FO	fr, lf	raw; vinegar; grated and dried; for cakes	
Malus domestica 'Zlatni delišes', Rosaceae	jabuka 'Zlatni delišes'	1	C	FO	ap	dried	
Malus sylvestris (L.) Mill., Rosaceae, ZAGR79062	divlja jabučica, divlja jabuka, jabučica divlja	7	N	FO, AL	fr, lf, sd, st	raw; dried; compote; in jam mixed with other fruits; for distillation ("rakija")	[22,25]
Malva sylvestris L., Malvaceae, ZAGR79063	crni sljez, sljez	2	N	DR, MD	bk, fr, in, lf	cough tea; expectorant; root decoction for rinsing the nose	[28]
Medicago sativa L., Fabaceae	lucerna	3	N	AF	fr, sd, sh	animal feed	
Melissa officinalis L., Lamiaceae, ZAGR79064	matičnjak, melissa	7	C	FO, DR, MD, OT	fl, fr, in, lg, sh	calming tea; against headache; against menstrual pain; fresh salad; syrup; condiment	[22,24,25,28]
Mentha arvensis L., Lamiaceae, ZAGR79065	divlja menta, metvica	2	N	DR, MD	fl, lf, st	tea against cough	[24,28,30]
Mentha × *piperita* L., Lamiaceae	menta, pitoma menta	4	C	FO, DR, MD, OT	fr, lf, pj, sd	tea against cramps and indigestion; stomach problems; poultice against rheumatism and toothache; mosquito repellent	[24,25,28,30]
Mespilus germanica L., Rosaceae, ZAGR79066	divlja mušmula, mušmula, mušmulja	9	N / C	FO	fr, in, lf, rt	raw; jam; kept in hay to fully mature	[24,25]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Morus alba L., Moraceae, ZAGR79067	bijeli dud, žuti dud	26	C	FO, DR, AL, AF, TL, MD, OT	ap, bch, fr, in, lf, rt, st, tk, tr	raw; juice; jam; for distillation ("rakija dudovača"); poultry feed; leaf tea lowers blood sugar; barrels for "rakija", in the past: for mulberry silkworm	[11,12,22,25]
Morus nigra L., Moraceae	crni dud, crveni dud	12	C	FO, DR, AL, AF, TL	ap, bch, fr, lf, sd, st, tk	raw; juice; jam; for spirit distillation ("rakija dudovača"); poultry feed; barrels for "rakija"	[11,12,22,25]
Narcissus pseudonarcissus L., Amaryllidaceae, ZAGR79068	zelenkada	2	C	CE	fr, lf	Palm Sunday ceremony; bouquets as decoration	[26]
Nasturtium officinale R. Br., Brassicaceae	potočarka	2	N	FO	lf	fresh salad	[2,22]
Nicotiana tabacum L., Solanaceae	duhan, duhan 'Berlej', duhan 'Berlejac'	9	N / C	OT	fl, fr, lf, rt, sd	smoking leaves; fly; moth; aphid repellent	[24,26]
Nymphaea alba L., Nymphaeaceae, ZAGR79123	lopoč	1	N	TL	bch	decoration	
Ocimum basilicum L., Lamiaceae, ZAGR79069	bosiljak	2	N	FO	lf	condiment	[30]
Olea europaea L., Oleaceae	maslina	2	C	FO, CE	fr	healthy oil; blessed on Palm Sunday	[22]
Origanum vulgare L., Lamiaceae	divlji mažuran, origano	2	N / C	FO, DR, MD	lf, fl	condiment; tea	[22,28,30]
Oxalis acetosella L., Oxalidaceae	kiseli cecelj	1	N		lf	young leaves as raw snack	
Papaver rhoeas L., Papaveraceae, ZAGR61051	divlji mak	3	N	FO, MD	fr, lf, sd	calming tea; capsules ("škropulja") were sold to the food industry	[2,22,25,30]
Papaver somniferum L., Papaveraceae	mak	10	C	FO, DR, AF, MD	ap, fl, fr, lf, sd	for cakes: "makovnjača", calming tea for children and animals; seeds in "rakija" against insomnia; decoration	[25]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Passiflora caerulea L., Passifloraceae	kristov trn	1	C	OT	ap	decoration	
Pelargonium zonale (L.) l'Hér, Geraniaceae, ZAGR79070	muškatl, pelargonija	2	C	COS, OT	lf	hair decoration on festive occasions (for girls ready for marriage); garden decoration	[26,30]
Petroselinum crispum (Mill.) A. W. Hill, Apiaceae, ZAGR79071	peršin	2	C	FO, MD	fr, lf	condiment; tea against bacterial poisoning	[26,30]
Phacelia tanacetifolia Benth, Boraginaceae	facelija	2	C	FO, OT	lg	honeybee pasture; green fertilizer	
Phaseolus vulgaris L., Fabaceae, ZAGR79124	grah	3	C	FO, OT	fr, st	cooked; for children's mill game	[24,25]
Phaseolus vulgaris 'Mahunar', Fabaceae	grah 'Mahunar'	2ut paper	C	FO	fr	cooked for salad and in stew	[26]
Phaseolus vulgaris 'Božićni', Fabaceae	grah 'Božićni'	1	C	FO	bch	cooked	
Phaseolus vulgaris 'Žuta olovka', Fabaceae, ZAGR79212	mahuna 'Žuta olovka', visoke mahune	8	C	FO	fl, fr, lf, rt, tk	cooked in stew	
Phaseolus vulgaris 'Prdov', Fabaceae	grah 'Prdov'	3	C	FO	ap, fr, sd, st	cooked in stew	
Phaseolus vulgaris 'Puterfizol', Fabaceae	grah 'Puterfizol'	3	C	FO	fr, lf, sd	cooked for salad and in stew	
Phaseolus vulgaris 'Tetovac', Fabaceae	grah 'Tetovac'	2	C	FO	lf, tk	cooked in stew	
Phaseolus vulgaris 'Trešnjevac', Fabaceae	grah trešnjar, grah 'Trešnjevac'	7	C	FO	fr, in, lf, sd	cooked for salad; soup; in stew; side dish	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Phaseolus vulgaris 'Zelenček', Fabaceae	grah 'kukuružnjak', grah 'Zelenček', grah 'Zelenčok', grah 'Zelenščak'	7	C	FO, OT	fl, fr, lf, sd, st, tb, tk, wh	cooked for salad; in stew; children's games with ear leaves and bean: mill game (local: "školice")	
Phragmites australis (Cav.) Steud., Poaceae, ZAGR79072	trska, trstika	7	N	TL, CON	bk, fl, fr, lf	young shoots for snacking; cooked root; for flour; building material in traditional houses; shelter from the sun	
Picea abies (L.) H. Karst., Pinaceae	smreka	3	N	TL, CON, MD	sh, lf, tr	cough syrup; raw against lung problems; building wood; garden stake	[24,26,28]
Pinus nigra J. F. Arnold, Pinaceae	bor, bor crni	3	C	CE, MD, OT	lf, sh, wh, rs	pine needle syrup against cough and bronchitis; glue resin; Christmas tree decoration	[33]
Pinus sylvestris L., Pinaceae, ZAGR79155	šumski bor	2	C	MD	lf, sh	pine needle syrup against cough and bronchitis	[26,28]
Pisum sativum L., Fabaceae, ZAGR79125	grašak 'Mahunar', grašak 'Telefon', ljubičasti grašak	3	C	FO	fr	cooked side dish	[25,26]
Plantago lanceolata L., Plantaginaceae, ZAGR79073	bokvica, traputac, trputac, uskolisna bokvica, uskolisni trputac	4	N	MD	lf	tea and syrup against cough; fresh leaf for treating wounds and ulcers	[24,25,28]
Plantago major L., Plantaginaceae, ZAGR79074	bokvica, širokolisni trputac, traputac, trputac, veliki trputac	12	N	MD	lf	tea and syrup against cough; fresh leaf for treating wounds and burns; for faster healing	[24–26,28]
Populus alba L., Salicaceae	topola	2	N	TL, CON	ap, tr	construction wood in traditional houses (floors and ceilings; slats; easels); furniture material	[36,42]
Portulaca oleracea L., Portulacaceae, ZAGR79075	tušt	6	N	FO, DR, AF	lf, ap	fresh salad; pig feed	[2]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Primula vulgaris Huds., Primulaceae, ZAGR79076	jaglac	2	N	FO, MD, OT	lf, fl	fresh flowers and leaves for salad; tea and syrup against cough; tea against constipation; insomnia; menstrual discomforts	[24,28]
Prunus armeniaca L., Rosaceae, ZAGR79126	kajsija, marelica	16	C	FO	fr, sd	raw; compote; jam; peach seeds eaten like almonds; grinded seed in cakes	[25,26]
Prunus armeniaca 'Mađarska najbolja', Rosaceae	kajsija 'Mađarica'	2	C	FO	fr, sd	raw; jam	
Prunus avium (L.) L., Rosaceae, ZAGR79077	divlja trešnja, trešnja 'Cepika'	13	C	FO, AL, TL, CON, MD	fr, tr, ap, rs, bch	raw; tea from twigs for better blood flow; for distillation ("rakija"); furniture material; resin as glue	[22,24–26]
Prunus avium 'Hrušt', Rosaceae	trešnja 'Hrušt', trešnja hruštavka	5	C	FO, MD	fr, sd	raw; compote; endocarp in pillows against rheumatism	
Prunus avium 'Spasovka', Rosaceae	trešnja 'Spasovka'	2	C	FO	fr	raw	
Prunus cerasifera Ehrh., Rosaceae, ZAGR79078	ringlov	3	C	FO, AL	fr	raw; for distillation ("rakija")	[11]
Prunus cerasus L., Rosaceae, ZAGR79079	višnja	12	N	FO, DR, AL	ap, bch, fl, fr, lf, st, tk	raw; juice; jam; compote; syrup; tea from a young twig; for distillation ("rakija"); "višnjevac" liqueur	[25,26]
Prunus cerasus 'Španjolka', Rosaceae	višnja 'Španjolka'	2	C	FO, DR, MD	fr, bch, sd	raw; compote; tea from young twigs; endocarp in pillows against rheumatism	
Prunus domestica L., Rosaceae, ZAGR79128	šljiva, šljiva plava	14	C	FO, DR, COS, AL	fr	raw; jam; compote; dried; for distillation ("rakija"); coloring of brandy	[24–26]
Prunus domestica 'Bistrica', Rosaceae	šljiva 'Bistrica'	7	C	FO, AL	fr	raw; dried; compote; jam; for distillation ("rakija")	[26]
Prunus domestica 'Čačanka', Rosaceae	šljiva 'Čačanka'	3	C	FO, AL	fr	raw; compote; for distillation ("rakija")	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Prunus domestica 'Debeljara', Rosaceae	šljiva 'Debeljara'	3	C	FO	fr	raw; compote	
Prunus domestica 'Jajara', Rosaceae	šljiva 'Jajara'	2	C	FO	fr	raw; jam	
Prunus domestica 'Kalanka', Rosaceae	šljiva 'Kalanka'	3	C	FO	fr	raw; dried; compote	
Prunus domestica 'Požežanka', Rosaceae	šljiva 'Požežanka'	3	C	FO, AL	ap, fr	raw; dried; jam; for distillation ("rakija")	
Prunus domestica 'Stenlijevka', Rosaceae	šljiva 'Stenlijevka'	3	C	FO	ap, fr, lf	raw; jam	
Prunus persica (L.) Batsch, Rosaceae, ZAGR79127	breskva	2	C	FO	bch, tb	raw; jam; compote	[26,30]
Prunus persica 'Golica', Rosaceae	breskva 'Golica'	1	C	FO	fr	raw	
Prunus persica 'Vinogradarska', Rosaceae	breska 'Vinogradarska'	4	C	FO, AL	fr, lf, sd, st	raw; jam; for distillation ("rakija")	
Prunus spinosa L., Rosaceae, ZAGR79151	divlja šljiva, trnina	8	N	FO, AL, TL	fr, ap	raw; dried for tea; liqueur; juice; syrup; jam; trunk hayfork	[22,24,28]
Pteridium aquilinum (L.) Kuhn, Dennstaedtiaceae, ZAGR79080	bujad	1	N	FO	sh	young shoots prepared as cooked salad like asparagus	[22]
Pulmonaria officinalis L., Boraginaceae, ZAGR79081	plućnjak	5	N	FO, DR, MD, OT	fl, lf	tea for respiratory system; lungs; against cough; fresh leaves eaten; for sale	[24,25,28]
Pyrus communis L., Rosaceae, ZAGR79129	kruška	5	C	FO, AL	fr, sd	raw; dried; compote; for distillation ("rakija")	[24–26]
Pyrus communis 'Citronka', Rosaceae	kruška 'Citronka', kruška 'Limonka'	4	C	FO	fr	raw	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Pyrus communis 'Gelertova', Rosaceae	kruška 'Gelertova'	1	C	FO	fr	raw	
Pyrus communis 'Jagodarka', Rosaceae	kruška 'Jagodarka'	1	C	FO	fr	raw	
Pyrus communis 'Lubeničarka', Rosaceae	kruška 'Lubeničarka'	2	C	FO	fr	raw; dried	
Pyrus communis 'Petrovka', Rosaceae	kruška 'Petrovka'	3	C	FO	fr	raw	
Pyrus communis 'Santa Maria', Rosaceae	kruška 'Santa Maria'	1	C	FO	fr	raw	
Pyrus communis 'Tepka', Rosaceae	kruška 'Tepka'	2	C	FO, AL	fr	raw; for distillation ("rakija")	[24,26]
Pyrus communis 'Tikvica', Rosaceae	kruška 'Tikvica'	7	C	FO, DR, AL	fr	raw; dried; compote; liqueur "kruškovac"	
Pyrus communis 'Vilijamovka', Rosaceae	kruška 'Vilijamovka'	2	C	FO, AL	fl, fr	raw; for distillation ("rakija"); fruit is grown in a glass bottle	
Pyrus communis 'Žetvenjača', Rosaceae	kruška 'Žetvenjača'	2	C	FO	fr	raw	
Pyrus pyraster (L.) Burgsd., Rosaceae	divlja kruška	2	N	FO	fr	raw; dried	[22,24,25]
Quercus petraea (Matt.) Liebl., Fagaceae, ZAGR79152	hrast kitnjak	3	N / C	AF, TL, CON, OT	fr, lf, tr, bch	pig feed; garden stakes; whistles from acorn caps; collected for sale to forest authorities for afforestation	[24–26]
Quercus robur L., Fagaceae, ZAGR79153	hrast lužnjak	8	N / C	FO, AF, TL, CON, OT	ap, fr, lf, tk, bch, bk	pig feed; garden stakes; acorns sold to state forestry for afforestation; wood for making barrels; building wooden furniture and houses; tanning leather with oak bark	[24]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Quercus sp. (include *Q. petraea*, *Q. robur* and *Q. cerris* L.) Fagaceae	hrast, žir	14	N / C	AF, TL, CON, OT	ap, bch, fr, lf, sd, tr	building wood; furniture material; forest pasture for pigs ("žirovanje"); oak leaf as a motif for folk costume; acorns for reforestation; acorn cap as a whistle ("fučaljka")	[22]
Rhus typhina L., Anacardiaceae, ZAGR79082	ruj	2	C	FO, OT	fr, ap	raw; decoration; juice	
Ribes nigrum L., Grossulariaceae, ZAGR79154	crni ribiz, crni ribiz divlji, crni ribizl, divlji ribizln	5	C	FO, DR	fr, sd	raw; syrup	[25]
Ribes rubrum L., Grossulariaceae, ZAGR79083	crveni ribizl, ribizl, ribiznl	5	C	FO, DR, AL	fr, sd	raw; liqueurs; jam	[25,26]
Ribes uva-crispa L., Grossulariaceae, ZAGR79130	ogrozd	7	C	FO	fr	raw	[24]
Ribes x *nidigrolaria* Rud.Bauer and A.Bauer, Grossulariaceae, ZAGR79135	josta	2	C	FO, DR	fr	raw; juice; jam	
Ricinus communis L., Euphorbiaceae	ricinus	4	C	COS, MD, OT	ap, fr, in, sd	hair growth oil (often used by men); anti-constipation oil used internally in very small amounts; decoration	[35]
Robinia pseudoacacia L., Fabaceae, ZAGR79084	agacija, bagrem, šemšir	26	N / C	FO, DR, AF, TL, MD, OT	ap, bch, fl, in, lf, tk, wh	raw; flower fried in batter or pancake mix and eaten as a wrap; nectar sucking; syrup; tea; good honey tree; hard garden stalks; firewood; leaf whistle; children's trumpet "trubica"	[22,24,25]
Rosa canina L., Rosaceae, ZAGR79085	ruža, šipak	26	N	FO, DR, COS, MD	ap, bch, fl, fr, in, lf, st	raw; tea against diarrhea; jam; fragrance; decoration; for sale	[22,24–26,28,30]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Rosmarinus officinalis L., Lamiaceae, ZAGR79086	ružmarin	12	C	FO, DR, COS, TL, CE, MD, OT	ap, bch, fl, lf	condiment; tea for circulation; massage oil with olive oil against rheumatism; abortifacient (in large quantities); traditional wedding decoration	[22,25,26,30]
Rubus caesius L., Rosaceae, ZAGR79087	divlja kupina, šumska kupina	19	N	FO, DR, AL, MD, AF, OT	fr, fl, lf	leaf anti-diarrhea tea; jam; juice; syrup; wine; for distillation ("rakija"); remedy for weak calves	[22,24]
Rubus idaeus L., Rosaceae, ZAGR79131	divlja malina, šumska malina	5	N	FO, DR, AL	fr, lf	raw; jam; "himpersaft" juice ("malinovac"); tea; for distillation ("rakija")	[22,24–26]
Rubus vulgaris Weihe et Nees, Rosaceae, ZAGR79088	kupina domaća	6	C	FO	fr	raw	[26]
Rumex acetosa L., Polygonaceae, ZAGR79089	kiselica, kiseljak, ščavljika,	25	N	FO, AF, MD	fl, fr, in, lf, st, ap	food snacking; salad; feed; tea against diarrhea for people and animals	[22,24,25,28]
Rumex crispus L., Polygonaceae, ZAGR79090	Štavljika, šćav, štavalj	2	N	FO, MD	lf, fl, ap	salad; tea against diarrhea for people and animals	[2]
Rumex obtusifolius L., Polygonaceae, ZAGR79091	čavlika, čavljika, poljska štavljika, ščavelj, ščavlika	5	N	AF, MD	bl, fl, fr, in	digestion agent for cattle; against diarrhea for people and animals	[2]
Ruscus aculeatus L., Asparagaceae, ZAGR79092	bodljikava veprina	3	N	CE, OT	ap	on cemeteries for All Saints Day; branches as decoration	[2,22,30]
Ruscus hypoglossum L., Asparagaceae, ZAGR79093	mekolisna veprina	2	N	OT	ap	decoration	
Salix caprea L., Salicaceae	cica maca, vrba	9	N	TL, CE, OT	bch, lf, ap	palms for Palm Sunday ceremony; weaving baskets after boiling in hot water; whistles; decoration	[25,43]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Salix purpurea L., Salicaceae	rakita	3	N	TL, OT	bch	weaving baskets; in the past: twigs for punishing children	[24,25]
Salix sp., *Salicaceae*	vrba	10	N / C	FO, TL, CON	ap, bch, lf	weaving baskets; kitchen utensils; water troughs; whistles	[25]
Salvia officinalis L., Lamiaceae	kadulja, ljekovita kadulja	2	N / C	AL, MD	fl, lf, in	tea against throat pain; liqueurs; massage oil; against moths and mosquitoes	[22,24,25,28,30]
Salvia pratensis L., Lamiaceae	divlja kadulja	2	N	COS, MD	lf, fl	tea against stomach pain	[33]
Sambucus ebulus L., Adoxaceae, ZAGR79094	abdovina, aftika, aptika	4	N	AL, MD	fl, fr, lf	in brandy; fruit to strengthen blood in horses; poultice from berries used for swelling and against rheumatism; antifungal treatment of nails	[24]
Sambucus nigra L., Viburnaceae, ZAGR79095	bazga	28	N	FO, DR, AL, TL, MD, OT	ap, bch, fl, fr, in	blossom fried in batter or pancake mix; flower or berry syrup; tea against cold and flu; syrup against cough: flower; milk and roasted sugar; in "rakija" brandy; tincture; wood for handles; shoe polish made of berries; toys from wood; for sale	[22,24–26,28]
Secale cereale L., Poaceae	raž	3	N	FO, AF, CE	fr, sd, ap	bread; animal feed; roof thatching	[24–26]
Sempervivum tectorum L., Crassulaceae, ZAGR79096	čuvarkuća, krovnjak	12	C	FO, DR, MD, OT	lf, pj	fresh salad; eaten mixed with honey for better immunity; ear infection or pain treatment (1—2 drops); ointment against swelling and warts; raw leaf treatments of wounds; poultice against infections; planted on the roof or in front of the house as decoration	[22,24–26,28]
Silene vulgaris (Moench) Garcke, Caryophyllaceae	škripavac	1	N	FO	lf	salad	[2,24,30]
Silybum marianum (L.) Gaertn., Asteraceae	sikavica	1	N	OT	in, sd	socialist cooperatives used to buy it out for the pharmaceutical industry	[24]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Solanum lycopersicum L., Solanaceae, ZAGR79097	paradajz	2	C	FO	fr	raw; cooked; pasteurized pureed juice	[25,26]
Solanum lycopersicum 'Krumpiraš', Solanaceae	paradajz 'Krumpiraš'	1	C	FO	fr	cooking and preserves / pasteurized	
Solanum lycopersicum 'Mađarac', Solanaceae	paradajz 'Mađarac'	1	C	FO	fr	raw; cooking	
Solanum lycopersicum 'Volovsko srce', Solanaceae, ZAGR79213	paradajz 'Volovsko srce'	3	C	FO	fr	raw; cooking and preserves / pasteurized	
Solanum tuberosum L., Solanaceae, ZAGR79132	krumpir	6	C	FO, AF, MD	tb	cooking; for bread; small tubers with peel boiled for pigs; raw slices placed on face or soles against fever	[25,26]
Sorbus domestica L., Rosaceae	jabuka oskoruša, oskoruša	3	N / C	FO	fr	raw	[24,25]
Sorbus torminalis (L.) Crantz, Rosaceae	brekinja	2	N / C	FO, DR	fr	raw; for distillation ("rakija")	[24]
Sorghum bicolor (L.) Moench, Poaceae	sirak	10	C	AF, TL	ap, bch, fr	animal feed; for making brooms	[26]
Stellaria media (L.) Vill., Caryophyllaceae, ZAGR79098	mišakinja, mišjakinja	4	N	FO, AF	ap, lf	fresh salad; pig and poultry feed	[33]
Symphytum officinale L., Boraginaceae, ZAGR79099	gavez	8	N	FOCOS, AL, AF, MD, OT	rt, fr, in, lf, sd	external use: poultice; massage tincture against rheumatism; root in "rakija" against arthritis; ointment with pig fat against skin diseases; arthritis; swelling; bumps; hemorrhoids; sciatica and sprains; for faster healing of wounds; fertilizer and pesticide	[22,24–26,28]
Syringa vulgaris L., Oleaceae, ZAGR79100	jorgovan	2	C	OT	bch, in, wh	gifted as a sign of sympathy or love; decoration	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Tagetes patula L., Asteraceae, ZAGR79101	kadifa, kadifica	2	C	MD, OT	fl, wh	against pests; decoration	[26]
Tamus communis L., Dioscoreaceae, ZAGR78924	bljušt, vilin korijen	2	N		sh, rt	prepared like asparagus; root in alcohol for poultice	[2,22]
Tanacetum cinerariifolium (Trevis.) Sch. Bip., Asteraceae	buhač	1	C	OT	wp	macerate sprayed against plant pests	[44]
Taraxacum spp., ZAGR79102	maslačak, divlji radič	25	N	FO, DR, TL, MD, OT, CE	ap, fl, in, rt, st	salad; dandelion "honey" (syrup extracted from flowers with sugar) against cough and to support immune system; root tea for blood pressure; as diuretic; whistle; ceremonial face wash on Palm Sunday	[22,24–26,28]
Thymus serpyllum L., Lamiaceae, ZAGR79103	majčina dušica, timijan	5	N / C	FO, DR, AL, MD	fl, lf	condiment; tea; liqueur	[22,24,26,28]
Tilia cordata Mill., Malvaceae, ZAGR79104	bijela lipa, lipa sitnolisna	25	N	FO, DRTL, CON, MD, OT	bch, fl, fr, in, lf, sd, st	tea against cold and flu; good for heart (but careful with heart patients!); tying material ("liko") made from bark; kitchen utensils, building wood; furniture material; good honeybee pasture; toys: spinning tops; soltwood; easy to process	[26,28]
Tilia platyphyllos Scop., Malvaceae, ZAGR79105	crna lipa, rana lipa	3	N	DR, MD	fl, fr, lf	calming tea against asthma; cough	[22,24,25,28]
Trapa natans L., Lythraceae, ZAGR79106	bodljikavi orah, orašak, vodeni orah	4	N	FO	sd	boiled fruit for food; seeds for flour; collected for sale	[36]
Trifolium incarnatum L., Fabaceae	inkarnatka	2	C	FO, AF	lf, wh	young leaves used for salad; animal feed	
Trifolium pratense L., Fabaceae, ZAGR79107	divlja djetelina, djetelina	6	C	FO, AF, OT	ap, lf, in, st	animal feed; good honey plant; Easter eggs decorations used as a motif, game: looking for 4-leafed clover	[24,33]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Triticum aestivum L., Poaceae, ZAGR79133	pšenica	12	C	FO, AF, TL, CON, CE, MD, OT	ap, fl, fr, in, lf, sd, st	flour (bread); immature grain chewed as a snack; straw for animal feed; building material (chaff) for masonry ovens; ropemaking; starch glue (flour and water); straw traditionally placed under the Christmas tree	[24–26]
Typha angustifolia L., Typhaceae, ZAGR79108	rogoz	4	N	TL, MD, OT	fr, in, tr, wh	sealant between the boards; mosquito repellent; material for weaving baskets; decoration	[42]
Urtica dioica L., Urticaceae, ZAGR79109	kopriva	34	N	FO, DR, COS, AF, MD, OT	ap, lf, sd, st	bread and stew; green boiled salad; fried with eggs; detox tea; against rheumatism; boiled root for leg problems; boiled for poultry and pigs; tea or tincture to strengthen hair; for washing bottles; Easter eggs decoration; insecticide against aphids and Colorado beetles; organic fertilizer; dried for sale	[22,24–26,28]
Valerianella locusta (L.) Laterr., Valerianeaceae, ZAGR61064	divlji matovilac, matovilac, poljski matovilac	11	N / C	FO	ap, lf	salad; stew	[24–26]
Vicia faba L., Fabaceae, ZAGR79110	bob	5	C	FO	sd	cooked side dish; stew	[25,26]
Viola odorata L., Violaceae, ZAGR79111	ljubičica	2	N	MD, CE	fl	tea against throat problems; ceremonial face wash on Palm Sunday; for sale to pharmaceutical industry (against rheumatism)	[2,22,24,28,30]
Viola tricolor, Violaceae, ZAGR79431	mačuhica, ljubičica	6	N / C	FO, TL, OT	fl, lf, ap	edible flowers on salad; dried for tea; decoration	[33]
Viscum album L., Santalaceae, ZAGR79113	imela	4	N	FO, CE, MD, OT	lf, fr	tea for oncology patients; glue made from berries; Christmas tree decoration; a kiss under the mistletoe to bring eternal love	[22,24]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Vitis labrusca L., Vitaceae, ZAGR79114	loza 'Otela', loza 'Bijela noja', loza 'Crna noja', loza 'Tudum', loza 'Nojem'	16	C	FO, DR, AL, OT	fr, lf	raw; wine; jam; for stuffed leaves with minced meat ("sarma"); leaves as toilet paper	
Vitis vinifera L., Vitaceae, ZAGR 79430	vinova loza, grožđe, vinova loza 'Belovarca'	8	C	FO, AL, MD, OT	fr, in, lf, sd	raw; jam; vinegar; anti-hypertensive wine; for distillation ("rakija komovača"); best for massage; as insecticide; for stuffed leaves with minced meat ("sarma")	[24–26]
Vitis vinifera 'Bijeli delevar', Vitaceae	vinova loza 'Bijeli delevar', vinova loza 'Bijeli delevar'	2	C	AL, OT	fr, lf	wine; leaves as toilet paper; for stuffed leaves with minced meat ("sarma")	
Vitis vinifera 'Bijeli francuz', Vitaceae	vinova loza 'Bijeli francuz'	1	C	AL	fr	wine	
Vitis vinifera 'Cardinal', Vitaceae	vinova loza 'Kardinal'	2	C	FO, DR, AL	fr	raw; wine	
Vitis vinifera 'Chardonnay', Vitaceae	vinova loza 'Chardonay'	2	C	FO, AL	fr	raw; wine	[26]
Vitis vinifera 'Crni francuz', Vitaceae	vinova loza 'Crni francuz'	1	C	AL	fr	wine	
Vitis vinifera 'Francuz', Vitaceae	vinova loza 'Francuz'	2	C	FO, DR, AL	fr	raw; wine	
Vitis vinifera 'Frankovka', Vitaceae	vinova loza 'Frankovka'	2	C	AL	fr	wine	
Vitis vinifera 'Graševina', Vitaceae	vinova loza 'Graševina'	1	C	AL, OT	fr, lp, in	wine; leaves as a baking mat; for stuffed leaves with minced meat ("sarma"); "vinkot" cake: reduced must with condiments	[26]
Vitis vinifera 'Hamburg', Vitaceae	vinova loza 'Hamburg'	1	C	FO, AL	fr, in	raw; wine	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Vitis vinifera 'Izabela', Vitaceae	vinova loza 'Izabela'	9	C	FO, DR, AL, OT	fl, fr, lf, sd, st	raw; dried; wine; wine coloring; juice as sugar free syrup; for stuffed leaves with minced meat ("sarma"); leaves as toilet paper	[26]
Vitis vinifera 'Kadarka', Vitaceae	vinova loza 'Kadarka'	4	C	FO, AL	fr, in	raw; wine	
Vitis vinifera 'Kraljevina', Vitaceae	vinova loza 'Kraljevina'	1	C	FO, DR	fr	raw; wine	[26]
Vitis vinifera 'Kraljica vinograda', Vitaceae	vinova loza 'Kraljica vinograda'	2	C	AL	fr	wine	
Vitis vinifera 'Mirišavka', Vitaceae	vinova loza 'Mirišavka'	1	C	DR, AL	fr	wine; juice as sugar free syrup	
Vitis vinifera 'Muškat žuti', Vitaceae, ZAGR79215	vinova loza 'Muškat žuti'	2	C	FO, AL, OT	fr, lf	raw; wine; dried; leaves as baking mat; for stuffed leaves with minced meat ("sarma")	
Vitis vinifera 'Muškat hamburg', Vitaceae	vinova loza 'Muškat hamburg'	2	C	FO, DR, AL	fr	raw; wine	[26]
Vitis vinifera 'Nevenka', Vitaceae	vinova loza 'Nevenka'	1	C	AL, OT	fr, lf	wine; leaves as baking mat; for stuffed leaves with minced meat ("sarma")	
Vitis vinifera 'Pamid', Vitaceae	vinova loza 'Slankamenka'	2	C	FO, DR, AL	fr	raw; wine	
Vitis vinifera 'Pinot', Vitaceae, ZAGR79157	vinova loza 'Crni pinot' i 'Bijeli pinot'	1	C	FO, AL	fr	raw; wine	[26]
Vitis vinifera 'Plamenka', Vitaceae	vinova loza 'Plamenka'	1	C	FO, OT	fl, fr, lf	a motif for folk costumes; for stuffed leaves with minced meat ("sarma")	
Vitis vinifera 'Plemenka', Vitaceae	vinova loza 'Plemenka'	1	C	FO, AL	fr, lf	raw; wine; for stuffed leaves with minced meat ("sarma")	
Vitis vinifera 'Rajnski rizling', Vitaceae	loza 'Rizling'	1	C	FO, AL	fr	raw; wine; dried	

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Vitis vinifera 'Ružica', Vitaceae	vinova loza 'Ružica'	2	C	FO, AL	fr, in, lf	raw; wine; "vinkot" cake: reduced must with condiments; for stuffed leaves with minced meat ("sarma")	
Vitis vinifera 'Welschriesling', Vitaceae, ZAGR79214	vinova loza 'Graševina', vinova loza 'Talijanska graševina'	3	C	FO, DR, AL	fr	raw; wine	
Vitis vinifera 'Zinfandel', Vitaceae	vinova loza 'Dalmatinac'	4	C	FO, AL, OT	fr, in, lf	raw; wine; dried; for stuffed leaves with minced meat ("sarma"); leaves as toilet paper	
Wisteria sinensis (Sims) Sweet, Fabaceae, ZAGR79115	glicinija	2	C	OT	fl, in, lf	decoration; plant attracts butterflies	
Zea mays L., Poaceae, ZAGR79116	kukuruz, kukuruz simplica	17	C	FO, DR, AL, AF, TL, MD, OT	ap, bk, bl, fl, fr, lf, rt, sd, st, tk	food ("polenta", silk for tea against urological problems; grain for sauerkraut); animal feed "šlempa": pomace with corn stalks; for distillation (ethyl alcohol); as toilet paper; toys; wicker baskets; slippers made of woven leaves; corn cobs: for children's game "bunar" (well); "mlin" (mill); "školice" (school); for kindling; formerly mattress ("stroža") filling	[25,26]
Zea mays 'Osmoredac', Poaceae	kukuruz 'Osmoredac'	4	C	FO, TL, CE, MD, OT	fl, fr, st	boiled; corn cob drink against cold; hair curling tube; as toilet paper; game: water well	[24]
Zea mays 'Pucanac', Poaceae	kukuruz kokičar, kukuruz 'Pucanac'	4	C	FO, TL	fr, in, lf, sd	roasted ripe corn; hair curling tube	
Zea mays 'Stodanac', Poaceae	kukuruz 'Stodanac'	2	C	FO	fr, in, sd	boiled	
Fungi							

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Agaricus campestris L., Agaricaceae	pečurka, šampinjon	9	N	FO	fruiting body	thermally processed	[24,45]
Armillaria spp., Physalacriaceae	mrazovača	2	N	FO	fruiting body	thermally processed	[26,45]
Auricularia auricula-judae (Bull.) Quél., Auriculariaceae	petrovo uho, judino uho	3	N	FO	fruiting body	raw	[45]
Boletus aereus Bull., Boletaceae	hajdinski varganj, vrganj	2	N	FO	fruiting body	thermally processed; dried	[24,45]
Boletus regius Krombh., Boletaceae	kraljevka	1	N	FO	fruiting body	thermally processed; dried	[24,26]
Boletus sp., Boletaceae	varganj, vrganj	19	N	FO	fruiting body	thermally processed; dried; pickled	[24,26]
Calocybe gambosa (Fr.) Singer, Lyophyllaceae	đurđevača	1	N	FO	fruiting body	thermally processed	[45]
Cantharellus cibarius Fr. Cantharellaceae	lisičarka, žutica, lisičica, lisička	16	N	FO	fruiting body	thermally processed	[24,26,45]
Coprinus comatus (O.F. Müll.) Pers., Agaricaceae	gnojištarka, velika gnojištarka	1	N	FO	fruiting body	thermally processed	[45]
Craterellus cornucopioides (L.) Pers., Cantharellaceae	crna truba, mrka trubača, truba, trubača	4	N	FO	fruiting body	thermally processed; dried	[45]
Entoloma clypeatum (L.) P. Kumm., Entolomataceae	šljivarka, sivkasta šljivovača	4	N	FO	fruiting body	thermally processed	[45]
Fomes fomentarius (L.) Fr., Polyporaceae	guba	5	N	OT, DR	fruiting body	for tea; in bee smoker; to keep embers burning; for kindling	[45]
Kuehneromyces mutabilis (Schaeff.) Singer and A.H. Sm., Strophariaceae	mrazovača, panjevčica	3	N	FO	fruiting body	sautéed with onion; thermally processed	
Lactarius deliciosus (L.) Gray, Russulaceae	rujnica	1	N	FO	fruiting body	thermally processed	[45]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Lactarius piperatus (L.) Pers., Russulaceae	mleč, mlična, mliječak, mliječna, mlječica, mlječika, mlječka, mlječnica, mlječva	12	N	FO	fruiting body	thermally processed	[45]
Langermannia gigantea (Batsch) Rostk., Agaricaceae	divovska puhara, puhara	2	N	FO	fruiting body	thermally processed	[45]
Leccinum aurantiacum (Bull.) Gray, Boletaceae	turčin	1	N	FO	fruiting body	thermally processed	[45]
Leccinum griseum (Quél.) Singer, Boletaceae	brezovi varganj, pasji varganj, dedek, varganj kozjak	3	N	FO	fruiting body	thermally processed	[45]
Lepista saeva (Fr.) P.D. Orton, Tricholomataceae	mrazovača	5	N	FO	fruiting body	thermally processed	
Lycoperdon perlatum Pers., Agaricaceae and possibly other related species	prstić, pezduš, puhara, babin pušak	4	N	FO	fruiting body	thermally processed; raw	[45]
Macrolepiota spp., Agaricaceae	sunčanica	5	N	FO	fruiting body	thermally processed	[45]
Marasmius oreades (Bolton) Fr., Marasmiaceae	vilin klinčac, piličarka	1	N	FO	fruiting body	thermally processed	[45]
Morchella spp., Morchellaceae	smrčak	1	N	FO	fruiting body	thermally processed	[24,45]
Pleurotus ostreatus (Jacq.) P. Kumm., Pleurotaceae	bukovača	3	N	FO	fruiting body	thermally processed	[45]

Table 1. *Cont.*

Botanical Taxon	Local Name	Frequency	Status	Use Category	Used Part	Use	Written Sources—Regional Examples
Pleurotus sapidus Quél., Pleurotaceae	potpanjuška	1	N	FO	fruiting body	thermally processed	[45]
Russula virescens (Schaeff.) Fr., Russulaceae	golubica, zelena golubica	4	N	FO	fruiting body	thermally processed	[45]
Sarcoscypha coccinea (Jacq.) Lambotte, Sarcoscyphaceae	babino uho	3		FO	fruiting body	thermally processed; raw	[45]
Suillus bovinus (L.) Roussel, Suillaceae	kozji varganj	1	N	FO	fruiting body	thermally processed	

Abbreviations: Use categories: FO—dood, DR—drink, non-alcoholic, COS—cosmetics, AL—alcoholic drinks, AF—animal feed, TL—tools and utensils, CON—building and construction, CE—ceremonial use, MD—medicine, OT—other unspecified ways of use. Status: N—native or long-established species (archaeophyte), C—only cultivated, N/C– native and cultivated. Part used: ap—aerial parts, bch—branch, bd—bud, bk—bark, bl—bulb, fl—flowers, fr—fruit, hu—husk, hy—hypocotyl, im—immature fruit, in—inflorescence, lf—leaf, lg—legumes, pcl—pedicel, pe—petal, pj—plant juice, rh—rhizome, rs—resin, rt—root, sd—seed, sh—shoot, st—stalk, sty—styles, tb—tuber, tk—trunk, tr—tree, u—underground parts, wh—whole plant. Without literature numbers, the taxa recorded in this study, which have not yet been published in written regional sources (mostly these are new documented varieties of cultivated plants or taxa used as ornamental plants)

Urtica dioica, *Robinia pseudoacacia*, and *Sambucus nigra* are the three taxa with the highest values in the usage reports (UR). Their use in different use categories was reported 50 times or more in the surveys (Figure 2). The taxa with the highest UR values are mainly used for food, beverages, medicinal, and other purposes (Table 2). Among them, *Taraxacum* spp. has the highest uniformity of use as measured by the fidelity level (*FL*) (*FL* = 0.96) for the food use category, followed by *Rosa canina* (*FL* = 0.79). The taxa *Tilia* spp. (*FL* = 0.86) and *Sambucus nigra* (*FL* = 0.84) have the highest degree of fidelity for the non-alcoholic beverage usage category.

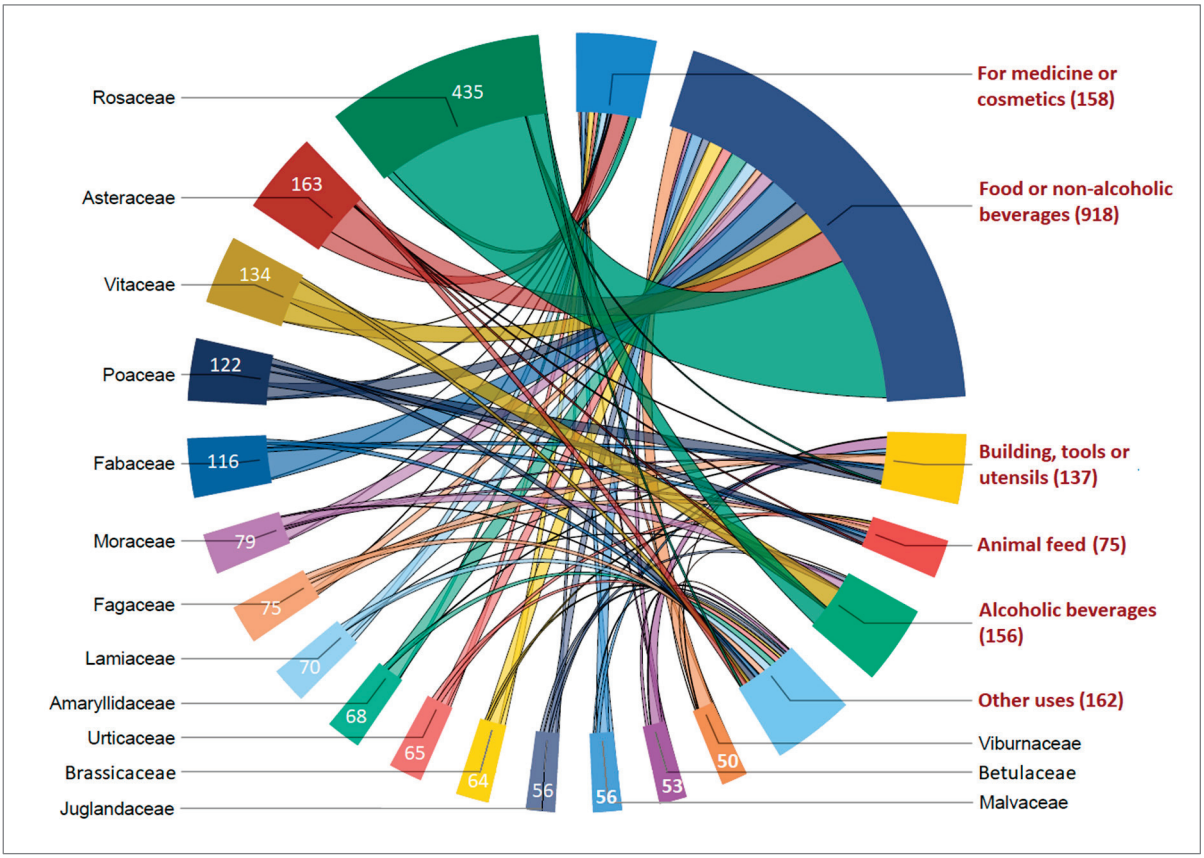

Figure 2. Plant families with the highest use reports in NW Slavonia area by use categories.

Table 2. Fidelity levels (*FL*) for the ten taxa with the highest number of reports of use.

	Food	Drink, Non-Alcoholic	Cosmetics	Alcoholic Drinks	Animal Feed	Tools and Utensils	Medicine	Other Uses
Urtica dioica L.	0.50	0.28	0.19	0.00	0.33	0.00	0.14	0.36
Robinia pseudoacacia L.	0.72	0.34	0.00	0.00	0.03	0.41	0.03	0.21
Sambucus nigra L.	0.45	0.84	0.00	0.03	0.00	0.06	0.19	0.03
Morus alba L.	0.72	0.04	0.00	0.56	0.16	0.16	0.04	0.12
Juglans regia L.	0.61	0.00	0.00	0.43	0.00	0.17	0.30	0.35
Rosa canina L.	0.79	0.41	0.03	0.00	0.00	0.00	0.07	0.00
Taraxacum spp.	0.96	0.04	0.00	0.00	0.00	0.08	0.19	0.04
Zea mays L.	0.69	0.06	0.00	0.06	0.44	0.44	0.06	0.38
Tilia spp.	0.09	0.86	0.00	0.00	0.00	0.27	0.05	0.05
Mean	0.62	0.32	0.03	0.12	0.11	0.18	0.12	0.17
SD	0.23	0.32	0.06	0.20	0.16	0.16	0.09	0.15

Use categories ceremonial use and building or construction were not recorded for the listed taxa.

For the principal component analysis (PCA), six variables or usage categories were formed, so that some usage types were combined into one:

- Food and non-alcoholic beverages are combined into "Food or drink";
- Medical use and cosmetics are combined into "Medicine or cosmetics";
- Uses for construction, making of tools and utensils have been combined into "Building, tools or utensils";
- Ceremonial use and other unspecified uses are summarized under "Other uses".

The PCA calculations are based on the absolute frequencies of plant uses in the various use categories. A PCA biplot shows the dispersion of the plants in relation to the first two components (Figure 3). The percentage of variance attributable to the first component is 60.487%, and the percentage of variance attributable to the second component is 12.438%.

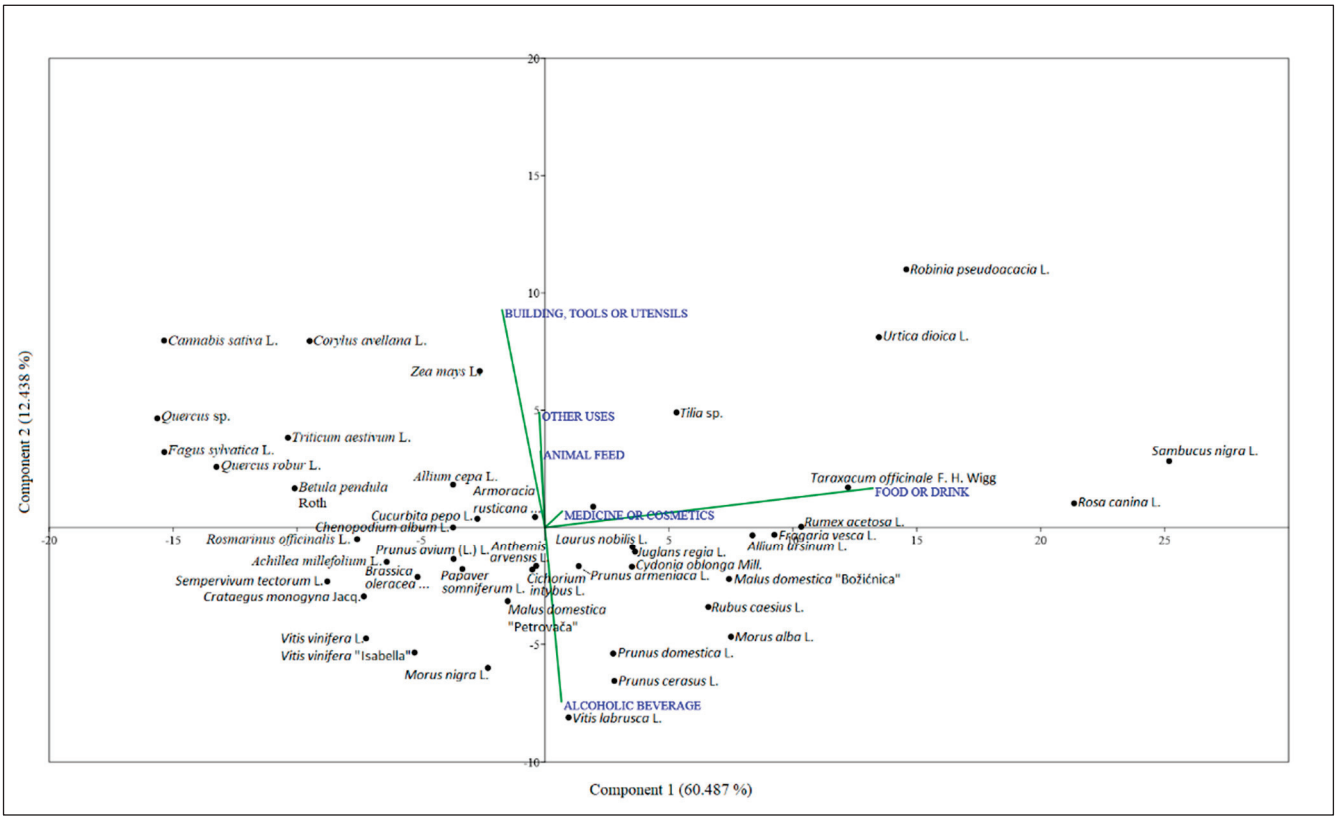

Figure 3. The PCA scatter with biplot for plants with 15 or more use reports.

The variable "Food or drink" has the highest positive loading of the first component. In the second component, the use categories "Building, tools or utensils" and "Other uses" have the highest positive loading, while the use category "Alcoholic beverage" has the highest negative loading. According to the PCA scores obtained, in the area of negative values of component 1, we find plants used for construction, manufacture of tools, and for other purposes not mentioned (Figure 3). In the second quadrant, we find plants used for the making of food or beverages, while in the third quadrant, we find edible plants and those used for the production of alcoholic beverages.

The number of interviews in which the use of a particular plant is mentioned is highest for the most frequently listed plant taxa: *Urtica dioica* (34) and *Sambucus nigra* (28), which means that all interviewees who mentioned these plants also mentioned at least one category of use for them. Relative frequency of citation (*RFC*) for these taxa is 0.900 and 0.775, respectively. The taxa *Robinia pseudoacacia* (*RFC* = 0.725) and *Rosa canina* (0.725) also have high *RFCs*. The plants with the greatest diversity of uses are *Morus alba*,

Rosmarinus officinalis, *Triticum aestivum*, and *Zea mays*. They all belong to seven out of the ten use categories.

The importance of the taxa for the study area was assessed using the cultural importance (*CI*) and relative importance (*RI*) indices. *Urtica dioica* (*CI* = 1.625), *Robinia pseudoacacia* (*CI* = 1.275) and *Sambucus nigra* (*CI* = 1.25) have the highest cultural value for the community. Two of the plants with the highest *CI* values are also among the three plants with the highest values of *RI*. Five plants with the highest *RI* are *Urtica dioica* (*RI* = 0.929), *Sambucus nigra*, (*RI* = 0.859), *Morus alba* (*RI* = 0.847), *Robinia pseudoacacia* (*RI* = 0.831), and *Tilia* sp. (*RI* = 0.734).

The most frequently used part of the plant is the fruit, which is mentioned 153 times. This is followed by leaves, with 83 mentions; above-ground parts, with 48; and seeds, with 45 mentions. Fruits are usually eaten, while the flower and leaf parts are used for drinks, medicinal purposes, and food. The chord diagram in Figure 4 presents the 15 plants with the highest *UR* according to their most frequently utilized parts.

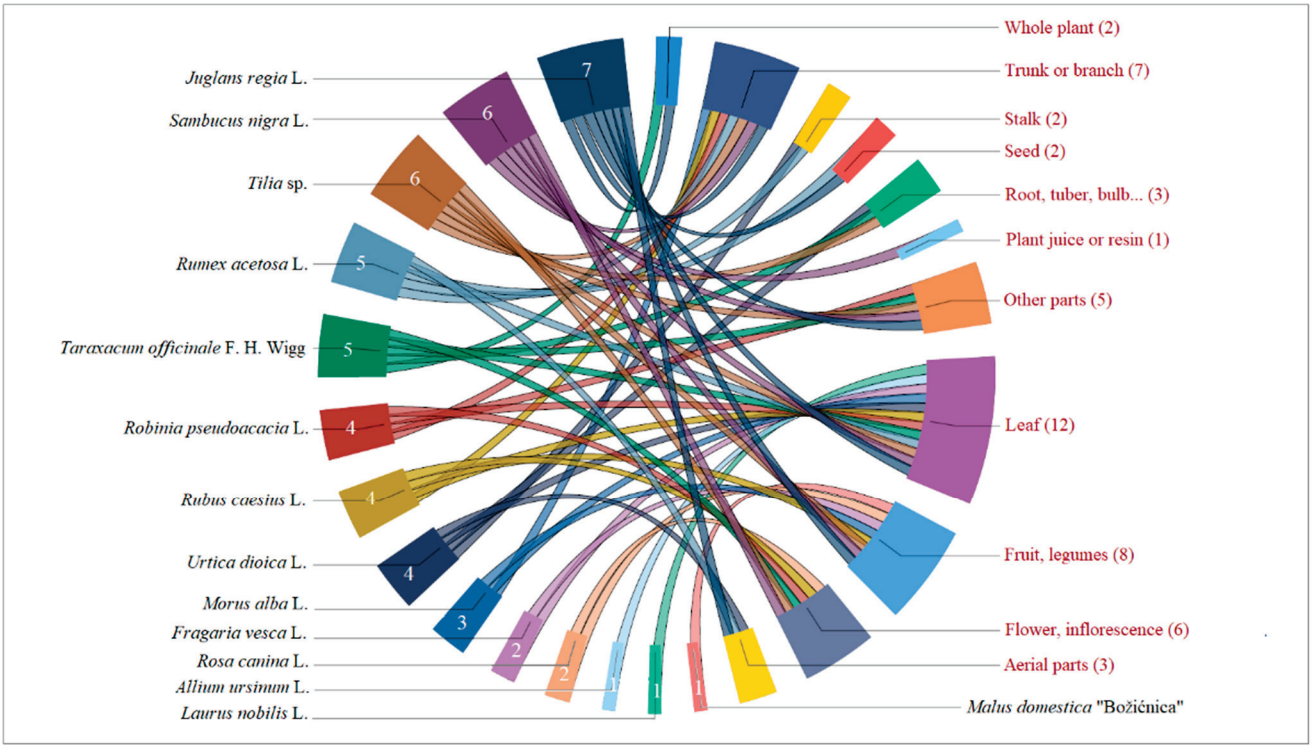

Figure 4. Chord diagram of plants with UR> = 15 and their commonly used plant parts in the NW Slavonia area. *(Note: The numbers next to the plant names indicate the number of plant parts used*).

2.1. Cultivated Plants

Since Northwest Slavonia is an agricultural region, the cultivation of plants has been an integral part of the duties and traditions of the local population. In the past, households were usually self-sufficient, producing their own food in vegetable gardens, vineyards, and orchards. It was common for housewives to spend their time in the vegetable garden as a secondary task to running the household. The food produced in the gardens and fields formed the basis for feeding people and domestic animals, as was also the case in the Central Lika region [24]. Surplus food was prepared and preserved for the winter using the following methods: drying, pickling, canning, storage in pits (mostly potatoes, using a pit called "trap" in Croatian), or in attics. Fruit species are mentioned particularly frequently, with *Malus domestica*, *Vitis vinifera*, *Prunus domestica*, and *Pyrus communis* as the basis of fruit consumption and the production of strong alcoholic beverages (brandy and liqueur). The fruits of these species were regularly dried for the winter and processed into jam. The

pear variety 'Tikvica' (*Pyrus communis* 'Tikvica') was most commonly dried. In Central Lika, the variety 'Jesenka' was used for this purpose [24].

The population of the studied area fed on cultivated fruit species from orchards and vineyards, and much less on wild fruit species. The apple tree was an indispensable fruit species, and its use was widespread, whether fresh, for pies, dried on a string or next to the oven, for making vinegar, compote, tea, brandy, juice, or baked as a dessert. We recorded a total of 19 varieties of apples.

The grapevine was an indispensable part of fruit growing. Due to their natural resistance to many diseases, the most grown grape varieties were 'Tudum' (*Vitis* x *labruscania*) and 'Izabela' (*Vitis vinifera* 'Isabella'). People favored these varieties because they produced the best yields at a time when only blue vitriol ($CuSO_4$) and Bordeaux mixture were used to protect the plants. Although the commercial production of 'Tudum' wine is forbidden today, the local population prefers must and wine from this variety. In the Samobor area, the local population also produced wine from the Tudum variety [26]. In the Virovitica area and the Žumberak–Somoborsko gorje [26], the varieties 'Isabella', 'Frankovka', 'Chardonnay', 'Kraljevina', 'Muškat', 'Pinot', 'Rheinriesling', 'Tudum' and 'Welschriesling' are cultivated, from which it can be concluded that the range of grape varieties in these areas was very similar.

The quince (*Cydonia oblonga*) was particularly prized in winter when few fresh fruits were available. It was used to make compote, jam, and quince cake: quince cheese, the local "kitnikez" (originally "Quittenkäse" in German). Quince was regularly placed on the bedroom cupboard as a room fragrance.

The walnut (*Juglans regia*) was regularly planted to celebrate the birth of a child, but also to provide shade in the gardens. The green fruits are used to make a strong alcoholic drink "orahovac", which is also mentioned in the Lika region [24] and Žumberak–Samoborsko gorje [26]. Its ground kernels are a common ingredient in various walnut cakes ("orahnjača"). The walnut leaf was used against pests (insects) or for smoking as a tobacco substitute.

Of the other fruit varieties recorded, brandy is made from figs (*Ficus carica*) or apricots (*Prunus armeniaca*). Mulberries (*Morus* sp.) are used for "dudovača" brandy, similar to the custom in the Mediterranean part of Croatia [24].

The local name and variety of apricot "kajsija", whose kernels taste like almonds (*Prunus amygdaloides* Schltr.), are also consumed. The apricot is gradually disappearing from the area of NW Slavonia due to late frosts.

In the 19th century, *Morus alba* and *M. nigra* were planted on a large scale in the territory of the Austro-Hungarian monarchy by order of the Austro-Hungarian Empress Maria Theresa in order to produce fodder for mulberry silk (L.), which was processed in two silk factories in the Virovitica region [12].

Laurel (*Laurus nobilis*) was an indispensable spice when pickling cabbage or preparing bean stew, and this custom was also widespread in other parts of Croatia [25].

Numerous ornamental flowers were an essential part of the well-tended garden. In addition to beautifying the garden, the flowers often had a useful value: chrysanthemums (*Chrysanthemum* × *morifolium* (Ramat.) Hemsl.) were brought to the cemetery especially for All Saints' Day, lilies (*Lilium candidum*) were carried to the church for the feast of St. Anthony (as in the town of Varaždin [25]), and were used to produce an ointment that promoted the healing of burns. *Forsythia* (*Forsythia* sp.) and narcissus (*Narcissus pseudonarcissus* and *N. poeticus*) were also prepared and carried to church on Palm Sunday (the Sunday before Easter).

Pelargonium (*Pelargonium zonale*) was a popular flower used by girls to decorate their hair (Virovitica Municipal Museum), which is also documented for the Žumberak–Samoborsko gorje Nature Park area [26].

The leaves of the ornamental plant *Hosta sieboldiana* are still used today as food to wrap meat with rice (in a dish called "sarma"). Dogan et al. [46] recorded a few dozen species used for this purpose in SE Europe and SW Asia, but this species was not mentioned

in their review and is an interesting local culinary tradition, maybe a recent innovation. *Hosta* spp. are however used in Japanese cooking [47].

Cannabis sativa and *Linum usitatissimum* were used for fiber production, as in the Varaždin region [25], Lika [24], and the Žumberak–Samoborsko gorje Nature Park area [26].

Sempervivum tectorum was planted in front of houses as protection from evil forces, or on roofs to protect houses from thunder. This belief is also present in neighboring Serbia [32], coastal parts of Croatia (ŁŁ, IVK personal observations, unpublished observations), and Poland [31].

2.2. Cultivated Vegetable and Cereals Taxa

Agriculture was practiced very intensively in the researched area. One of the reasons for this was the breeding of numerous domestic animals (cattle and horses), whose feed requirements had to be met. The main crops grown in the fields were: *Hordeum vulgare*, *Avena sativa*, *Linum usitatissimum*, *Triticum aestivum*, *Secale cereale*, and *Zea mays*.

The plants grown in vegetable gardens are still important today, and more recently the cultivation of *Ipomea batatas* was recorded. The interviewees state that, in the past, much more *Vicia faba* and *Pastinaca sativa*, different varieties of *Phaseolus vulgaris*, and *Pisum sativum* were grown, then "thrown away" and forgotten with the advent of modern varieties. To save space in the field, *Zea mays*, *Phaseolus vulgaris*, and *Cucurbita pepo* were often sown together, similar to the Varaždin region [25]. *Valerianella locusta* was also often sown between *Solanum tuberosum*.

2.3. Animal Feed and Medicine

Animals were called "treasures", and horses were loved and appreciated because they were a means of transport (carriage) and the most important "mechanization" for work in the fields. They were also a status symbol. Sometimes they were even treated as "family members". The "Lipicans" [48] were the most famous. Even today, there is a state stud farm for Lipicans in the town of Lipik.

The horses' feed consisted of *Zea mays* and *Triticum vulgare* seeds, to which *Urtica dioica* was added as a "healthy plant" and a source of protein. *U. dioica* was also fed to turkeys, chickens, etc.

In addition, common ragweed (*Ambrosia artemisiifolia*) and danewort (*Sambucus ebulus*) were used to prevent disease; they were given to horses to prevent and avoid blood poisoning, called "ukrviti se". This particular use is not known in the neighboring countries, but for comparison, in Western Herzegovina combinations of *Sambucus ebulus* juice, whole egg, oil, and soot were used against mastitis, and oak bark was used to release blood above the udder [49]. It is interesting that *A. artemisifolia*, an invasive plant from North America, became a traditional medicine for horses. Although occasionally recorded as a traditional medicinal plant in North America, its use in Europe is surprising [50]. Respondents claimed that the invasive *A. artemisiifolia* appeared during the Second World War with humanitarian aid packages from North America.

2.4. Wild Plants

In total, 108 taxa of useful wild plants were recorded in the study area. One possible reason for a relatively good knowledge of wild herbs is the organized buying that took place in the past in buying stations, where people brought collected herbs that were then resold to pharmaceutical factories. In this way, the local population was able to further increase their household incomes. Table 1 shows which herbs were sold (for sale).

Picking fruits or above-ground parts of shoots of perennial plants in moderate quantities is rarely problematic, except in the case of rare and endangered species whose harvest could endanger many edible and medicinal plant species [51]. In this category, the water nut (*Trapa natans*) is a nearly threatened (NT) species of Croatian flora, according to IUCN. It grows by water and is traditionally used as food, similar to chestnuts [37]. Its large seeds

are edible, have a sweet taste, and are rich in starch. They are eaten boiled, fried, or ground into flour.

Many wild-growing plants are of medicinal use and cultivated in gardens. Benedictine monks, who raised the level of health culture in Croatia, grew medicinal plants in their monastic gardens, and practiced medicine, are believed to have introduced this custom [36,52].

Plants are usually used in the form of infusions or decoctions. Alternatively, they are soaked in brandy. The leaves or grated roots are placed on wounds to drain pus and facilitate the healing process. The best indicator of trust in the healing power of plants is the large quantities of fresh and dried plants available every day at open-air markets in Croatia [36].

An interesting newly reported use is the utilization of young shoots of *Phragmites australis* for snacking, flour (boiled root), building material in traditional houses, and as shelter from the sun. A similar use as a sweetener (sugar substitute) has been documented for young shoots of *Arundo donax*, used in the Izola Region (Slovenia) [33]. It was most likely introduced during sugar shortages caused by World Wars I and II or by the poorest of the poor at the time. *Pteridium aquilinum* was used as a vegetable in the past. The shoots and underground rhizomes of the species are widely used as food in Asia [53,54], but the food use of the shoots has hardly been recorded in Europe. Only in the Basque region of Spain, young fronds were occasionally chewed raw as a snack [55], or cooked in Istria (Croatia) [22]. Occasionally also bracken rhozmes were used as famine food, e.g., in Belarus [56] and France [3].

At a time when coffee was not on the market or was very expensive, the local population prepared a substitute for coffee, so-called "white coffee", from the root of wild-growing chicory (*Cichorium intybus*) [22].

Some forest species had a special significance, i.e., they were revered and favored. These included many oak species (*Quercus* spp.) and the wild cherry (*Prunus avium*), whose wood was particularly valued for its hardness and color. The trunks ("majpan") of tall hornbeam (*Carpinus betulus*), beech (*Fagus sylvatica*), poplar (*Populus* sp.), or willow (*Salix* sp.) were felled on May 1st, placed onsite when the construction of a house began, or decorated with ribbons and placed in the central squares. This custom probably spread from Central European countries [57–59].

On the eves and mornings of holidays, magical procedures were performed to protect family members and animals from diseases and troubles throughout the year. Plants play a significant role in these rituals because they transfer their vital and protective power to people and animals. An illustrative example is a custom of washing one's face with water in which spring flowers (*Viola* sp., *Bellis* sp., *Taraxacum* spp., etc.), were soaked on the morning of Palm Sunday. Plants brought to church on the same day also symbolize health. *Cornus mas*, a plant of health par excellence, is the most important among them; its curative power is evident from the folk saying "healthy as a cornelian cherry" [36].

Other plants brought into the church, such as *Rosmarinus officinalis*, *Laurus nobilis*, *Taxus baccata*, *Corylus avellana*, and *Salix* sp., were also regarded as guardians of health. Their power was enhanced by the blessing of the church. In the Northern Croatian coastal region, olive and palm branches are brought to the church to be blessed [30].

The custom of using olive branches for Palm Sunday has recently (around 1980) spread from coastal parts of Croatia [30], and the blessed branches are kept until the next Palm Sunday to protect the house from bad weather. In some regions, these plants were burned as incense.

In another area of Slavonia, around Slavonski Brod, *Cornus mas*, *Salix caprea*, *Dipsacus sylvestris* Mill., *Filipendula hexapetala* Gilib., and *Epilobium parviflorum* L. are tied into a bouquet on Palm Sunday [43]. *Cornus mas* stands for general health, while the other plants are used for specific diseases. For example, the inflorescences of *Salix caprea* ("maca") are eaten for chest pain, *Dipsacus sylvestris* is used for scabies and mange, *Epilobium parviflorum* is burned as incense for skin rashes, and *Filipendula hexapetala* heals those afflicted by evil powers [43]. The bouquets in this area are also brought for consecration on other feast days,

e.g., on the feasts of St. John, St. Peter, and St. Paul. They are also kept for apotropaic purposes and to protect health.

2.5. Fungi

As many as 28 taxa of fungi were recorded, 27 of which are used exclusively as food. Eight were mentioned only once. Most fungi are used following heat treatment (boiling, frying). They are more rarely consumed raw. Sometimes they are preserved by drying or pickling. *Boletus* sp. (19 mentions), *Cantharellus cibarius* (16 mentions), and *Lactarius piperatus* (12 mentions) were the most commonly used (Table 1).

In comparison, *Agaricus campestris*, *Boletus edulis*, *Cantharellus cibarius*, and *Macrolepiota procera* are the most common in Northwestern Continental Croatia. In the Varaždin [25] and Central Lika regions [24], only the first three were mentioned. Only the use of *Boletus edulis* and *Cantharellus cibarius* was recorded in the Žumberak–Samoborsko gorje area [26]. Similar species to those recorded in our study area are also used in the Dalmatian Zagora [60] and other regions of Europe [57,58].

Auricularia auricula-judae is the only species stated to have only been used as a raw snack. The same name and use were recently recorded from Serbia [45], though there it was reported to have been used in salads or cooked in soups, and considered to improve blood vessel function. No other food use of the species has been reported as traditional in Europe.

Fomes fomentarius is a fungus used in beekeeping, where it is lit to smoke the bees. Its use as kindling has also been mentioned; it is particularly important because it keeps the embers burning for a long time. Interestingly, it is also used to make an infusion (hot drink).

In contrast to wild plants, which were traditionally not collected on a large scale because there was no need for them (no famine), wild mushrooms had always been collected and eaten in Slavonia on a large scale. The local population knew them and ate them without fear.

Fungi were mostly picked by men, who knew the forest better. Only known fungi were collected to avoid possible poisoning. The porcini mushroom (*Boletus* sp.) was most prized, and prepared as a sauce, breaded, or used as a spice in stews. The surplus was cut into thin slices and dried in the sun to preserve it throughout the year. Such a custom was also widespread in the Žumberak–Samoborsko gorje National Park [26] and in Varaždin [25]. For many, the sale of dried porcini mushrooms was an additional source of income.

Some fungi, such as the field fungi (*Agaricus campestris*), the honey fungi (*Armillariella* spp.), and the shield mushroom (*Entholoma clypeatum*) grew in orchards, which made them a special and easily accessible delicacy. They were prepared in goulashes.

Puffballs (Lycoperdaceae) were eaten as a raw snack or fried. They are also used in the neighboring Serbia [45].

The shaggy ink cap (*Coprinus comatus*) is not consumed with alcohol. It was suspected to contain the compound coprine, which can react with ethanol and have a toxic effect on the body. Therefore, alcohol should be avoided before, during, and after coprine consumption [61]. This view was widespread among the local mushroom pickers but finally, no coprine was found in this species [49]. In Serbia, *C. comatus* is used cooked or fried, dried, and used as chips. Medicinally, it is used for lowering blood sugar levels [45].

Evidence of the edible use of *Sarcoscypha coccinea* is of particular interest. It has hardly been reported as traditionally eaten in the past. Only in Serbia was it reported as part of a poached dessert [45]. However, the taxon has recently become popular in Europe, e.g., in the UK [62] and Poland (Łuczaj, personal observations, unpublished data) due to its interesting color and easy identification of the genus.

3. Materials and Methods

3.1. Description of the Area Studied

The Croatian region of Slavonia is not administratively defined, but in a broader sense, it includes the administrative areas of four counties (Osjek-Baranja, Požega-Slavonija,

Brodsko-Posavska, and Vukovarsko-Srijemska), the largest part of Virovitica-Podravska County, and smaller parts of Bjelovar-Bilogorska and Sisak-Moslavina Counties. Thanks to its soil resources and suitable climatic conditions, Slavonia is the most important agricultural area in the Republic of Croatia, especially for agricultural production, and is often referred to as the "granary of Croatia". The five counties that are wholly or largely part of Slavonia (out of a total of twenty-one counties in Croatia) make up 22% of the country's total area, while their share of the total area of arable land is 58% [63]. The average agricultural area in Croatia is 7.04 ha per farm, and 14.49 ha per farm in the Slavonian counties [63].

The climatic characteristics of this area can be described as a fresh continental climate. The average annual temperature in the city is 10 °C. Air temperatures rise throughout the year and reach their maximum in July and August. The climate in this area is characterized by the fact that there are no dry periods in the year and precipitation is distributed throughout the year. The total annual rainfall is 808 mm and there are two rainfall peaks per year, the first in June and the second in November. The lowest rainfall occurs in late summer, early fall, and winter. The area is a typical lowland region and lies around 80 to 130 m above sea level [64,65].

The geological conditions and relief favor the socio-economic upgrading of the area and are not a limiting factor for development. The settlements are located in the flat part of the town and on the gentle slopes of Bilogora, which ensures uninterrupted economic utilization and infrastructure development. The Slavonian economy has always been strong. At the beginning of the 20th century, the oak forests in the entire forest area began to be exploited through investments of French capital [10]. In the Virovitica area, the timber company Tvin d.o.o. was founded in 1913 and still produces furniture today. In 1976, Viro tvornica šećera d.d., a factory for the production and processing of sugar based in Virovitica, was founded. In addition, there used to be two silk factories for the production of mulberry silk [66].

3.2. Data Collection

The data were collected through interviews during extensive field visits to a Slavonian municipality—the town of Virovitica and surrounding settlements (Figure 5).

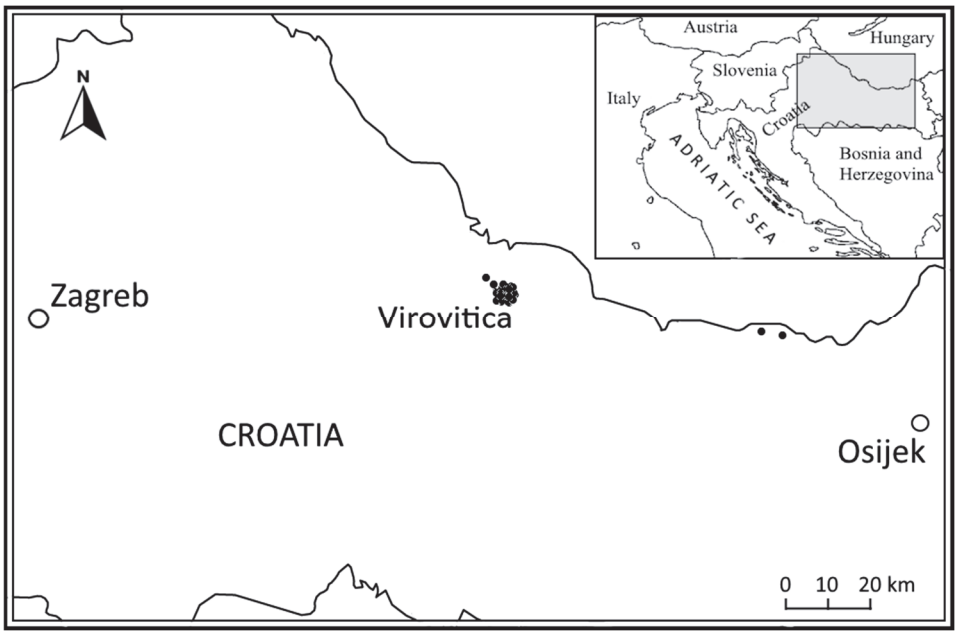

Figure 5. The geographical position of the Northwest Slavonia study site (source: based on the county and municipality maps of Croatia available at https://vemaps.com/croatia/ (accessed on 11 June 2024)).

The interviews were conducted in the period from July 2022 to September 2023 using the semi-structured method of in-depth interviewing and the technique of free listing. Interviewees were selected from the local population using local connections and the snowball method or based on recommendations from key interviewees. Whenever possible, the interviews were conducted outdoors so that the interviewees could not only name the plant but also see and recognize it. In addition to the fname, interviewees were asked about the plant's uses, the parts used, and the methods used to prepare or process the plant. Thirty-five people were interviewed, with an average age of 78.37 years, ranging from 48 to 96 years. The interviewees included 22 (63%) women and 13 (37%) men. The principles of the American Anthropological Association Code of Ethics [67] and the International Society of Ethnobiology Code of Ethics [68] were followed in conducting the interviews.

For each plant, interviewees could name one or more of the following modalities or categories for different uses: food, beverage (non-alcoholic), cosmetics, alcoholic beverage, animal feed, tool or utensil, building or construction, ceremonial use, medicine, and other unspecified uses. The use reports were then used to assess their importance to the inhabitants of the study area.

Standard floras for this area of Europe were used to identify and authenticate the plants, e.g., Nikolić's guide to the identification of the flora of Croatia [69], Pignatti's Flora of Italy [70], and the Flora Croatica Database [71]. The plant names are compared with WFO online [72]. The voucher specimens were collected, herbarized and stored in the herbarium of the Faculty of Agriculture of the University of Zagreb, ZAGR (http://herbarium.agr.hr/ (accessed 22 October 2023)). The fungi were housed at the Faculty of Agriculture of the University of Zagreb in Zagreb, and the names of the fungi follow the Index Fungorum [73].

3.3. Data Analysis

The following variables from the final dataset were used to analyze the collected data: interview ID, scientific plant name, plant family, useful parts of the plant, use categories, and the preparation method for its specific use (if available). Qualitative methods and quantitative ethnobotanical indicators were used for the analysis. To determine the level of awareness of a particular plant or fungus species, absolute frequencies (FC), i.e., the number of interviews in which a particular taxon was mentioned, were first used [74]. Additional use was made of relative frequencies (RFC), i.e., the ratio of FC to the total number of interviews (N = 40) according to Tardio and Pardo-de-Santayana [75].

$$RFCs = FCs/N, \tag{1}$$

For each taxon, we then determined the number of use categories, i.e., the number of uses per species (NU), which could range from zero to a maximum of ten available use categories.

For each taxon, a use report (UR), i.e., the total number of uses by all respondents (from i_1 to i_N) and all use categories for that taxon, was calculated. The following formula was used [74]:

$$UR_S = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} \tag{2}$$

The symbol *NC* stands for the number of different use categories, while *N* stands for the number of interviews or respondents.

The importance of the taxa for the study area was estimated using indices of relative importance (RI) and cultural importance (CI). The index of relative importance takes into account the position of the species in terms of relative abundance and the number of uses according to the taxa that have the highest values of these indicators. The RI_s index is the

average of the position of a taxon in relation to the number of surveys in which its use and number of different uses is mentioned:

$$RI_s = \frac{RFC_{s(\max)} + RNU_{S(max)}}{2}, \quad (3)$$

In the above formula $RFC_{s(max)}$ is the ratio between the taxon s and the taxon with the highest RFC_S value, and $RNU_{s(max)}$ is the ratio between the relative number of uses of *s* and the maximum value [75].

The index of importance for a given taxon s is the ratio of *URs* and the number of respondents *N* [75]:

$$CI_S = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}/N \quad (4)$$

where UR_{ui} is the use report for taxon *s*, i.e., the number of uses by all respondents and in all use categories.

The uniformity of the use of plants for the same use categories or the tendency to use a plant for a specific purpose is determined by the fidelity level (FL):

$$FL_s = \frac{N_s \cdot 100}{FC_s} \quad (5)$$

The symbol N_s is the number of respondents using plant s for a particular use, and FC_s is the frequency of mentions for that species [76].

Preliminary data analyses and calculations of descriptive statistics were performed using the program Microsoft Excel Version 2016, Microsoft Corporation, Redmond, WA (USA) [77]. Other calculations and analyses were performed with the package "ethnobotanyR" [78] in R, Version 4.3.2, R Foundation for Statistical Computing, Vienna, Austria [79]. To determine the relationship between the plants in terms of their use, we performed a PCA in PAST 4.03 [80]. For the PCA, we used a matrix with plant names in the rows and use categories in the columns, with the absolute frequencies given as values. The eigenvalues and eigenvectors of the variance–covariance matrix were calculated using the SVD algorithm.

4. Conclusions

Ethnobotanical research is a crucial first step for local rural development and small-scale trade in indigenous medicinal and food plants and fungi. High migration rates, depopulation, and aging are typical for the rural continental part of Croatia and lead to an accelerated loss of traditional ethnobotanical knowledge. Our study provides new information on the traditional use of plants in Croatia. New and interesting uses include food uses of *Hosta seiboldiana*, *Pteridium aquilinum*, and *Trapa natans*, and the ethnoveterinary use of *Ambrosia artemisiifolia* and *Sambucus ebulus*. Among the fungi, the use of *Sarcoscypha coccinea* is particularly noteworthy. To summarize, plants and fungi are an integral part of the diet of the local population, and their local names and uses are documented as part of local tradition. We should focus more on documenting this knowledge to facilitate its dissemination in the communities that possess it, or at least to preserve it for future generations.

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plants

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Article

Going or Returning to Nature? Wild Vegetable Uses in the Foraging-Centered Restaurants of Lombardy, Northern Italy

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Abstract: Wild vegetables (WVs) have been an essential source of human nutrition since ancient times. Foraging is a millennia-old practice that has gained more attention recently and is becoming fashionable, especially in restaurants in urban areas, as they attract customers who see WVs as an innovative sensory element and specialty food. Some cooks have used very few WVs for decades, but most chefs have only recently introduced them in their modern restaurants. Our study aims to have a deeper understanding of the diversity of WVs used by restaurants in the Lombardy region in Northern Italy and to know how they are introduced onto different menus, as well as the source of knowledge and the innovation paths related to the use/introduction of WVs in the selected sample of restaurants. Semi-structured interviews were conducted with 15 restaurant managers, chefs, and their professional foragers in the Lombardy region in Northern Italy in 2022; fifty-four wild plant taxa were recorded to be used in the considered restaurants. The collected data were analyzed to understand the current situation and the potential developments of this practice by exploring the reasons/motivations that underpin the inclusion of WVs in restaurants. A broad spectrum of restaurants was considered to evaluate the potential differences in handling and sourcing these ingredients. The results demonstrated that this trend has mainly been driven by attempts to revitalize traditional cuisines and to generate a positive impact on health, but the actual culinary preparations based upon WVs are often original and remarkably diverge from the Italian food ethnobotanical heritage. Moreover, concerns related to the environmental sustainability of these practices have been addressed.

Keywords: ethnobotany; wild food plants; Lombardy; Italy; chefs; gastronomy

1. Introduction

Wild vegetables (WVs) are those plant species gathered in the wild to be eaten as food or consumed as drinks [1,2]. WVs have been an important source of nutrition since ancient times, and they have played a crucial role in human survival for a long period of history [3–5]. Archaeological studies demonstrate that foraging wild plants occurred as early as 10,000 B.C. during the Early Pre-Pottery Neolithic age [6].

Due to several social and cultural factors, foraging has changed over time and space [7–9]. Wild foods still play a key role in some societies' diets, while others have abandoned using these resources [7]. The use of WVs has been linked in several studies to famine and war-time food [4,5,10], and often perceived from the 1970s onward, at least in the Western European realm and the Levant, especially by younger generations, as a non-prestigious food [3,11]. The decrease in the consumption of WVs, which is linked

to an increase in the availability of industrial food production and a detachment of people from nature, has led to the erosion of their associated traditional food and ecological knowledge [1].

Despite these negative trends, from the second half of the 20th century, renewed interest in WVs arose in several European countries [7,12,13], on a large scale, primarily in Northern and Central Europe and later also in the South of the continent. In the 1970s, the first interest in WVs by mass media rose with the publication of books such as "The Handbook of Edible Wild Plants" by Euell Gibson [14] and "Food For Free" by Richard Mabey [15].

In the past two decades, the practice of "foraging" WVs has gained immense popularity in the restaurant sector, especially among fine-dining restaurants, due to the remarkable role played by the Nordic Food Movement and, most notably, René Redzepi, one of the key ambassadors of this trend [16–18].

Traditional and non-traditional wild plants are increasingly used in the West's restaurant sector, combining ancient practices with innovative cooking techniques. However, the first prodromic interest in wild food plants was anticipated in Europe in France: in 1963, Jean and Pierre Troisgros created a dish that symbolized the nouvelle cuisine made of salmon escalope with *Rumex acetosa*. This example shows how high-end restaurants changed the perception of this product from being a famine food to a delicacy and an element to innovate their culinary offering [19].

At the end of the nineties of the past century, WVs emerged as the prominent pillar of cuisine by a few French chefs, such as Michel Bras, Jean Marie Dumaine, and Marc Veyrat, active in France, Switzerland, and Germany [20–22].

The link between food and the local landscape is through the inclusion in restaurants' menus of ingredients and dishes that represent the terroir and the taste of a place [23–26].

Most people perceive foraging, i.e., collecting food plants from the wild, as a sustainable practice that celebrates local produce, promotes well-being, and creates custodians of natural habitats [27]. Huang and Hall [28] claimed that food foraging can benefit the locality in terms of local seasonality, culinary culture, and biodiversity.

However, a careful literature study reveals essential concerns, especially regarding gathering specific species, which have gained the attention of the markets and, therefore, become often overexploited [29]. In a recent study among Nordic foragers, the awareness about bio-conservation and sustainability issues seems to be robust [30].

WVs have been studied in the past decade, especially in developing countries, as they are an essential source of nutrition for communities' diets [31,32]. Meanwhile, Western societies focus more on the role of wild food plants in the rural and sustainable development of peripheral areas [33,34].

The restaurant sector in the Global North is now using WVs often as they are promoted as a sustainable ingredient, usually locally sourced, widely available, and fresh [18]. Some WVs have been used by renowned international chefs in signature dishes. In the restaurant sector, the use of WVs (and more generally of local ingredients) has been pointed out as a strategy to strengthen the embeddedness of the restaurant in the local foodscape, to provide an ethical and environmental footprint to the restaurant, and to innovate the culinary offering of the restaurant [35]. As highlighted in academic studies and the media, the role of chefs as explorers and sustainability educators has emerged, as the examples in the robust corpus of literature show.

An increasing number of studies have delved into issues associated with the evolving patterns of contemporary foraging, such as those related to recreational activities [12,36–38] and the factors pushing this practice, as well as within the context of food-related activities such as tourism [39,40] and, to a lesser extent, the restaurant sector [41,42]. However, limited attention has been directed toward examining the dynamics that drive the incorporation of WVs in restaurants. Furthermore, there is a dearth of exploration into the primary implications of this phenomenon in terms of innovation trajectories and sustainability issues related to this emerging trend.

To partially fill this gap, we focused on the trend of foraging in restaurants in the Lombardy region (Northern Italy), one of Southern Europe's most dynamic and wealthiest areas.

We specifically aimed to:

- Record the diversity of utilized WVs and their dishes in selected restaurants in Lombardy and their culinary uses;
- Assess the main differences in the use of WVs according to the type of restaurants and their geographical location.

2. Results and Discussion

2.1. Wild Vegetables Used in Restaurants of Lombardy

Table 1 shows wild vegetables reported by our interviewees. In total, 54 taxa were documented with different frequencies, belonging to 31 plant families. Asteraceae, Apiaceae, Aspargaceae, Boraginaceae, and Caryophyllaceae were the most represented plant families. Among the recorded species, *Allium ursinum*, *Borago officinalis*, *Humulus lupulus*, *Taraxacum officinale*, *Oxalis acetosella*, and *Urtica dioica* were our informants' most frequently mentioned and used WVs.

Table 1. Table of recorded WVs used in the selected restaurants in Lombardy.

Scientific Name	Botanical Family	Common Name(s)	Part(s) Used	Culinary Preparations (Italics Refers to Traditional Lombardy Uses)	Frequency of Quotation
Achillea millefolium L.	Asteraceae	Achillea	Flowers and leaves	*Seasoning grappa*	C
Aegopodium podagraria L.	Apiaceae	Girardina	Flowers	Catfish with a mix of herbs	R
Alliaria petiolata (M.Bieb.) Cavara & Grande	Brassicaceae	Alliaria	Leaves and flowers	Decoration, dried and added on tomato sauce	C
Allium ursinum L.	Amaryllidaceae	Aglio orsino	Leaves and flowers	Pesto, *risotto*, stuffing for tortelli (stuffed pasta) with ricotta, *seasoning snails*	VC
Arctium lappa L.	Asteraceae	Bardana	Leaves and stems	Wrapped around a filling, blanched with garlic	R
Asparagus tenuifolius Lam.	Asparagaceae	Asparago selvatico	Shoots	Soups, *omelettes*, *and risotto*	C
Bellis perennis L.	Asteraceae	Pratoline	Flowers	Garnishing various preparations	R
Betula pendula Roth	Betulaceae	Betulla	Lymph	Syrup, wine, and desserts	R
Borago officinalis L.	Boraginaceae	Borraggine	Leaves and flowers	Salads and garnishing filled pasta	VC
Calendula officinalis L.	Asteraceae	Calendula	Flowers and leaves	*Salad* with miso and infused oil, infusions, and kombucha	C
Cetraria islandica (L.) Ach.	Parmeliaceae	Lichene	Thallus	Infusion	R
Chenopodium album L.	Chenopodiaceae	Farinello	The entire plant if young, otherwise the leaves	*Blanched*, *filling for pasta*, dried, *and gnocchi (malfatti)*	C
Chenopodium bonus-henricus L.	Chenopodiaceae	Paruch, Spinacio di montagna	Leaves	*Polpette* with cheese and *lasagne*	C
Cichorium intybus L.	Asteraceae	Cicoria selvatica	Leaves	*Blanched, as a side dish*	R
Clinopodium nepeta (L.) Kuntze	Lamiaceae	Nepitella	Leaves	*Infusions*	R
Foeniculum vulgare Mill.	Apiaceae	Finocchietto	Leaves and fruits	Pasta with mussels, *blanched*	C
Equisetum arvense L.	Equisetaceae	Coda cavallina, Equiseto	Fertile stems	Salads	R
Gentiana lutea L.	Gentianaceae	Genziana	Roots	*Seasoning grappa*	C

Table 1. *Cont.*

Scientific Name	Botanical Family	Common Name(s)	Part(s) Used	Culinary Preparations (Italics Refers to Traditional Lombardy Uses)	Frequency of Quotation
Helichrysum italicum (Roth) G.Don	Asteraceae	Liquirizia selvatica	Entire plant	Seasoning grappa	R
Humulus lupulus L.	Cannabaceae	Bruscandoli, Luppolo selvatico	Shoots	*Risotto, omelette, agnolotti* (stuffed pasta) with meat stew, soups, and *blanched and served with lemon*	VC
Lathyrus oleraceus Lam.	Papilionaceae	Pisello selvatico	Flowers	As a side dish of catfish	R
Malva sylvestris L.	Malvaceae	Malva	Leaves and flowers	Gnocchi (*malfatti*)	R
Melilotus officinalis (L.) Lam.	Fabaceae	Meliloto	Flowers	Infusions	R
Melissa officinalis L.	Lamiaceae	Melissa	Leaves and flowers	Pasta filling	R
Muscari comosum (L.) Mill.	Asparagaceae	Lampascione	Bulbs	*Fried*	R
Myosotis arvensis (L.) Hill	Boraginaceae	Non ti scordar di me	Aerial parts	Bittersweet syrup of spruce shoots with chocolate	R
Nasturtium officinale W.T.Aiton	Brassicaceae	Crescione	Aerial parts	Seasoning, esp. mussels and cabbage	R
Oxalis acetosella L.	Oxalidaceae	Acetosella	Leaves	Sorbet, infusions, and salad with almonds and watercress	VC
Papaver rhoeas L.	Papaveraceae	Rosole	Young aerial parts	Salads and *tortelli filling*	C
Parietaria officinalis L.	Urticaceae	Parietaria	Leaves	Soups and omelettes	R
Phacelia tanacetifolia Benth.	Boraginaceae	Facelia	Flowers	Decoration	R
Phytolacca americana L.	Phytolaccaceae	Fitolacca	Young shoots	Dessert	R
Picea abies (L.) H.Karst.	Pinaceae	Abete rosso	Shoots and pine cones	Pine cones in oil, bittersweet *syrup* with chocolate, and myosotis leaves	R
Pinus mugo Turra	Pinaceae	Pino mugo	Young pine cones	*Syrups*	C
Plantago lanceolata L.	Plantaginaceae	Piantaggine	Flowers and leaves	Salads, salt-cured, savoury pies, and pizza topping	C
Portulaca oleracea L.	Portulacaceae	Portulaca	Aerial parts	*Salads*	C
Poterium sanguisorba L.	Apiaceae	Pimpinella	Leaves	*Salads*, salads with bacon	C
Primula vulgaris Huds.	Primulaceae	Primula	Leaves and flowers	*Salads*, *blanched*, and garnish	R
Robinia pseudoacacia L.	Fabaceae	Acacia	Inflorescences	Garnish on pastries, *deep-fried*	C
Rumex acetosa L. and *R. acetosella* L.	Polygonaceae	Erba brusca, Acetosella	Leaves	Seasoning spaghetti with clams and black truffles	C
Rumex obtusifolium L.	Polygonaceae	Lapazio	Leaves	Rolls with trout filling	R
Ruscus aculeatus L.	Asparagaceae	Pungitopo	Shoots	*Fried with eggs* and mullet roe	R
Salvia pratensis L.	Lamiaceae	Salvia dei prati	Aerial parts and flowers	Syrups and infusions	R
Sambucus nigra L.	Caprifoliaceae	Sambuco	Flowers and fruits	Garnishing pastries; *infusions*, *syrups*, fried, tiramisù, lactofermented, jam, and panna cotta	VC
Silene vulgaris (Moench) Garcke	Caryophyllaceae	Silene	Leaves	*Salads, savoury pies*; with almonds, lemon, and black pepper; sesame *panelle* (chickpea flour fritters); with lettuce and sumac; accompanying grilled branches; as a side dish with black cherries and hazelnuts; crepes; and *risotto* with smoked butter	C

Table 1. *Cont.*

Scientific Name	Botanical Family	Common Name(s)	Part(s) Used	Culinary Preparations (Italics Refers to Traditional Lombardy Uses)	Frequency of Quotation
Silybum marianum (L.) Gaertn.	Asteraceae	Cardo mariano	Aerial parts and stems	In fava bean soups	R
Stellaria media (L.) Vill.	Caryophyllaceae	Pavarina	Leaves	Salads	R
Symphytum officinale L.	Boraginaceae	Consolida	Leaves	Salads, savoury pies, and pasta filling	R
Taraxacum officinale F.H.Wigg.	Asteraceae	Tarassaco	Leaves and roots	*Salad, filled pasta, coffee substitute (roots),* risotto, grilled snails, fried roots, fermented roots with legumes and cereals, and *tortelli* with *seirass* cheese	VC
Tilia spp.	Malvaceae	Tiglio	Leaves	Salads and soups	R
Tropaeolum majus L.	Tropaeolaceae	Nasturzio	Leaves	Pesto with hazelnuts and almonds and risotto	R
Urtica dioica L.	Urticaceae	Ortica	Leaves	*Filled pasta, tagliatelle green coloring agent, risotto, soups, and gnocchi with herbs*	VC
Veronica arvensis L.	Plantaginaceae	Ederella	Leaves	Blanched, as a side dish	R

VC—very common: quoted by five or more study participants; C—common: quoted by 2–4 study participants; R—rare: quoted by one study participant only; *italics* writing in the "culinary preparations" column: traditional uses.

Our results demonstrate a relatively high diversity of WVs compared to some previous ethnobotanical studies on WVs in Italy [43]; this could be attributed to the different origins of our study participants, which resulted in more diverse traditions and knowledge related to WVs. Previous studies from Italy have also shown that some of the highly reported species in our study (VC) are important species in many areas all over the country (e.g., *Borago officinalis*). A comparative study on wild food plant consumption in 21 local communities in Italy demonstrates that there are plants species that are common in various Italian regions (such as *Asparagus acutifolius*, *Reichardia picroides*, *Cichorium intybus*, *Foeniculum vulgare*, *Sambucus nigra*, *Silene vulgaris*, *Taraxacum officinale*, and *Urtica dioica*) [44,45]. All of these species (except *Reichardia picroides*) were reported in our study.

Ghirardini et al. [45] found the dominant botanical family for the top 15 quoted wild food plants in Northern Italy to be Rosaceae, while it is Asteraceae in Southern Italy. Our study highlights Asteraceae as the dominant family, which may be interpreted by our focus solely on WVs.

Most reported WVs were harvested for their leaves, shoots, and flowers but rarely for their roots. Some chefs are also using new parts of WVs and creating innovative recipes.

Some of our reported species can also be found cultivated in home gardens (e.g., *Tropaeolum majus* and *Foeniculum vulgare*); however, our study participants reported that they collect all of these species from the wild (unless mentioned otherwise).

2.2. Recipes with WVs

Traditionally, wild plants have been used for various preparations, both cooked and raw, depending on the season and the time they are gathered. However, they often must be blanched for a few minutes to be more digestible and palatable. Namely, they are used to prepare omelets, soups, pasta fillings, and quiche-like savory pies.

One of the most used plants in Lombardian tradition is *Taraxacum officinale*, which was used by our respondents both to recreate traditional recipes (using the leaves), such as risotto with *T. officinale* (*risotto al tarassaco*), filled pasta with ricotta and *T. officinale*, and salad with *T. officinale* and boiled eggs (Figure 1). However, to avoid food waste, the roots can also be used as a substitute for coffee by toasting them or as a starter by serving them fried. More innovative uses of this plant can be seen in high-end restaurants, where flowers of *T. officinale* are preserved in syrup with bittersweet spruce shoots syrup with chocolate

and myositis leaves. In other cases, it is fermented with legumes and cereals to create crumbs added on some first courses.

Figure 1. Wild vegetable-based dishes. **1**: Tortelli filled with *seirass (ricotta cheese)* and *Taraxacum officinale,* garnished with *Borago officinalis* and *Sambucus nigra* flowers and leaves of (cultivated) fennel. **2**: Pastry prepared with strawberries and *Sambucus nigra* flowers. **3**: Deep-fried flowers of *Sambucus nigra.* **4**: *Phytolacca americana* where young shoots are used for dessert. (Photo credits: S.B. and C.N.).

Urtica dioica is mainly used in traditional first-course dishes, such as fresh pasta, soups, or gnocchi, which are often prepared using *T. officinale, Allium ursinum,* mint, *Silene vulgaris*, *U. dioica*, and sage as well. According to some study participants, it tastes similar to arugula and can be consumed fresh when collected at the beginning of spring.

Rise Vartis (rice with young shoots of *Humulus lupulus*) is another traditional recipe. Many interviewees mentioned that such a dish would be eaten at their grandparents' house; according to them, the wild hop shoots resemble tiny asparagus shoots and have a slightly aromatic but delicate taste.

Some of our reported species have different other uses across Italy and neighboring countries. For example, in addition to the frying method of preparation, *Muscari comosum* is cooked and pickled to reduce its bitterness, it is also preserved in vinegar and eaten as an appetizer with several kinds of food [44,46].

"Frittelle di sambuco" (fritters made with the inflorescences of *Sambucus nigra*) was another typical sweet of childhood time for most of the study participants. *S. nigra* was also one of the most mentioned species, mainly used to produce syrups. However, in high-end restaurants, elderflowers are lacto-fermented and used as pastry ingredients. On the other hand, *A. ursinum*, the leaves are widely used to prepare a pesto sauce or to garnish first courses such as pasta. *Oxalis acetosella* is commonly used in salads and in the creation of innovative recipes.

2.3. Relationship between the Study Participants' Background and the Use of WVs

Out of the fifteen interviewees, only three were not originally from Lombardy, with one from Sicily in the south of Italy, another from Veneto in the northeast of Italy, and the third from the United States of America. The chefs' recipes reflected their place of origin and the area in which the restaurant is located as they use WVs that are locally foraged.

Our results show that some chefs used plants typical of their traditional area of origin, which does not necessarily match Lombardy's traditional domestic cuisine. For instance, the majority of the wild vegetables used by a Sicilian chef, the owner of a restaurant in Milan, are typical for the South of Italy (e.g., *Silybum marianum, Foeniculum vulgare,* and *Cichorium intybus*), who prepared some dishes such as fava beans puree and *Taraxacum officinale* and pasta with mussels and *F. vulgare*. However, the participant stated that when he moved to Milan, he began to integrate new species into his cuisine that he had never used before, such as *Borago officinalis*, despite the use of this species being common in both Northern and Southern Italy [45]. Meanwhile, another study participant (a chef), originally from Veneto, also reported that he often offers traditional recipes from his region (Veneto), such as wild hop (*Humulus lupulus*) risotto, which is also typical in Lombardy due to the geographical closeness.

It is interesting to notice how more traditional Lombardian restaurants tend to offer more first courses, such as pasta with wild vegetables; for example, one of the interviewed chefs offers gnocchi (*Malfatti*, a traditional Lombardian dish) made with *B. officinalis*, *U. dioica*, Grana cheese, and *Portulaca* and egg pasta with *H. lupulus*. One of the sampled restaurants, located in the province of Varese, also has on its menu *T. officinale* and *U. dioica*, which can be found in the following dishes: "Pasta filled with *B. officinalis*, perch fish, saffron (*Crocus sativus*) and edible flowers" and spelt gnocchi with *Urtica dioica* and hazelnuts (*Corylus avellana*).

Meanwhile, high-end restaurants tend to be more innovative in using WVs. One such restaurant is located in a small village in the Como province; it offers, for example, cow meat with sorrell and raspberries, risotto with watercress and fermented trout, and snails with *Allium ursinum* and the mushroom *Auricularia heimuer*.

2.4. Foraging and Study Participants' Knowledge of WVs

Restaurant chefs and staff managed to forage on their own if situated close to nature, and 70% of chefs and restaurateurs reported that they forage wild vegetables on their own. On the other hand, restaurants located more in the city center obtained wild plants gathered by professionals or retired women who had the knowledge to engage in this activity. However, even when chefs were buying wild plants from an external party, they showed deep understanding and interest, explaining that, when possible, they would forage in areas closer to the mountains.

Regarding the harvesting practices, the chef and owner of a fine-dining restaurant in the Como province explained that he maintains a constant presence, with the entire kitchen staff joining the foraging activities. He also imparts knowledge to newcomers on what and how to collect, eventually entrusting them with solo collection tasks for more straightforward items like *U. dioica* and *Robinia pseudoacacia*. While time-intensive, the team's self-sourcing of wild plants allows for selection of more sophisticated specimens and fosters a cohesive experiential bond among team members. However, as chefs are

usually busy with other tasks in the kitchen, they often ask the staff to gather the plants needed for the menu.

The restaurants in Milan stated that they rarely have time to forage and, therefore, ask independent foragers to provide them with the wild species they need. Most WVs are collected in the spring, between April and May, when the temperatures are not too elevated. However, due to climate change, the interviewees stated that the season of each plant is slowly shifting. Some species, such as *U. dioica*, *T. officinale*, and *H. lupulus*, grow both on plains and at higher altitudes. Therefore, they can be collected at different times and have a longer mountain harvest season.

A thorough examination of interviews with chefs and foragers unveiled a compelling interconnection among professional training, avenues of knowledge acquisition, and individual motivations that influence the incorporation of wild plants in restaurant practices.

Participants' statements consistently reference family traditions as the primary source of knowledge acquisition regarding the recognition and use of wild herbs. Quotes from participants underscore the generational transmission of such knowledge, emphasizing the pivotal role played by parents and grandparents in this process.

Most restaurants outside of urban areas inherited the business from their parents or grandparents and all the knowledge related to this practice due to their close contact with nature. While interviewing some chefs who owned or worked in restaurants in rural areas, it emerged that it was an integral part of people's lives to gather WVs. Many recipes are still the same tradition that represents the territory and gastronomy of Lombardy, being handed down from generation to generation. Still, nowadays, they are appreciated by customers, and this makes these restaurants unique. "*I inherited a cookbook from my mother, made of recipes that she gathered from friends, relatives and public libraries*", one participant reported. However, some participants reported that they have observed a change in traditional knowledge of WVs over time and space. In this context, Ghirardini et al. [45] proposed a hypothesis that the erosion of traditional knowledge in Southern Italy on wild vegetables is slower than in Northern Italy and also the likelihood that Southern Italians' have a higher appreciation of wild vegetables that have a strong and bitter taste.

One of the interviewees specified that she often uses alternative tools to recognize some plants she is not sure about by using software applications like "Herbarium", which is an application that provides a detailed description of a specific species just by taking a picture of it. Moreover, it allows you to save the previous plants you have researched. Only two interviewees, both chefs in experimental haute cuisine restaurants, reported acquiring their knowledge primarily within a professional setting.

2.5. Motivations for and Perspectives of WV Use

The interviews shed light on compelling motivations driving chefs to incorporate wild plants into their culinary offerings. Three primary themes emerged: the expression of local territory, the desire to uphold tradition, and the inclination to experiment and innovate from both a sensory and raw materials perspective. A notable aspect was the age-dependent prevalence of the desire to experiment and innovate, with exclusively younger interviewees, those under 45, expressing this motivation.

Most of the study participants emphasized the significance of their geographical location, considering it a responsibility and duty to reflect the endemic WVs found in the surrounding environment in their cuisine. The usage of wild plants is inherently tied to the natural setting, expressing a commitment to showcasing the region's diversity beyond conventional culinary pairings. One of our participants reported: "*The first reason is absolutely the place in which we find ourselves; here in nature, there are many endemic herbs, and it seems only right to use them*".

Even in urban settings, as in the case of a restaurant in Milan, participants acknowledged the significance of their location in influencing their choice to incorporate spontaneous plants into their cuisine. For some chefs, especially those who inherited the business from their parents, using WVs has been a common practice connected to the culinary

tradition of their families and communities. However, this activity changed from being related to survival to a recreational one as a way to reconnect to nature.

"*We started gathering wild plants 25 years ago. Our purpose was to add value to our land by using local products that are part of our gastronomic tradition*", one of the participants reported.

All restaurants indicated that communication on using WVs occurs through service staff who are knowledgeable about the ingredients and their origin. In some cases, pictures of the plant are shown to customers to give a better overview of the species used in a particular dish. However, only one restaurant stated that it uses the local and scientific names of WVs on the menu. Meanwhile, another chef reported that they do not like to stress the fact that they use uncultivated plants but prefer the dish to "talk for itself", as food needs to be enjoyed first.

Even though such communication is not accessible, one chef and owner of a restaurant in the Como province explained his perspective on this issue:

> "*On social media, we communicate the use of wild plants simply. Our goal is to explain our philosophy, emphasising that we use ingredients that we gather in the surrounding area. Meanwhile, I try to go more in-depth when I talk to a client interested in this topic*".

A few restaurants reported that they use social media to communicate the use of WVs and their story, which can be very powerful in educating customers. "*We tell the story of each plant and the origin of their local names both in the presence and through social media. We also organise experiences in the wild to show the plant to our customers. However, we believe that telling a story in person is more effective*", a chef and owner of a traditional restaurant in Pavia province reported.

Communities' perception of wild vegetables has changed with time, and until the 1960s, it was associated with a subsistence lifestyle. Moreover, the standardization and modernization of food production has accelerated the loss of this practice and knowledge [47]. Thanks to movements like the New Nordic Cuisine and Slow Food, traditional practices are being valued again, while chefs are determining new "transnational food identities" [48]. In general, chefs noticed that their customers are curious and knowledgeable about the wild foods they offer. In the case of long-standing customers, they are familiar with the ingredients used and sometimes ask the restaurant for some wild plants to take home. More often, customers become informed beforehand or ask several questions to gain knowledge about the story related to the specific variety. "*A while ago, people would criticise us, saying that we only served grass at the restaurant; meanwhile, nowadays, people enjoy and appreciate them*," one chef reported. As WVs were usually related to periods of hunger until 15 years ago, their use in restaurants was not seen in a good light. However, it is now perceived as an element of innovation.

Respondents agree that sustainability in foraging is a significant issue. If some plants become too prevalent in gastronomy, they might be overharvested. These concerns especially arise when roots are harvested, preventing the plants from growing again, particularly with perennial species. "*Having become fashionable, foraging faces a risk of no longer being sustainable. As long as I am in my small town where few people collect herbs, it is fine; however, when it becomes a trend, there is a serious concern*", one participant reported. Considering these sustainability concerns, we checked our reported species with the IUCN Red List and found no critically endangered species [49].

Consuming wild vegetables has many benefits, as they contribute to a healthy diet, promote local economies, and improve landscape multifunctionality [50]. Some of our documented species have been previously reported for consumption as "food-medicine", such as *A. ursinum*, *F. vulgare*, and *C. intybus* [8]. Overall, they have high economic potential for local people and health benefits, as they contain antioxidants, vitamins, and minerals, which are important, especially in the diets of communities from developing countries. They can also be used as a medicine, preventing chronic diseases such as obesity and type II diabetes [51]. Moreover, as they are uncultivated species, they have no cost and preserve tradition.

Our participants' perspectives on WV use mainly focused on environmental impact, health considerations, and the tension between fashion and tradition. While most respondents touched upon all three subjects, they presented varied arguments. From an ecological standpoint, foraging was viewed as having positive and negative aspects based on its practice. Harvesting was often deemed sustainable as it contributes to biodiversity preservation, aids pollination, and avoids using irrigation, pesticides, and fertilizers. However, concerns were raised about negative impacts when harvesting is carried out improperly or disrespectfully. Respondents emphasized the importance of responsible foraging to prevent environmental overexploitation. The health benefits of wild plants were highlighted by many, with ten out of fifteen respondents expressing satisfaction that foraging has become popular due to its potential health advantages. This is reflected in one of the participants' statements: "*There is a reason why our grandparents lived to be 90 y.o.*". Some mentioned that certain herbs can be more nutritious than fruits and vegetables when harvested correctly. Despite the positive outlook, there was a shared concern among some respondents about inexperienced individuals mistakenly consuming toxic or contaminated plants. The theme of the contrast between fashion and tradition was prevalent in eleven interviews. While some celebrated the continuation of a tradition dating back to "the dawn of time," others expressed discontent with foraging becoming a trendy activity. Critics argued that some people engage in foraging solely for fashion, misrepresenting cultivated plants as wild and diluting the practice's authenticity:

> *"In Italy, in difficult times, foraging was done out of necessity. Now, it has become a luxury. Many say they forage, but in reality, they buy. Just because it's edible, an ingredient is not necessarily good, like fermentation"*, one of our study participants reported.

However, comparing the quoted culinary preparation with the *Italian Compendium of Gastronomy* by the Italian Touring Club, published in 1931 [52], and with the survey conducted in Lombardy half a century ago by Nino Arietti [53], a crucial finding emerges: more than half of the contemporary restaurants' culinary preparations are not part of the traditional heritage of Italian cuisine (see uses reported in italics in Table 1). This is an essential outcome since the Traditional Knowledge (TK) regarding WVs that the study participants seemed to indicate as one of the drivers in using these wild ingredients has possibly been acting as a nostalgic trigger for the practice of foraging but less for the acting of processing/cooking WVs, as a lot of innovation seems to be currently embedded into the dishes that the considered restaurants offer.

This nostalgia was represented by a few participants' statements, such as:

> "*I started foraging with my grandfather as a kid. I remember going for walks in nature and collecting wild hops*" (conveyed by a forager born in northern Italy).

As for future developments, those who expressed opinions unanimously predicted a decline in the foraging trend. However, this decline was seen positively, with the belief that it would filter out those who engage in foraging solely for trend-following purposes, leaving committed and conscientious practitioners.

Two interviewees anticipated that foraging would persist mainly in regions with historical roots, emphasizing its connection to local traditions. Respondents hoped for increased awareness and responsible practices, anticipating a shift from trend-driven foraging toward a more thoughtful and professional approach.

Some of our study participants highlighted an increase in the time required for WV preparation due to inconsistencies in the availability of WVs, which consequently necessitated designing more flexible dishes and menus. *C. intybus* was mentioned as one of the most complex plants to clean and work with, as it always comes in different shapes and requires a lot of preparation. Some of our study participants reported that using WVs does not mean dominating nature but being wholly dependent on it. "*You cannot predict the availability of a certain product, it depends on the weather conditions and if it was a good year*", one chef stated. There is a paradigm shift, as chefs can no longer decide exactly which

ingredients to use on their menus, but have to wait until they receive the ingredients, and then they create the menu according to what they have.

3. Materials and Methods

3.1. Study Area

This study was conducted in the Lombardy region, situated in the Northern part of Italy. Moreover, in Lombardy, 25% of the land is characterized by protected areas, 24 regional parks, 3 natural reserves protected by the state, 67 protected by the region, and National Stelvio Park (the biggest national park in Europe).

Lombardy is located between the mountain Alpine range and the Po River, which creates the perfect conditions for rich flora and fauna. It is characterized by an extended plain (Pianura Padana), which covers 47% of the land; 41% of the land is occupied by mountains (Prealpi Lombarde, Alpi Orobie, Alpi Lepontine, and Alpi Retiche); and 12% by hills [54]. Lombardy's extensive territorial expanse, diverse morphological configurations, and the presence of lakes and rivers correspond to a remarkable climatic variety and, consequently, plant species diversity. The region boasts a total of 3220 floristic species, accounting for just under 50% of the national floristic diversity [55], including 61 endemic species, with 48 exclusive to Lombardy [56].

3.2. Field Study

Fieldwork research was conducted in Lombardy during spring 2022 (Figure 2). General scouting of restaurants in the Lombardy region was performed using web platforms and restaurant guides, including the Italian Michelin Guide and the Slow Food Osterie d'Italia Guide. In this context, the descriptions of the restaurants in the sources, as mentioned earlier, were reviewed to identify any specific mentions of WVs. Furthermore, by analyzing the websites and social media pages of these restaurants, we were able to outline the culinary offerings in general terms and gain a better understanding of the role and relevance of WVs on their menus.

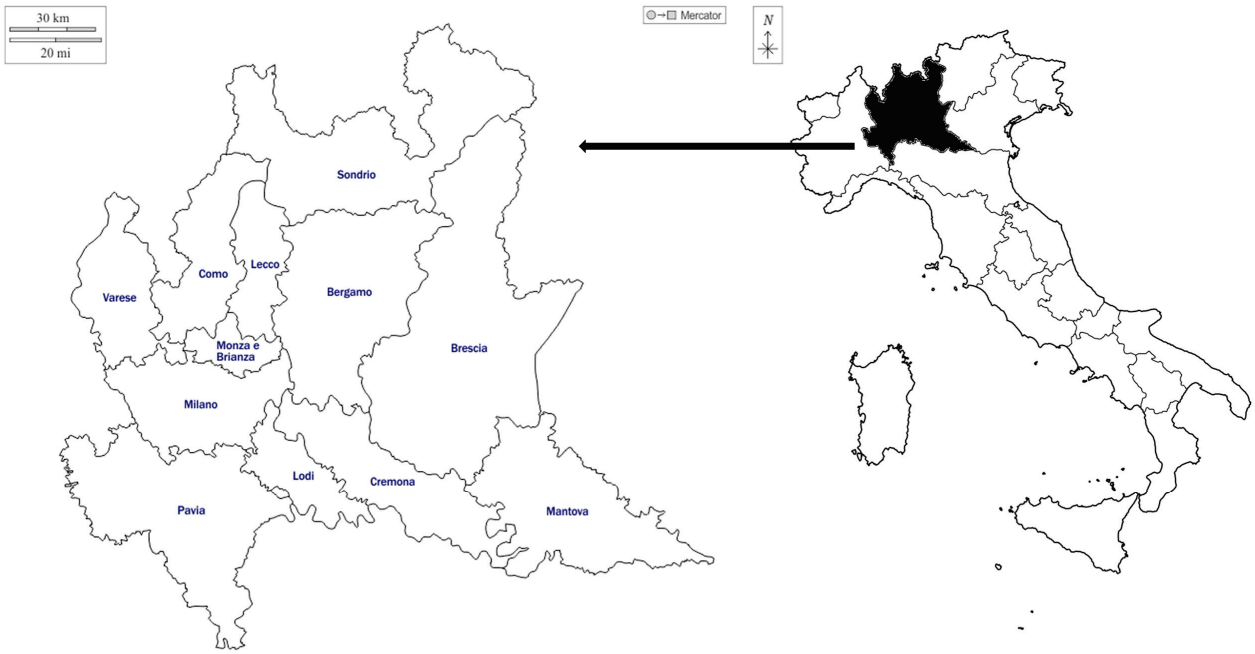

Figure 2. Study area map. Key locations: Bergamo (Foppolo), Como (San Fermo della Battaglia), Cremona (Stagno Lombardo, Lodi, Milano (Milano, San Bovio, San Felice), Sondrio (Madesimo), and Varese (Cuasso al Piano).

Based on the described criteria, we prepared a list of 25 restaurants in seven Lombardy provinces. Those restaurants were using WVs substantially and consistently rather than

occasionally. Subsequently, we contacted the restaurants to explain the research aims and to arrange interviews. Of the 25 restaurants, 11 (managers or chefs) agreed to participate in the study. Additionally, to gain a broader perspective of WV use in restaurants, we interviewed four professional foragers who gather WVs for a few of these restaurants (Table 2).

Table 2. Information on the study participants.

Participant Profession	Restaurant Name	Location
Cook/Chef	Radici Restaurant	San Fermo della Battaglia (Como)
Cook/Chef	Ristorante Cantinone	Madesimo (Sondrio)
Cook/Chef	Trippa	Milan
Cook/Chef	Ristorante Albergo Selvatico	Rivanazzano (Pavia)
Cook/Chef	K2 hotel e ristorante	Foppolo (Bergamo)
Cook/Chef	Cascina Lagoscuro	Stagno Lombardo (Cremona)
Cook/Chef	Pasta Madre	Milan
Cook/Chef	Erba Brusca	Milan
Cook/Chef	Lago Scuro	Stagno Lombardo (Cremona)
Manager	Molino del Torchio	Cuasso al Piano (Varese)
Manager	Erba Brusca	Milan
Forager	-	Milan
Forager	-	San Bovio (Milan)
Forager	-	San Felice (Milan)
Forager	-	Lodi—Parma

Both high-end/modern and traditional/popular restaurants were considered to ultimately have a better overview of the use of WVs in different restaurant settings and different territorial contexts, i.e., rural and urban areas.

The interviews took place between April and May 2022. Fifteen in-depth interviews were conducted with restaurant managers, chefs, and a few of their foragers. Half of the interviews took place in the urban area of Milan, as the restaurant density is higher and many facilities have implemented the use of WVs in their cuisine. In contrast, the rest of the restaurants were located in the most remote areas, in the provinces of Milan, Sondrio, Bergamo, Pavia, Varese, and Cremona, as more representative of the Lombardy cuisine related to the use of WVs.

The questionnaire was designed to gain a precise understanding of WV use in the restaurant sector. We applied the same questionnaire to the 15 study participants. However, specific parts of the questionnaire were discussed more in-depth based on the interviewee's profession; for instance, questions to the foragers were mainly focused on the foraging activity rather than the culinary ones and vice versa with the chefs.

Participants were firstly asked to list all of the WVs they forage and use in the restaurants. They were requested to report the plant's local names, parts used, seasonality, and culinary preparations. Additional inquiries were directed toward exploring the ethnobotanical knowledge sources of our study participants and the motivations behind incorporating wild plants into their cuisine. Informants were also asked to report the advantages and disadvantages associated with WV use in cooking, and how they market their WV-based dishes to customers. Discussions with our study participants delved into the current trend of foraging and its evolving role in the hospitality industry.

The Code of Ethics of the International Society of Ethnobiology was followed during this research, as every interviewee was previously notified of the aims and goals of this project [57]. Oral informed consent was required in order to be recorded during the interview and to publish the results of the research. Following the ethical obligations in ethnographic research, the results will be made accessible, maintaining respectful and ethical behavior [58]. Interviews were conducted in Italian; most quoted wild plant specimens had been collected, identified, and deposited at the UNISG Herbarium in previous ethnobotanical fieldwork conducted by some of the authors in NW Italy [59]. The non-collected species were identified using local names and plant descriptions following a previous (food) economic–botanical survey in the Brescia area, Lombardy [53].

The study was largely based on a qualitative analysis of the collected data. The interviews and the field notes were transcribed and analyzed using NVivo qualitative data analysis version 12.5.0 [60]. Data were analyzed using quality content analysis [61] to explore the main motivations, perceptions, and issues behind the inclusion of WVs in the culinary offerings of the selected restaurants. We calculated the frequency of plant citations based on the number of mentions by the interviewees.

Data gathered in the survey were compared with those of the *Italian Compendium of Gastronomy* by the Italian Touring Club, published in 1931 [52], and with the economic–botanical field survey conducted in Lombardy half a century ago by Nino Arietti [53].

The limitations of this study were mainly represented by the relatively small number of restaurant chefs who agreed to be interviewed on the studied topic. However, we tried to mitigate this limitation by conducting in-depth interviews with all of the study participants. Another limitation was related to the very scarce academic literature on the past use of wild plants in lowland Lombardy's cuisine since this practice, with the exception of the Alpine portion of the region, was possibly abandoned earlier than in other Italian regions or was not the object of ethnobotanical/traditional foraging studies during the past three–four decades, as has happened in other Northern Italian areas.

4. Conclusions

The results of this study show that foraging is a practice that is part of the tradition of every participant. Even if it is increasingly becoming a trend, the respondents showed real interest in the topic and detailed technical knowledge. It is a return to the roots, which can be positive by creating awareness about wild foods but could also lead to the overharvesting of specific species considered trendy in restaurants. Climate change also plays a vital role in the growth and use of these plants. Moreover, as more chefs move to cities such as Milan, combining traditional recipes with wild vegetables from different Italian regions creates new recipes that might become part of the Lombard tradition. Most restaurants in remote areas of Lombardy showed some relationship to tradition and old recipes, while more young and innovative urban chefs are developing new cooking techniques with WVs; however, more than half of the overall recorded culinary preparations are not part of the traditional heritage of Italian cuisine.

Overall, many have mentioned how foraging is an activity that helps them reconnect with nature and themselves. By cooking with wild foods, chefs cannot control directly which plants they will have on their menu, but they have to respect nature's cycle and cook with what ingredients are available. The COVID-19 pandemic increased the interest of chefs and customers in wild foods. Many foragers also built a strong community on social media by sharing their knowledge and creating curiosity, even among people unfamiliar with WVs.

Future research trajectories could more closely examine how restaurants can impact customers' and citizens' relationships with nature and wild foods.

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plants

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Article

Wild Edible Plants Used in Dalmatian Zagora (Croatia)

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Abstract: Background: Dalmatian Zagora has experienced significant depopulation trends over recent decades. The area is very interesting because of its rich biodiversity of species as well as its history of the use of wild foods. Since there is a danger of permanent loss of knowledge on the use of wild edibles, we focused our research on recording traditions local to this area. Methods: We conducted interviews with 180 residents. Results: A record was made of 136 species of wild food plants and 22 species of edible mushrooms gathered in the area. The most frequently collected species are *Rubus ulmifolius* Schott, *Cornus mas* L., *Portulaca oleracea* L., *Asparagus acutifolius* L., *Sonchus* spp., *Morus* spp., *Taraxacum* spp., *Amaranthus retroflexus* L., *Cichorium intybus* L., and *Dioscorea communis* (L.) Caddick & Wilkin. Conclusions: The list of taxa used is typical for other (sub-)Mediterranean parts of Croatia; however, more fungi species are used. The most important finding of the paper is probably the recording of *Legousia speculum-veneris* (L.) Chaix, a wild vegetable used in the area.

Keywords: ethnobotany; ethnomycology; wild food plants; Mediterranean diet

1. Introduction

The documentation of ethnobotanical knowledge holds significant scientific value, particularly in the present age, marked by rapid social transformations, diminishing plant biodiversity, and the erosion of traditional knowledge of wild plant uses [1].

In the Mediterranean part of Europe, there is a long tradition of using wild plants for nutrition and medicinal treatment. The Mediterranean diet is known worldwide to have many health benefits, and the consumption of wild Mediterranean foods has certainly played a part in this. The frequent collection of wild foods, especially wild green vegetables, can be seen as an important, but often overlooked, part of the Mediterranean diet [2,3]. There are numerous studies showing that the Mediterranean diet, rich in alpha-linolenic acid, is responsible for the prevention and suppression of cardiovascular disease [4,5]. Green vegetables, nuts, seeds, game, and wild seafood are good sources of omega-3 fatty acids, and wild-collected vegetables are particularly rich in antioxidants and alpha-linolenic acid [6,7].

The use of wild foods in southern Europe is unfortunately declining, but the memory of many interesting wild vegetables is still preserved [8–17]. In order to save this intangible cultural heritage from being lost, it is imperative that the last remnants of traditional knowledge and practices are captured, given their worrying decline [1].

Croatia is a Mediterranean country with rich plant biodiversity and a long tradition of using wild food and medicinal plants [14]. The first comprehensive ethnobotanical research in Croatia was carried out between 1962 and 1986 by Josip Bakić and his colleagues from the Institute of Naval Medicine of the Yugoslav Navy in Split [18]. Afterwards, there was a long pause in research on the use of wild plants in the area. This trend has changed, and new research has been carried out to fill this gap. Recent ethnobotanical studies have been carried out mainly in the Croatian coastal parts [12,14,19,20], and only to a lesser extent in

the hinterland [21–24]. In a review article of ethnobotanical research in Croatia, authors Ninčević Runjić et al. [25] observed that rural inland areas remain scarcely investigated and are at the risk of permanent loss of traditional knowledge held by the local elder population. A look at the available literature shows that Dalmatian Zagora has not yet been sufficiently researched and represents a valuable source of traditional knowledge. In Dalmatian Zagora, only two smaller areas—Knin [23] and Poljica [22]—have been explored so far, with a large area remaining uninvestigated. Moreover, there is little data on the traditional use of edible mushrooms in Croatia, and research about it is very sparse [14,21,22,24].

Geographically, three natural borders and one state border define Dalmatian Zagora. The coastal mountain range is the border to the coastal part of Dalmatia, the river Krka is the border to the west, and Vrgorsko polje is to the east. In the north, the border overlaps with the state border of Bosnia and Herzegovina [26]. Large parts of Dalmatian Zagora have been included in the Natura 2000 ecological network.

From a social perspective, Dalmatian Zagora has long been confronted with negative population growth due to depopulation, emigration, and aging of the population [27]. Historical upheavals and foreign invaders have had a strong influence on migration, but also on the customs of the inhabitants. In the late 15th and early 16th centuries, the Turks conquered most of Dalmatian Zagora. For the next hundred years, this area was the border between the Ottoman and Christian worlds [26]. Emigration processes in Dalmatian Zagora began a long time ago and have intensified in the second half of the 20th century through the process of littoralization and deruralization, meaning that economic activities, populations, and settlements become increasingly concentrated in coastal regions. This trend often involves the abandonment of inland settlements, leading to a migration of both people and resources from the interior towards the coast [28]. The influence of littoralization on Dalmatian Zagora can be seen in the processes of urbanization, deruralization, industrialization, and tertiarization. At the same time, this area has remained ecologically preserved due to the lack of hard industry [29]. All of the above factors, as well as changing dietary habits, have contributed to the decline of traditional knowledge and practices related to wild food gathering and indicate the urgent need to document remaining knowledge. Thus, the aim of the study was to record the use of wild plants and fungi as food and in drinks in Dalmatian Zagora. The findings of this study will contribute to our understanding of the botanical richness within the region and underscore the importance of preserving traditional knowledge before it is lost to time.

2. Results

We recorded 136 species of edible plants used in the area (Table 1). On average, a respondent mentioned 15 species of wild food plants. The most cited edible plant species were *Rubus ulmifolius* Schott, *Cornus mas* L., *Portulaca oleracea* L., *Asparagus acutifolius* L., *Sonchus* spp., *Morus* spp., *Taraxacum* spp., *Amaranthus retroflexus* L., *Cichorium intybus* L., and *Dioscorea communis* (L.) Caddick & Wilkin.

Table 1. Wild taxa of fungi and plants consumed in the study area.

Scientific Name	Local Name (s)	FB—Fruiting Body, FR—Fruit, L—Leaves, R—Underground Part, WH—Whole above Ground Part (Flowers and Leaves)	Preparation Method	Number of Use Reports	Voucher Specimen Number
Fungi					
Agaricus cf *macrosporus* (F.H.Møller & Jul.Schff.) Pilát	kračun	FB	fried	7	WA01
Agaricus spp. (other smaller species)	šampinjon, pečurka	FB	cooked, fried	29	WA02
Amanita caesarea Scop.	blagva	FB	fried, raw	9	WA03

Table 1. *Cont.*

Scientific Name	Local Name (s)	FB—Fruiting Body, FR—Fruit, L—Leaves, R—Underground Part, WH—Whole above Ground Part (Flowers and Leaves)	Preparation Method	Number of Use Reports	Voucher Specimen Number
Armillaria sp.	puza	FB	boiled	1	
Boletus edulis Bull.	vrganj	FB	boiled	16	WA04
Cantharellus cibarius Fr.	lisičarka	FB	boiled	9	WA05
Chroogomphus rutilus (Schaeff.) O.K.Mill.	borov čavlić	FB	boiled	2	
Clitocybe nuda (Bull.) H.E.Bigelow & A.H.Sm.	modrikača	FB	boiled	1	
Craterellus cornucopioides (L.) Pers.	trubača	FB	boiled	1	WA06
Coprinus comatus (O.F.Müll.) Pers.	gnjojištarka, gnojištarke	FB	boiled	2	
Hydnum repandum L.	prosenjak	FB	boiled	2	WA07
Hygrophorus russula (Schaeff.) Kauffman	medenka	FB	boiled	1	
Imleria badia (Fr.) Vizzini	kostanjevka	FB	boiled	1	WA08
Infundibulicybe gibba (Pers.) Harmaja	martinčica	FB	boiled, fried	5	WA09
Lactarius sect. *Deliciosi*	rujnica	FB	boiled	13	WA010
Leccinum aurantiacum (Bull.) Gray or *Suillus* sp.?	osinac	FB	boiled	1	
Lycoperdaceae	puhara	FB	boiled	2	WA011
Macrolepiota sp.	sunčanica	FB	boiled, fried	14	WA012
Morchella sp.	smrčak, smrčka	FB	boiled	6	WA013
Pleurotus ostreatus (Jacq. ex Fr.) P.Kumm.	bukovača	FB	boiled	2	WA014
Ramaria sp.	koraljka	FB	pickled	1	
Suillus granulatus (L.) Vill.	slinavac, krušćić, slinavka	FB	boiled	4	
Plants					
Achillea millefolium L.	stolisnik, hajdučka trava	WH	infusion, travarica	14	78776
Alchemilla sp.	divlja vrkuta	L	jeger	1	78854
Alliaria petiolata (M. Bieb.) Cavara & Grande	češnjača	L	boiled	1	78804
Allium ampeloprasum L.	divlji luk, divji luk	WH	boiled	24	78824
Allium sp.	divlji luk, divji luk	WH	boiled	28	78780
Allium ursinum L.	medvjeđi luk, divlji luk, sličke	WH	boiled	5	78855
Allium sphaerocephalon L.	koziroga	WH	boiled	1	78856
Allium nigrum L.	žbun-luk	WH	boiled	2	78857
Allium vineale L.	jukelj, ljukelj	WH	boiled	15	78858
Allium paniculatum L.	balučka	WH	boiled	2	78859
Amaranthus retroflexus L.	štir, šćir	L	raw snack, boiled	79	78860
Anchusa officinalis L.	boražina	WH	raw snack	2	78863
Arbutus unedo L.	maginja	FR	raw snack, liqueur	2	78765
Arctium sp.	čičak	L	mišanca	2	78861
Aria edulis (Willd.) M.Roem. (syn. *Sorbus aria* (L.) Crantz)	mukinja	FR	raw snack	15	78782
Artemisia absinthium L.	pelin	WH	travarica, liqueur	9	78807
Arum italicum Mill.	kozlac	L	mišanca	4	78799
Asparagus acutifolius L.	šparoga	SH	raw snack, boiled	99	78764
Asphodelus sp.	sindulji	R	raw snack	2	78823
Bellis perennis L.	tratinčica	WH	mišanca	3	78826
Beta vulgaris L.	blitva	L	mišanca, jeger	4	78862
Bunias erucago L.	grzdulja	L	boiled on its own or in mišanca	33	78864
Capsela bursa-pastoris (L.) Medik.	šurlin, šurin, rusomača	L	mišanca	23	78788
Castanea sativa L.	kesten	FR	jeger		78865
Caucalis platycarpos L.	podlanica	L	mišanca	1	78793

Table 1. *Cont.*

Scientific Name	Local Name (s)	FB—Fruiting Body, FR—Fruit, L—Leaves, R—Underground Part, WH—Whole above Ground Part (Flowers and Leaves)	Preparation Method	Number of Use Reports	Voucher Specimen Number
Celtis australis L.	kostela, koštela, kostelja, kostila, košten	FR	raw snack, liqueur, jam	64	78866
Centaurea solstistalis L.	kravlja gubica		boiled	1	78867
Centaurium sp.	kičica	WH	travarica	1	78868
Chenopodium album L.	loboda	L	mišanca	58	78811
Chondrilla juncea L.	mličika	L	mišanca	4	78869
Cichorium intybus L.	žutinica, konjogriz, radić, žuća, cikorija, jastrebljak, žutenica, ženetriga, vodopija, mličika	L, R	boiled, raw snack, dried and roasted for beverage	76	78870
Clinopodium nepeta (L.) Kuntze	[no name given]	WH	travarica	2	78871
Colutea arborescens L.	pucaljke	L, FR	young shoots and seeds, raw as children's snack	1	78872
Convolvulus arvensis L.	slak, slavak	L	mišanca	1	78873
Cornus mas L.	drijenak, drijen, drinja, drinjina, drina, drin, drinak, dren, drinovina, drenjina	FR	cooked for jam; in grappa, juice, liqueur, and travarica	112	78834
Crataegus monogyna Jacq.	glog, gloginja, bili trn	FR	raw snack, travarica	58	78874
Crepis sancta (L.) Bornm.	zečevac	L	mišanca	1	78786
Crepis sp.	krepis	L	mišanca	1	78832
Daucus carota L.	divlja mrkva, iglica, lovačka mrkva	FR, L, R	boiled, raw snack	32	78875
Dioscorea communis (L.) Caddick & Wilkin	kuka, blješt, blušć, kukača, bljušt, kukenjač	SH	boiled, raw snack	74	78822
Diplotaxis tenuifolia (L.) DC. and *D. erucoides* (L.) DC.	riga, divlja riga, nadimača, divlja rikula	L	mišanca, raw snack	7	78815
Erodium cicutarium (L.) L'Hér.	iglica, čapljan	L	mišanca	3	78827
Eryngium amethystinum L.	brnbeč	L	mišanca	1	78876
Erythronium dens-canis L.	pasji zub	R	boiled, raw snack	1	78877
Ficus carica L.	smokva	FR, L	juice, liqueur (FR), infusion (L)	2	78879
Filipendula vulgaris Moench	končara	R	raw snack	1	78880
Foeniculum vulgare Mill.	koromač, komorač	L, FR, stem	raw snack, mišanca, travarica, spice in sausage	71	78810
Fragaria vesca L.	šumska jagoda, medina jagoda, divlja jagoda	FR	mostly raw snack (FR), infusion (L)	21	78789
Fraxinus ornus L.	crni jasen	sap	sap	1	78881
Fumaria cf. *officinalis* L.	dimnjača	L	mišanca	1	78796
Galium aparine L.	broč, ljepljiva bročika	L	travarica	1	78798
Gentiana lutea L.	srčanik	R	travarica	7	78882
Geranium lucidum L.	krvavac	L	mišanca	1	78802
Helianthus tuberosus L.	divlji krumpir, čičoka, artičoka	R	boiled	1	78883
Helichrysum italicum (Roth) G.Don	smilje	WH	travarica	1	78766
Heracleum sphondylium L.	medvjeđa šapa, vučja šapa	L	mišanca	5	78884
Humulus lupulus L.	hmelj	SH	boiled like asparagus	1	78885
Hypericum perforatum L.	gospina trava, kantarion	WH	travarica	4	78781
Juglans regia L.	orah	FR	liqueur	22	78886

Table 1. *Cont.*

Scientific Name	Local Name (s)	FB—Fruiting Body, FR—Fruit, L—Leaves, R—Underground Part, WH—Whole above Ground Part (Flowers and Leaves)	Preparation Method	Number of Use Reports	Voucher Specimen Number
Juniperus communis L.	borovica, kleka	FR, L	travarica	4	78887
Juniperus macrocarpa Sm.	pukinja, pukinjaš	FR	travarica, raw	3	78888
Juniperus oxycedrus L.	smrič, smrikovina	FR	travarica, raw	26	78771
Lactuca serriola L.	divlja salata, salatuša	L	mišanca	4	78791
Lamium sp.	crljenak	L	mišanca	1	78829
Laurus nobilis L.	lovor	L	culinary herb for food, travarica	22	78767
Legousia speculum-veneris (L.) Chaix	zečje mudance, venerina zrcalica, mišje mudance, mačje mudance	L	mišanca	7	78889
Leucanthemum vulgare Lam.	ivančica	L	mišanca	1	78890
Malus sp.	divlja jabuka, divljakinja	FR	raw snack, boiled, vinegar	27	78893
Malva sylvestris L.	sljez	L	mišanca	3	78812
Melissa officinalis L.	matičnjak	WH	travarica	2	78891
Mentha spp. (*M. x piperita* L. & *M. spicata* L.)	menta	L	infusion, juice, culinary herb, travarica	11	78787
Morus alba L. & *M. nigra* L.	bijela murva, bila, crna, crvena murva, dud žutica i crnica (VC)	FR	raw snack, syrup, liqueur	95	78894, 78895
Myrtus communis L.	mirta	FR	travarica	1	78892
Nigella sativa L.	crni kim, žuta žila	L	mišanca	2	78896
Origanum vulgare L.	origano, mravinac	WH	culinary herb	14	78773
Paliurus spina-christi Mill.	drača (the fruit is called 'šeširić')	FR	travarica	3	78897
Papaver rhoeas L.	mak, makalj, kukurik	L	mišanca	72	78817
Parietaria judaica L.	crkvina	L	mišanca	2	78774
Plantago lanceolata L. (mainly) & *P. major* L.	trputac	L	mišanca	13	78830
Portulaca oleracea L.	tušt	WH	raw snack, mišanca	106	78898
Primula vulgaris Huds.	jaglac, jagorčevina	WH	raw snack, jeger	3	78899
Prunus cerasifera Ehrh.	divlja šljiva, đenerika, zerdelija, zerzelija, srdelija, razdelija, zerdelinka, šlama, srndelija, drndelija, zerzelinka, vinika, vinka	FR	raw snack, jam, juice	50	78900
Prunus mahaleb L.	rašeljka, rašejka	FR	liqueur, jam, raw snack	6	78901
Prunus persica L.	vinogradska breskva	FR	raw	1	78902
Prunus spinosa L.	trnina, trn sv. Ante, crni trn, gloginje	FR	raw snack, liqueur, jam	58	78903
Punica granatum L.	šipak, ljutur, ljuti šipak	FR	syrup, jam	3	78904
Pyrus communis L. subsp. *communis*	divlja kruška, divja kruškica	FR	raw snack	29	78835
Pyrus spinosa Forssk.	krušvina, divlja kruška, divja kruška	FR	raw snack	25	78905
Quercus sp.	žir, hrast	FR	roasted as coffee substitute	4	78769
Ranunculus sp.	vučja stopa, vučja stopica, vrania nožica	L	boiled	14	78831
Rhagadiolus stellatus (L.) Gaertn.	bila mličika, kosovac	L	mišanca	1	78878

Table 1. *Cont.*

Scientific Name	Local Name (s)	FB—Fruiting Body, FR—Fruit, L—Leaves, R—Underground Part, WH—Whole above Ground Part (Flowers and Leaves)	Preparation Method	Number of Use Reports	Voucher Specimen Number
Robinia pseudoacacia L.	bagrem	FL	boiled	1	78906
Rosa canina L.	šipurika, divlji šipak, svrbiguzica, šepurina, svrbiguza	FR	infusion, jam, liqueur	22	78907
Rosa x centifolia L.	ruža	FL	liqueur, syrup	7	
Rubus idaeus L.	malina	L	infusion	5	78908
Rubus ulmifolius Schott	kupina, jagoda	FR	raw snack, syrup, jam, liqueur, wine (FR), infusion (L)	122	78833
Rumex spp. (*R. pulcher* L., *R. crispus* L. and *R. acetosa* L.)	štavelj, štavolj, šćavelj, štavalj, ljuta trava, kiselica, kiseljača, teta lija	L	mišanca, raw snack	52	78800 78816 78792
Ruscus aculeatus L.	marine jagode, koprčine (Radošić)	SH	boiled	1	78909
Ruta graveolens L.	rutica, rutva	FL, L	travarica	3	78910
Salvia officinalis L.	kadulja	L	syrup, liqueur, travarica, culinary herb	36	78778
Salvia rosmarinus Spenn. (syn. *Rosmarinus officinalis* L.)	ružmarin, ruzmarin	L	culinary herb, travarica	40	78775
Sambucus nigra L.	bazga, zova, zovina, zovkovina	FL, FR	syrup, liqueur, jam, boiled	47	78911
Sanguisorba minor Scop. subsp. *balearica* (Nyman) Muñoz Garm. & C. Navarro	krvara, mala krvara	L	mišanca	2	78801
Satureja montana L.	vrisak	L	culinary herb, travarica	24	78777
Scandix pecten-veneris L.	venerin češalj, koromačika	L	mišanca	1	78814
Scorzonera sp. & *Gelasia villosa* (Scop.) Cass.	turutva, turita, kozja brada	L, R	mišanca	21	78819
Silene latifolia Poir.	volujsko uho, volovo, volunje uho, zečje uši, ušac, volunjski ušac, tušac	L	mišanca	16	78794
Silene vulgaris (Moench) Garcke	škripavac, pucavac, pušina, pucalina	L	mišanca	26	78808, 78797
Smyrnium cf *perfoliatum* L.	prorasla lesandra, lesandra	L, T	boiled	2	78912
Sonchus spp. (*S. oleraceus* L. and *S. asper* (L.) Hill.)	kostrić, kostriš, radić, trnak, bijeli trnak, trnjak, brnbeć, skulovac (Prim. Dolac), kozja brada, šušak	L	mišanca	92	78805
Sorbus domestica L.	oskoruša	FR	raw snack, liqueur, jam	35	78770
Torminalis glaberrima (Gand.) Sennikov & Kurtto (syn. *Sorbus torminalis* (L.) Crantz)	brekinja	FR	raw snack	9	78768
Stachys cretica L.	ranjenik	L	mišanca	1	78913
Stellaria media (L.) Vill.	mišjakinja	L	mišanca	1	78914
Taraxacum spp.	maslačak, divlji radič, radić, smrčika, slačak, mličika	L	mišanca	75	78821
Teucrium chamaedrys L.	dubčac	WH	travarica	1	78820
Teucrium montanum L.	trava iva	WH	travarica	11	78806

Table 1. *Cont.*

Scientific Name	Local Name (s)	FB—Fruiting Body, FR—Fruit, L—Leaves, R—Underground Part, WH—Whole above Ground Part (Flowers and Leaves)	Preparation Method	Number of Use Reports	Voucher Specimen Number
Thymus longicaulis C. Presl & *T. serpyllum* L.	majčina dušica	WH	culinary herb, travarica	14	78809 78772
Tilia sp.	lipa	FL	infusion	1	78915
Tordylium apulum L.	mačja muda	L	mišanca	1	78916
Tragopogon sp.	kozja brada	L	mišanca	5	78818
Tussilago farfara L.	podbijel	WH	jeger	1	78917
Urtica dioica L. and other *Urtica* spp.	koprva, kopriva, žara	L	boiled	63	78828
Valerianella cf. *locusta* L.	lucina pica, divlji matovilac, macina pica	L	mišanca	12	78813
Veronica persica Poir.	čestoslavica	L	mišanca	1	78795
Vicia faba L.	divlji bob	L	mišanca	1	78803
Viola odorata L.	ljubičica	FL	raw snack, jeger	4	78779
Viola arvensis Murray	kokošija volja, kokošja volja, kokošija voljica, kokina voljica, šena	WH	mišanca	32	78783

We also recorded 22 taxa of edible fungi (Table 1), but only 16 taxa are eaten by more than one informant. On average, 0.8 species of fungi were mentioned per interview (only 30 informants, i.e., 18% of them, mentioned gathering fungi). The most commonly mentioned were *Agaricus* spp., *Boletus edulis*, *Lactarius* section *Deliciosi*, *Macrolepiota*, and *Cantharellus cibarius*. Fungi are gathered mainly in Sinj and Vrlika, with reports from seven informants per settlement out of the total 30 for the whole studied area.

In the entire Dalmatian Zagora, the largest number of taxa in terms of the mean number of species listed per interview was recorded in the Sinj area (25 species), then followed by Zagvozd and Podbablje (22) and Runović and Zmijavci (20). The lowest mean number of species was recorded in Šestanovac, Zadvarje, and Omiš (10), Prgomet (12), and Unešić and Ružić (12). There was a moderate positive correlation ($r = 0.51$, $p = 0.044$) between the mean number of species mentioned per interview and the number of inhabitants in each of the 16 studied units (regions). The units in which more than the average numbers of species were mentioned tend to be located east of Split, and those with the lowest knowledge were in the west. The number of cited species exceeded forty in four interviews: two from Sinj (sixty-one and forty-seven species), one from Podbablje (forty-five species), and another from Runovići (forty-four species).

The most collected parts were green parts (47%), followed by fruits (41%), flowers and flowering shoots with leaves (9%), and underground parts (3%).

Mišanca, also called divlje zelje, is the most commonly made wild dish, prepared in all parts of Dalmatian Zagora from different wild vegetables such as *Sonchus oleraceus*, *Taraxacum officinale*, *Cichorium intybus*, *Allium ampeloprasum*, *Chenopodium album*, *Bunias erucago*, *Viola tricolor*, *Rumex* sp., *Foeniculum vulgare*, *Allium vineale*, *Bunias erucago*, *Silene vulgaris*, *Papaver rhoeas*, and *Capsela bursa-pastoris.* Vegetables are boiled for a short time, often with the addition of potatoes. At the end, they are seasoned with salt and olive or sunflower oil.

The second most common dishes mentioned by respondents were *Dioscorea communis* and *Asparagus officinalis* eaten as a raw salad, or briefly cooked or fried with eggs, and seasoned with olive oil or vinegar. *Portulaca oleracea* was often mentioned as a favorite single-species salad.

A specialty associated with the Imotski region is the plant grzdulja, grdulja, i.e., *Bunias erucago*. It is mentioned numerous times by informants and also occurs in the records of the

priest Silvestar Kutleša (1876–1943) [30], who wrote down the folk knowledge and customs of the people in the Imotski region. In the book, he mentions the frequent folk use of other wild plants: *šurlin* (*Capsela bursa-pastoris*), *sparoga* (*Asparagus officinalis*), *koprva* (*Urtica* sp.), and *bljušt* (*Dioscorea communis*). *Grzdulja* used to be boiled and seasoned with oil, butter, or lard; today, it is usually cooked with dried meat or as a vegetable pie.

Mushrooms are usually fried and served as a side dish and rarely cooked in stew (goulash or sauce). Apart from the drying of *Boletus edulis*, there is no tradition of mushroom preservation. The use of mushrooms in villages near Trilj and Sinj is related to their location by the river Cetina, where the agroclimatic conditions are suitable for their growth.

Wild fruits are often mentioned as having versatile uses. They are usually used ripe for immediate consumption or, more rarely, dried. They are also made into jam, liqueur, or compote. One frequently mentioned species is *Rubus ulmifolius* Schott. Older interviewees, in particular, stated that they ate it as children but also picked it for sale and used the money earned to buy books for school. *Celtis australis*, *Cornus mas*, *Prunus spinosa*, *Morus nigra*, and *M. alba* were mostly eaten while herding cattle on the pastures. The importance of the mulberry tree for the population's diet is demonstrated by the popular saying "Pure i murve", "polenta and mulberry", which were eaten together as a poor man's meal. *Aria edulis*, *Torminalis glaberrima*, *Sorbus domestica*, *Pyrus communis subsp. communis*, and *Malus sylvestris* were frequently eaten in the past, but respondents state that they rarely consume them today.

Some of the plants mentioned in the list are only used to flavor traditional alcoholic drinks, mainly *travarica*, where the >40% rakija contains a mix of several aromatic herbs, most commonly *Satureja*, *Salvia rosmarinus*, *Laurus nobilis*, *Foeniculum vulgare*, *Teucrium* sp., etc. Two respondents also mentioned a new trend of making *jeger*, a homemade Jägermeister-like drink inspired by the famous German liqueur. The difference between *travarica* and *jeger* is that the latter is made with plants more typical of the continental part of Croatia, as the people have borrowed the recipe from Germany; it is also sweetened, in contrast to the dry *travarica* made with aromatic Mediterranean herbs.

3. Discussion

The number and composition of wild foods gathered in the area is similar to other parts of southern Croatia [14,19,21,22]. In the research conducted in Dubrovnik, the usage of 95 wild edible species was documented [14]. On the Adriatic islands, 89 taxa of wild vegetables were identified [19], whereas 55 species were recorded in the Zadar area [21]. Additionally, the number of wild foods in the Krk and Poljica regions was 80 and 76, respectively [22]. The composition of wild foods comprising mainly wild vegetables is typical for the Mediterranean in contrast to Central Europe where the use of fruits and mushrooms dominates [11,31].

Although the most commonly mentioned species are widely known as edible, we found at least the memory of the use of some more unusual food plants.

Legousia speculum-veneris (L.) Chaix was mentioned by several informants as a wild vegetable eaten in the area. The use of this species as food has been reported in the literature only by Paoletti [32] in the Friuli region in NE Italy.

Another interesting species is *Arum italicum* Mill. Although plants from this genus are occasionally used in southwestern Asia and the Caucasus [33–36], it is not widely used in Europe nowadays as a food plant due to it incredibly sharp taste when eaten raw or underprocessed, owing to the presence of oxalates. According to Paura and Di Marzio [37], Arum sp. has been utilized as a food source across various regions of Europe, particularly valued for the starch extracted from its tubers, which is used in bread preparation. In Bosnia, the tubers of *Arum italicum* and *A. maculatum* continue to be employed in the cooking of boiled meats or focaccia [38]. Albania had a history of consuming *Arum italicum* during times of scarcity, with its usage evolving over time [39]. Additionally, the leaves are consumed in southeastern Europe after being boiled repeatedly, while in Switzerland Arum leaves are ingested in spring as part of a cleansing regimen [40]. In Italy, *Arum italicum*

and *A. maculatum* are predominantly recognized for their medicinal properties, finding application in various ailments [41].

One more interesting species is *Centaurea solstitialis* L., previously mentioned as used only in the Ravni Kotari area near Vrana [21]. In the abovementioned paper, the species was only reported with the local name kravlja gubica (the same as in Zagora, literally "cow's face") and it was only a year after the publication of the paper that the authors identified the taxon, which is also eaten in Turkey [42].

It should be noted that over a third of the species in this study were mentioned only by one informant. The researcher is in a difficult position when assessing the use of species mentioned only by a single informant, as this information may be confounded by several factors:

1. Relic uses—species once used more frequently, now remembered by one person;
2. Rare uses—in cases when the plant was never an important useful species used only, e.g., as famine food;
3. Idiosyncratic uses—uses restricted to one person are sometimes developed by them through experimentation or observation of foraging animals, e.g., sheep, goats, or pigs;
4. Mistaken identification—when the informant does not remember the species well or supplies a mistaken voucher specimen.

In the case of our study, in most instances, we could assess the reliability of one-informant mentions by comparing local names and uses of plants in the neighboring regions. Some doubts remained concerning two uses not recorded elsewhere in the Balkans: *Fumaria officinalis* and *Erythronium dens-canis. F. officinalis* is a relatively toxic medicinal plant, so it was surprising to see it in a wild vegetable mix, and care should be taken with using it. In the case of *E. dens-canis*, ours is the first record of its consumption in the Balkans. The species has edible, starchy, and delicious underground corms. Only Sturtevant [43] mentions the use of the species in west or central Asia, quoting Gmelin (1747) [44]. He wrote that Tartars collected and dried the bulbs and boiled them with milk or broth [43], but this probably refers to the species sensu lato, now classified as *E. sibiricum.* The latter was widely eaten in Siberia [45], and *E. japonium* was consumed by the Ainu in Japan [46]. The American species of *Erythronium* were an important food item for the ethnic groups that lived in the western part of North America [47].

The presented data show that wild edible mushrooms are gathered by many inhabitants, although the inventory of most frequently used species is not long. By comparing out findings with other data on fungi uses in Europe, we could conclude that the local population is somewhere in the middle of the mycophilia–mycophobia spectrum invented by Wasson [48]. Some species are known by a portion of the population but there are also people who neither know or collect them. The reason for the relatively low interest in mushroom gathering may be the dry climate and the scarcity of wooded areas near settlements.

The relatively large list of wild vegetables and the frequent use of several of them place the local population high on the herbophilia spectrum [31], typically for the Mediterranean part of Europe, where gathering wild vegetables is one of the important though overlooked parts of the Mediterranean diet [2,3,13,49–54].

Another use of wild taxa recorded in research area was for preparation of traditional alcoholic beverages, mainly *travarica* (grape pomace distillate flavored with single or mixed species), that have received limited attention from researchers so far in Croatia [24,55]. What is worth highlighting is that nearly all the plants mentioned are either wild or cultivated locally, and the alcohol is produced locally, showing that traditional alcoholic beverages have a great role in the traditional culture and social life of the studied communities. This particularity related to alcoholic beverages was also recorded in the Tuscany and Emilia-Romagna regions [56,57].

Recently Łuczaj [1] wrote about the urgent need to record the disappearing uses of plants in the world. The large number of uses mentioned only by single individuals in this study illustrates the devolution of human–plant interactions. Here, in Dalmatian Zagora,

some uses that were probably widely known by most inhabitants of many villages are now remembered by a single person in one.

4. Materials and Methods

4.1. Study Area

Dalmatian Zagora, while not an officially recognized administrative unit, is a conceptually expansive term delineating a region outlined by Delić [58]. Dalmatian Zagora represents part of the Dalmatian hinterland, and exact boundaries are given by the following authors. The definition by Faričić and Matas [26], corroborated through empirical research by Vukosav [28,59], forms the basis of its geographical extent, encompassing areas beyond the coastal hills of Trtar (738 m), Opor (650 m), Kozjak (780 m), Mosor (1330 m), Omiška Dinara (864 m), Biokovo (1762 m), and Rilić (1155 m). Its northern border aligns with the state border of Bosnia and Herzegovina, the western frontier is traced by the Krka basin, and the eastern border includes Vrgorsko polje and Rastok polje (Figure 1).

Figure 1. The area of Dalmatian Zagora.

Administratively, Dalmatian Zagora spans the territory of two counties: Split-Dalmatia and Šibenik-Knin, comprising 8 cities, 25 municipalities, and 293 settlements [60]. The 2021 Census reported 157.534 inhabitants within Dalmatian Zagora, among which there were 90.282 rural residents [61]. Dalmatian Zagora included a quarter of the population of the two counties in which it is located. At the same time, Dalmatian Zagora covered over 50% of the territory of these two counties. This disparity in population density is a consequence of littoralization and exceptional polarization between the coast and the hinterland [58]. Dalmatian Zagora sustains an average population density of 31 inhabitants/km^2, notably lower than the Republic of Croatia's 76 inhabitants/km^2. As a result of numerous historical upheavals, this region witnessed a population decline of 81,011 inhabitants in four decades, signifying a reduction of over a third from its initial population [58].

Climate categorization, according to the Köppen classification, reveals two prevailing types in Dalmatian Zagora: a moderately warm humid climate with hot summers (Cfa) and a moderately warm humid climate with warm summers (Cfb) [62]. The region's climate exhibits sub-Mediterranean characteristics closer to the coast, gradually transitioning to stronger continental influences farther inland. Vegetation primarily comprises degraded forms of maquis and garrigue [63].

Geographically, Dalmatian Zagora is characterized by limited arable land, with only single larger karst fields. Consequently, developmental opportunities in this region remain

constrained, with agricultural pursuits—specifically arable farming and extensive animal husbandry—forming the primary economic activities [64].

4.2. Field Study

In this study, we included the entire Dalmatian Zagora, except the Poljica and Knin area, as it has already been comprehensively studied by Dolina et al. [22] and Varga et al. [23]. Initially, our field research plan aimed for a minimum of 15 interviews per local unit. However, upon visiting the settlements, we encountered challenges in identifying knowledgeable informants, owing to the region's sparse population density. For this reason, we had to merge certain settlements into one unit, resulting in a total of 16 units instead of 19 (Table 2).

Table 2. List of the studied units (municipalities).

Unit No.	Municipalities and Towns	Number of Species per Interview	Rural Population *	Settlements
1	Vrgorac	16	3566	Banja, Dragljane, Draževitić, Duge Njive, Dusina, Kljenak, Kokorići, Kotezi, Kozica, Mijaca, Orah, Podprolog, Poljica, Kozička, Prapatnice, Rašćane, Ravča, Stilja, Umčani, Veliki Prolog, Vina, Višnjica, Vlaka, and Zavojane
2	Runović	20	1968	Podosoje, Runović, and Slivno
	Zmijavci		1654	Zmijavci
3	Zagvozd	22	957	Biokovsko Selo, Krstatice, Rastovac, Rašćane Gornje, Zagvozd, Župa, and Župa Srednja
4	Podbablje	15	4035	Drum, Grubine, Hršćevani, Ivanbegovina, Kamenmost, Krivodol, Podbablje Gornje, and Poljica
	Imotski		5145	Donji Vinjani, Glavina Donja, Glavina Gornja, Gornji Vinjani, Imotski, and Medvidovića Draga
	Proložac		3112	Donji Proložac, Gornji Proložac, Postranje, Ričice, and Šumet
	Lokvičići		667	Dolića Draga and Lokvičići
5	Lovreć	15	1402	Dobrinče, Lovreć, Medovdolac, Opanci, and Studenci
	Cista Provo		1799	Aržano, Biorine, Cista Velika, Cista Provo, Dobranje, and Svib
6	Šestanovac	10	1699	Grabovac, Katuni, Kreševo, Šestanovac, and Žeževica
	Zadvarje		289	Dupci, Kraljevac, Krnići, Krželji, Pejkovići, Potpoletnica, Santrići, and Zadvarje
7	Omiš	16	6020	Nova Sela, Podašpilje, Slime, Svinišće, Kučiće, Blato na Cetini, Čisla, Donji Dolac, Dubrava, Gata, Gornji Dolac, Kostanje, Ostravica, Podgrađe, Putišići, Seoca, Srijane, Svinišće, Trnbusi, Tugare, and Zvečanje
	Trilj		8182	Bisko, Budimir, Čačvina, Čaporice, Gardun, Grab, Jabuka, Kamensko, Košute, Krivodol, Ljut, Nova Sela, Podi, Rože, Strizirep, Strmrndolac, Tijarica, Trilj, Ugljane, Vedrine, Velić, Vinine, Vojnić Sinjski Voštane, Vrabač, and Vrpolje
8	Otok	15	4998	Gala, Korita, Otok, Ovrlje, Ruda, and Udovičić
9	Dugopolje	13	3742	Dugopolje, Koprivno, Kotlenice, and Liska
	Dicmo		2805	Dicmo, Ercegovci, Kraj, Krušvar, Osoje, Prisoje, Sičane, and Sušci
10	Sinj	25	12,681	Bajagić, Brnaze, Čitluk, Glavice, Gljev, Jasensko, Karakašica, Lučane, Obrovac Sinjski, Radošić, Sinj, Suhač, Turjaci, and Zelovo

Table 2. *Cont.*

Unit No.	Municipalities and Towns	Number of Species per Interview	Rural Population *	Settlements
11	Hrvace	14	3144	Dabar, Donji Bitelić, Gornji Bitelić, Hrvace, Laktac, Maljkovo, Potravlje, Rumin, Satrić, Vučipolje, and Zasiok
12	Vrlika	15	1728	Garjak, Ježević, Koljane, Kosore, Maovice, Otišić, Podosoje, and Vinalić i Vrlika
	Civljane		171	Cetina and Civljane
13	Muć	13	3465	Bračević, Crivac, Donje Ogorje, Donje Postinje, Donji Muć, Gizdavac, Gornje Postinje, Gornje Ogorje, Gornji Muć, Mala Milešina, Neorić, Pribude Radunić, Ramljane, Sutina, Velika Milešina, and Zelovo Sutinsko
	Klis		1730	Brštanovo, Dugobabe, Konjsko, Korušce, Nisko, Prugovo, Veliki Bročanac, and Vučevica
	Lećevica		495	Divojevići, Kladnjice, Lećevica, and Radošić
14	Prgomet	12	498	Bogdanovići, Labin, Prgomet, Sitno, and Trolokve
	Primorski Dolac		686	Primorski Dolac
15	Unešić	12	1269	Cera, Čvrljevo, Donje Planjane, Donje Utore, Donje Vinovo, Gornje Planjane, Gornje Utore, Gornje Vinovo, Koprno, Ljubostinje, Mirlović Zagora, Nevest, Ostrogašica, Podumci, Unešić, and Visoka
	Ružić		1283	Ružić, Gradac, Otavice, Moseć, Kljaci, Baljci, Umljanovići, Čavoglave, and Mirlović polje
16	Drniš	19	3524	Žitnić, Pokrovnik, Pakova selo, Radonić, Siverić, Trbounje, Velušić, Badanj, Bogatić, Brištane, Drinovce, Kadinu Glavicu, Kanjane, Kaočine, Karalić, Ključ, Kričke, Lišnjak, Parčić, Sedramić, Širitovce, and Štikovo, Tepljuh
	Promina		943	Oklaj, Razvođe, Lukar, Suknovci, Marasovine, Matasi, Puljani, Ljubotić, Čitluk, Mratovo, Bogetić, Podi, Nećven, and Bobodol
	Šibenik		6625	Brnjica, Čvrljevo, Goriš, Gradina, Lepenica, Mravnica, Perković, Podine, Radonić, Vrsno, Danilo, Danilo Biranj, Danilo Kraljice, Boraja, Sitno Donje, Slivno, and Konjevrate
	Total		90,282	

* Seven towns were excluded (Imotski, Omiš, Sinj, Trilj, Vrgorac, Drniš, and Šibenik), and only their rural parts were accounted for.

The population of Dalmatian Zagora is gathered mostly around a few centers that have formed smaller historical regions: Drniš region, Imotski region, Knin region, Omiška (Poljička) Zagora, Sinj (Cetina) region, Vrgorac region, and Zagora (in the narrower sense) [26].

We conducted semi-structured interviews from March 2021 to September 2023. Data were collected mainly using the free listing method. The informants were selected following the snowball method [65] or were encountered during their work in the fields. Interviews were conducted in Croatian. The criterion was to examine only local residents, or those who have lived in the area for most of their lives. When possible, we organized walks with selected key informants to show us precisely which plants they collected. Plants were mostly identified on-site; otherwise, specimens were collected and identified by an experienced botanist (see Acknowledgments) using standard identification keys and iconographies [66,67].

We collected information about the respondents' age, gender, place of residence, and place of origin. Altogether, 170 interviews were conducted with 195 people (145 interviews with single respondents and 25 interviews with 2 respondents). Among the respondents,

115 were women (59%) and 80 were men. The age of the interviewees ranged from 31 to 95 (average age = 66.38 median = 66).

Interviewees were asked questions about collected wild vegetables, roots, fruits, and mushrooms; their preparation methods; and the plant parts utilized. This study was conducted following the guidelines of the International Society of Ethnobiology Code of Ethics [68] and the American Anthropological Association Code of Ethics [69]. Voucher plant specimens were collected and deposited in the Herbarium Croaticum (ZA) at the University of Zagreb, Faculty of Science. Voucher fungi specimens were collected and deposited at the Department of Plant Sciences, Institute for Adriatic Crops and Karst Reclamation. Plant nomenclature adhered to Plants of the World Online [70].

The data matrix was stored in Microsoft Office 365 Excel version 2402. Correlations were calculated using the same program with Pearson's correlation coefficient [71].

5. Conclusions

The studied region exhibits a rich diversity of edible plants indicating a significant knowledge of wild food resources. The wild plants consumed in the region studied are typical of this part of the Mediterranean and differ most from the Croatian coastal area in the higher consumption of mushrooms. There were some regional differences in the knowledge of edible plants and a moderate positive correlation was observed between the mean number of species mentioned per interview and the number of inhabitants in each region. Traditional dishes like "Mišanca", made from various wild vegetables, are being prepared throughout the researched area, and specialty dishes containing *Bunias erucago* are specific only to certain regions within the area. Many plants are used to flavor traditional alcoholic drinks, showing a connection between local flora and cultural practices. The memory of the use of some other unusual food plants was also recorded: *Legousia speculum-veneris*, *Arum italicum*, and *Centaurea solstitialis*. The study was probably the last chance to document the fading tradition of wild food plant usage in this part of Croatia. The results will contribute to the general understanding of ethnobotany of the Mediterranean.

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Article

Traditional Use of Wild Edible Plants in Slovenia: A Field Study and an Ethnobotanical Literature Review

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Abstract: No comprehensive research has been conducted on the traditional use of wild-grown edible plants in human nutrition for the Slovene ethnic area so far. In the literature on edible wild plants, authors often draw information about their use from foreign or international sources, such as books and databases, from which it is often unclear what people in different countries really include into their diet. Therefore, our purpose was to determine which edible wild-growing plant species have been used in Slovenia on a traditional basis. In our research, we gathered data using different methods. The data obtained from the literature review, i.e., the ethnobotanical literature and traditional cookbooks, were combined with those derived from the online sources and a field survey. This enabled us to create a database of 219 plant taxa encompassing more than 500 species from 62 families that are traditionally used in Slovenia. The most frequently represented families were Asteraceae, with 28 taxa, Rosaceae, with 22 taxa, Lamiaceae, with 18 taxa, Brassicaceae, with 17 taxa, Apiaceae, with 16 taxa, and Amaranthaceae, with 10 taxa. Plants are most often boiled, blanched, stewed or roasted, sometimes also baked in an oven or raw with additives, such as sour cream, sugar, salt or vinegar, but seldom fried. Selected traditional cookbooks and ethnological books provided good insight into the past use of wild plants, while an online and field survey enabled a comparison of their past and current state of use. The survey has shown that some very old wild plant recipes are still used within certain local communities, while younger people, influenced by new books about wild cuisine, are constantly introducing new plant species and recipes into their diet thereby establishing new traditions.

Keywords: Slovenia; traditional use; wild edible plants; ethnobotany

1. Introduction

Slovenia, which is bordered by Italy to the west, Austria to the north, Hungary to the northeast, Croatia to the southeast, and the Adriatic Sea to the southwest, covers only 20,271 square kilometers but is characterized by a rich diversity of plant species, ecosystems, and landscapes (Figure 1). This diversity results from Slovenia's transitional position at the contact area of tectonic units and biogeographical regions (the juncture of the Mediterranean Basin, the Pannonian Plain, the Eastern Alps, and the Dinaric Mountains), changing relief from sea level to high mountains, and from diverse pedological, climatic and hydrological conditions [1]. The involvement of the Slavic, German and Roman cultures in influencing human activities in the last few millennia have also contributed to the rich landscape diversity of the present Slovene territory, as well as the high variety of practices regarding plant use for consumption and herbalism [2,3].

Figure 1. Diversity of ecosystems in Slovenia: from sea fields, steep alpine gravel slopes and spruce-larch forests to shady beech forests and various grasslands in the lowlands.

In this respect, well-preserved forests, mountain areas and freshwater underground ecosystems with high plant diversity, including many endemic species and diverse ecosystems, are of particular importance. Fifty-eight percent of the territory is covered by forests, and approximately 25% of the territory is agricultural land in use [3–5]. According to estimates, approximately 60% of the environment is in a natural or seminatural state, including landscapes and areas that were managed in a traditional way in the past and where activities were abandoned a long time ago [6]. The rich cultural, landscape and plant diversity have been threatened greatly because of the pollution of surface and underground waters, soil and air, caused by the rapidly expanding industry, urbanization and agriculture in the last century. Approximately 19% of ferns and seed plants species are threatened, of which 29 are extinct, 80 are endangered, 254 are vulnerable and 257 are rare [7]. With an intention to reduce the decline in the biotic diversity many parts of the country have been classified as protected areas, such as parks, natural reserves and monuments. More than 41% of the Slovene territory is protected as national, regional and landscape parks, nature reserves or natural monuments and included in Natura 2000 sites [7]. According to the available data, there are more than 3500 registered native taxa of vascular plants and more than 850 taxa of bryophytes in Slovenia [8,9]. Their basic characteristics are derived from Alpine and Central European floristic elements and Pannonian, Dinaric and Mediterranean species. The degree of endemism (60 endemic taxa, including 22 narrow endemics with a predominant distribution in Slovenia) is considerably high in comparison to the smallness of the area [7–9]. Slovenian traditional medicine, which derives its knowledge in some part from the Roman and Germanic tradition, but also includes Slavic influences, uses over 500 wild-growing plants with over 6000 vernacular names [2]. Many of these medicinally important plants are also edible and were once regularly included into the diet of our people, in addition to tenths or even hundreds of others groups [2,10–12].

Nevertheless, the data about the traditional use of wild plant species among Slovenians is incomplete and scattered in numerous cookbooks and ethnological books. No comprehensive research has been conducted on the use of wild-grown edible plants in human nutrition for the entire Slovene ethnic area until now. In the Slovenian literature on edible wild plants, most authors often draw information about their use from foreign or international sources, such as books, ethnobotanical articles and databases, where it is most

often unclear what people in different countries eat or have eaten [10–14]. Up until now, only a list of 218 potentially edible wild plants with no specifications of the traditionality of their use has been presented for Slovenia until now [15]. This list is not all-inclusive, as there are more than 800 potentially edible wild species in Slovenia [12]. However, our purpose was not to present the comprehensive list of potentially edible wild plant species, but to determine which of them are traditionally used in Slovenia and in what kind of dishes. Our approach was therefore similar to that chosen in the wild food ethnobotany surveys conducted in other European countries [16–20].

2. Results

2.1. Data Sources

We reviewed 67 Slovene written sources, including 41 traditional cookbooks containing 1532 recipes of the actual use of wild-growing plants and 26 ethnobotanical books or articles containing 1209 mentions of traditional wild edible plant use [2,12,21–85]; their regional affiliation is shown in Figures 2 and 3. It should be mentioned that some of the cookbooks contained additional ethnological descriptions of the wild plants used in the diet.

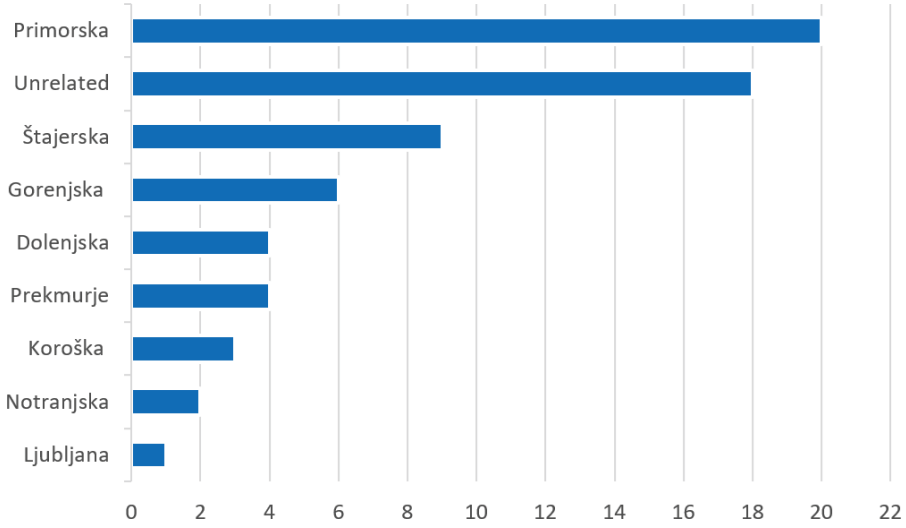

Figure 2. Regional affiliation of cookbooks and ethnological literature (N = 67).

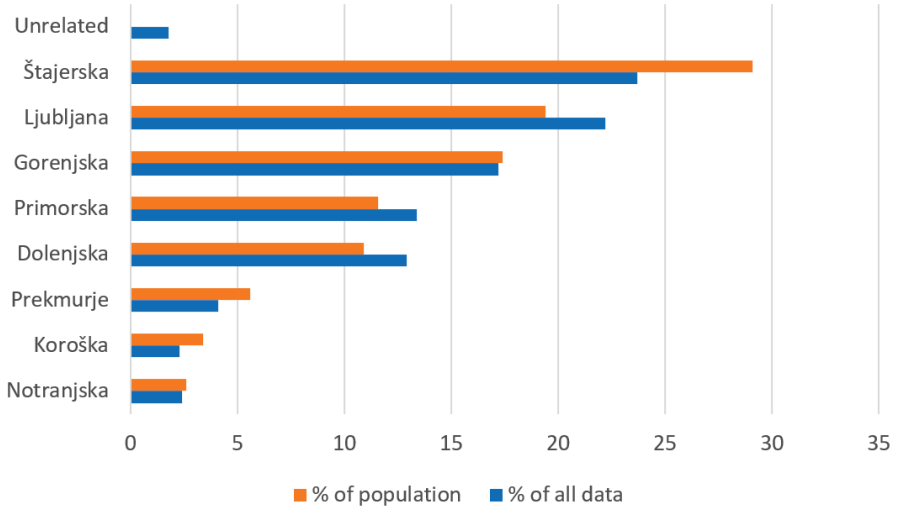

Figure 3. The regional affiliations of all analyzed data, including ethnological mentions, recipes in cookbooks, answers in survey and interviews (N = 4885), were compared to the statistical distribution of inhabitants among different regions (available at https://www.stat.si/obcine (accessed on 21 February 2024)).

The data obtained from the literature review were supplemented primarily with those derived from the online and field survey (altogether 2144 mentions of edible wild plants use), which included 132 informants (118 responses to a structured survey questionnaire and 14 in-depth unstructured interviews) of different ages (<25 years: 32%; between 25 and 50 years: 49%; >50 years: 19%), sex (female: 69%; male: 31%) and geographical affiliation (Figure 3) (see the Materials and Methods section for a detailed methodological data).

2.2. Analysis of the Collected Data

Almost 12% of the survey respondents use wild-growing plants on a regular basis; approximately 46% include them in their diet occasionally (at least a few times per year), while the rest use them only seldomly (less than twice a year) or never. Almost 30% of respondents likes wild plant collecting because it is usually combined with a relaxing walk in the nature, a quarter of them reported to gather plants primarily because of their taste, while 16.5% of them highlights the importance of their vitamin and mineral content. Only 1.2% reported that they use wild plants out of necessity in case of hunger.

Most of the respondents (64.5%) were informed about the use of wild edible plants by their parents, relatives or friends, but specialized ethnobotanical books and cookbooks also seemed to be important sources of information on this topic (Figure 4). About 57% of them introduce new edible wild plants only after a thorough inspection of the existing literature, including the internet, a half of them also require a practical confirmation by an experienced person. However, nearly 17% of wild plant users introduce a new plant into their diet based only on one written or oral source. Almost 27% of the respondents wrote that they do not collect wild-growing plants introduced to them in adulthood.

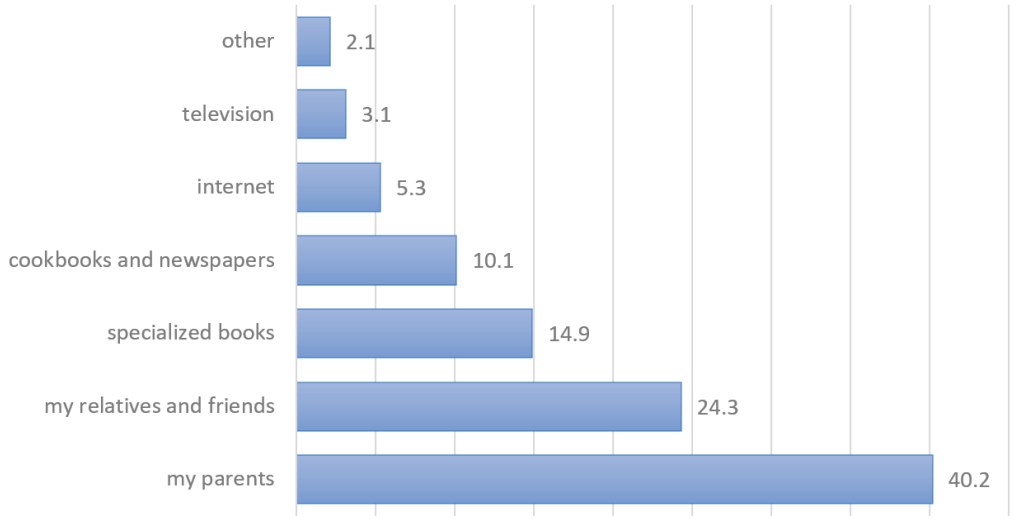

Figure 4. Most important sources of information about the use of wild edible plants (in %).

A comprehensive literature review combined with a survey has enabled us to create a database of 219 plant taxa encompassing more than 500 species from 62 families that are traditionally used in Slovenia (Table 1).

Table 1. List of edible wild plants used traditionally in Slovenia.

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Adoxaceae	*Sambucus nigra* L.	bezgovina, bezgovc, beza, bzg, bažovina, boz, zobovec, zovina	63/43/74	fruits and flowers/beverages, spirits, egg and fruit dishes	/	[21,22,26,27,29–31,39,41,42,45,46,50–52,55,60,62,63,66,67,69–72,74,77,78,84,85]
	Sambucus racemosa L.	divja beza, češuljek, rdeči bezeg	0/0/1	fruits/spirits	/	/
	Viburnum opulus L.	kozja pogačica, kalina, kačji les, kalinovec, tršljika, žgalinovec	0/2/0	fruits/beverages, jams	/	[2,43]
Amaranthaceae (incl. Chenopodioideae)	*Amaranthus* L.	ščer, amarant	0/1/0	seeds, young shoots/bread, soups, salads	/	[28]
	Atriplex L.	loboda	1/5/0	leaves/sauces, garnishes	Primorska	[65,82,83,85]
	Beta vulgaris (L.) Arcang.	primorska pesa	0/3/0	young shoots/salads, soups, egg and vegetable dishes	Primorska	[12,43,85]
	Chenopodium L. (*C. album* L. and *C. hybridum* L.)	škrobla, bela metla, loboda, beli kozji rep	3/2/12	leaves/sauces, garnishes	Primorska	[43,65,85]
	C. polyspermum L.	mnogosemenski kozji rep	0/0/1	leaves/soups	/	/
	Chenopodium bonus-henricus L.	dobri jurko, kopjasti kozji rep, kozji rep	0/0/1	leaves/soups, spreads	Gorenjska	/
	Halimione portulacoides (L.) Aellen	tolščakasti lobodovec, tolščakasta loboda, morska loboda, omahlina	0/3/0	young shoots and leaves/salads, soups, egg and vegetable dishes	Primorska	[12,43,85]
	Salicornia europaea L.	osočnik, zelnati osončnik, salikornija, omaga, omakalj	1/4/1	young shoots/salads, soups, egg and vegetable dishes	Primorska	[12,43,82,85]
	Salsola L. (especially *S. soda* L)	solinka, slanica	0/2/0	young shoots/salads, soups, egg and vegetable dishes	Primorska	[12,43]
	Suaeda maritima (L.) Dum.	obrežna lobodka, primorski slanorad	0/2/1	young shoots/soups, vegetable dishes	Primorska	[43,85]
Amaryllidaceae	*Allium* L.	luk	5/3/10	aerial parts, bulbs/soups, salads, spreads, garnishes	/	[36,41,55]
	Allium ampeloprasum L.	poletni luk	3/4/2	aerial parts/soups, spreads	/	[36,42,55,78]
	Allium angulosum L.	robati luk	0/0/1	aerial parts/salads, soups	/	/
	Allium schoenoprasum L.	drobnjak, sibirski luk, drobnik, šintelc, šnitlah	0/1/2	aerial parts/soups, spreads, garnishes	Gorenjska	[36]
	Allium ursinum L.	čremož, divji česnik, gozdni česen, kačji lek, štrkavec	27/16/56	aerial parts/soups, salads, spreads, egg dishes	Ljubljana	[32,36,41,42,55,78,85]
	Allium victorialis L.	vanež	0/0/1	aerial parts/salads	/	/

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Apiaceae	*Aegopodium podagraria* L.	regačica, samojeja	0/2/4	young leaves/soups, vegetable dishes	Gorenjska	[42,43]
	Angelica sylvestris L.	gozdna angelika, kadunec, ilka, kravojec	0/2/1	roots, fruits/beverages	/	[2,43]
	Anthriscus Pers.	krebuljica, francoski peteršilj	1/1/2	leaves/soups, vegetable dishes	/	[42,43]
	Carum carvi L.	čumna, bela cemena, kimca, kimelj, kim, divji kumen, kumič, kumin	52/17/10	fruits and leaves/sauces, garnishes, spirits, soups, vegetable, milk, meat and egg dishes	/	[21,24,27,29,31,36,38,41,42,48–50,57,60,66,69,85]
	Crithmum maritimum L.	morski koprc, motar, matar. Ščulec, petrovo zelje	2/2/5	leaves/salads, pickled, sauces	Primorska	[43,60,69,85]
	Daucus carota L.	koren, kuzmorka, mrkelca, merlin, svinjski koren, merlen, korenje	1/3/4	roots/soups and sauces	Ljubljana	[42,55,85]
	Ferulago campestris (Besser) Grecescu	koromačnica	0/1/1	young leaves/soups, vegetable dishes	Primorska	[43]
	Foeniculum vulgare Mill.	komarček, fenkelj, morač, fidoči, koprc, koromač, morski janež	49/33/14	fruits, inflorescences and leaves/sauces, garnishes, spirits, soups, vegetable, fruit and egg dishes	Primorska	[21,22,31,32,36,38,41,44,45,48,57,60,62,64,65,67,69,84,85]
	Heracleum sphondylium L.	bršč, medvedove tace, konjska kumna, moška moč	0/3/3	young leaves/soups, vegetable dishes	/	[12,42,43]
	Laserpitium latifolium L.	jelenovec, košutnik	0/2/2	roots and fruits/beverages	Štajerska	[12,43]
	Ligusticum mutellina (L.) Crantz.	velestika, veleždin, ljubačac, lesandrina, milobud, miloduv, selim	0/1/1	young leaves/soups, vegetable dishes	Gorenjska	[43]
	Meum athamanticum Jacq.	planinski štrbec	0/0/1	leaves, fruits/desserts, beverages	Gorenjska	/
	Myrrhis odorata (L.) Scop.	kromač, dišeča krebulca	2/2/3	leaves and fruits/syrups, beverages, desserts	Gorenjska	[42,43,55]
	Pastinaca sativa L.	rebrinec, pastinak, pastinaka	4/3/6	roots/soups, vegetable dishes	/	[35,36,43,45,85]
	Pimpinella L.	bedrenec, bibernelica	0/3/2	leaves and fruits/syrups, beverages, desserts	/	[12,43]
	Smyrnium perfoliatum L.	repušica	0/2/0	young leaves/soups, vegetable dishes	Primorska	[12,43]
Araceae	*Arum italicum* Mill.	štrkat, zminac, zmijinac	0/2/0	rhizoma/spirits, cooked	Primorska	[43,85]
	Arum maculatum L.	kačjak, kačje zelje, kačnik, kozlac	0/2/0	rhizoma/cooked	Primorska	[43,85]
Asparagaceae	*Asparagus* L.	beluš, beluša, pojanica, pojavec, špargelj, smrečica	69/50/40	aerial parts/soups, spreads, egg, vegetable and meat dishes	Primorska	[21,31,32,36,41,42,45,52,60,63–65,69,71,85]
	Ruscus aculeatus L.	lobodika, bodeča mlejzek	2/4/1	young shoots/egg dishes, vegetable dishes	Primorska	[50,60,65,85]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Asteraceae (incl. Cichorioideae)	*Achillea* L.	jezičec, arman, hrman, kačjek, raja, repiček, stolistnik, škarucelj, škrebec, romancvet, škoreča	8/6/29	aerial parts/soups, egg dishes, beverages, spirits	Primorska	[27,29,32,44,45,50,51,60,63,70,85]
	Achillea clavenae L.	korocvet, skorecelj	0/3/0	aerial parts/fermented beverages	Primorska	[60,68,69]
	Antennaria dioica (L.) Gaertn.	griževnik, majnica	0/0/1	inflorescences/teas	/	/
	Aposeris foetida (L.) Cass. ex Less.	gozdni regrat, krompirjevka	0/4/7	leaves/salads	Ljubljana	[12,42,55]
	Arctium L.	kloš, kencelj, reginec, repivec, repje, starec, torica, torika, podbev, lepenj, lepir	0/3/0	roots/soups, vegetable dishes	/	[12,43,85]
	Arnica montana L.	brdnja, aronk, črnivec, gorski kokovičnik, gorska svetlica, moravka, zlatenica, maerni koren volčji zob	0/9/6	aerial parts/beverages	/	[2,82,83]
	Artemisia L.	pelin	2/2/2	aerial parts/spirits	/	[2,42,67]
	Artemisia absinthium L.	grenki pelin	3/4/13	aerial parts/spirits	Primorska	[42,56,69,70,85]
	Artemisia vulgaris L.	komoljika	2/3/8	aerial parts/spirits	Primorska	[42,56,67,70]
	Bellis perennis L.	marjetica, iskrica, rigelc, ranik, mezinčica, kostanjička, katarinčica, micike, mičkice, margaretica	2/4/5	leaves/salads, beverages, garnishes	Gorenjska	[42,55,82,85]
	Carlina acaulis L.	bodeča neža, bržavda, bodič, kampaneža, neževje, sitnec, skočnjak, veliki striček	0/1/1	young flowerhead bud/salads, vegetable dishes	/	[85]
	Chondrilla L.	hrustavka	0/1/1	leaves/salads	/	[85]
	Cichorium intybus L.	potrošnik, cikorija, jedrik, mleč, petrovčnik, ozlika, podvornica, popotnik, radič	20/16/7	leaves and roots/salads, spreads, garnishes, soups, egg dishes, beverages	Primorska	[22,27,48,49,59–61,63–65,69,85]
	Cirsium oleraceum (L.) Scop.	sršje, vodenika	0/3/1	roots, young leaves/salads, soups, spreads	/	[2,43,83]
	Helianthus tuberosus L.	papežica, sladki krompir, topinambur, laška repa, papeževa repica, gomoljasta sončnica	0/4/4	tubers/vegetable dishes	/	[12,43,82,85]
	Helichrysum italicum (Roth) Loudon	smilje, madronščica, božja strešica, magriž, malagriž	0/2/0	leaves, inflorescences/soups, vegetable, meat and fish dishes	Primorska	[43,85]
	Hypochaeris L. (especially *H. radicata* L.)	svinjak, trpežni svinjak	0/2/1	leaves/salads, soups, spreads	/	[12,43]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Asteraceae (incl. Cichorioideae)	*Lapsana communis* L.	kolenček, kolenče	0/0/1	leaves/salads	/	/
	Leontodon L.	jajčar, otavčič, žoltenica	0/2/3	leaves/salads, soups, spreads	/	[12,83]
	Leucanthemum Mill.	ivanjščica, navadni hlapček, volovsko oko, kresnica	0/0/1	flower buds/salads, soups, in vinegar	/	/
	Matricaria sp. L. (especially *M. recutita* L.)	maternik, maternjak, kamilica, gamilica, hermanek, kamenika, mrvca, rumenek, gomiljica, vonjavka	8/5/39	inflorescences and leaves/garnishes, beverages, soups, egg dishes	Primorska	[27,42,46,50,69]
	Scolymus hispanicus L.	sikalina, bermeč rumeni badelj, brmbeč	0/2/0	young shoots/soups, vegetable and egg dishes	Primorska	[12,85]
	Scorzonera hispanica L.	zmijak, črni koren, španski koren	0/2/0	roots/vegetable dishes, salads	Primorska	[12,85]
	Sonchus L. (especially *S. oleraceus* L. and *S. asper* (L.) Hill)	škrbinka, mleč	0/4/3	young leaves/soups, salads, vegetable and egg dishes, pastries	Primorska	[12,43,82,85]
	Tanacetum parthenium (L.) Sch.Bip.	madrijalica, madrijolica, mandrijana, madrjanca, mandrijerica	4/6/1	leaves/egg dishes, soups	Primorska	[44,57,60,62,67,69,82,85]
	Taraxacum F.H. Wigg	jajčar, lederče, mleč, virgrad, solatnik, števnica, mlečje, otavčič, smolika, smolička, farška plata, žehtelnica	71/39/96	leaves and inflorescences/salads, soups, spreads, syrups, beverages, egg, meat and vegetable dishes	Primorska	[21,24,27,30–32,36–39,42,45,50,51,56,60,62–67,69–71,77–79,85]
	Tragopogon L.	kozja brada	2/2/5	young shoots, inflorescences/spreads, salads, soups	/	[43,64,65]
	Tussilago farfara L.	arpinc, elpejž, lupinec, jurjevka, kopačnica, lepušček, spodbel, stiper, svinjarica, štipor, vinogradska kopačica	1/8/4	Inflorescences, leaves/spirits and salads	/	[2,12,42,43]
Berberidaceae	*Berberis vulgaris* L.	babkovina, česmin, cvič, češniga, češmigovec	3/4/6	fruits/beverages, jams, desserts	/	[42,63]
Betulaceae	*Corylus avellana* L.	leska, leščevje, lešnjik, liškan	96/28/43	seeds/desserts, fruit dishes, pastries	/	[31,36,38,41,42,45,50,51,58,60,63,64,68,78,84,85]
Boraginaceae	*Anchusa officinalis* L.	volovski jezik	0/0/1	leaves/soups	/	/
	Borago officinalis L.	boreč, boraga, buraža, poraga, lisičika, lisičina	2/2/3	aerial parts/salads, soups, garnishes	/	[42,43,67]
	Pulmonaria L (especially *P. officinalis* L.)	cmulež, pikec, navadna plučnica, kuščernjak, srčnica, zajčeki	1/5/3	leaves/spirits, salads	/	[2,60,63]
	Symphytum officinale L.	celivec, sveni, svaljnik, črni koren	1/3/2	young leaves/soups, vegetable dishes	/	[43,50,55,82,85]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Brassicaceae	*Alliaria petiolata* (MB.) Cav. et Grande	česnovka, hostni česen	0/0/2	leaves, young shoots/spreads, salads	/	/
	Armoracia rusticana G.Gaertn., B.Mey. & Sch-erb.	hren, turman, ren	103/40/32	roots and leaves/sauces, garnishes, vegetable, meat and egg dishes	/	[21,22,24,27,30–32,36,41,44–46,51,57,60,63,66,70,80,85]
	Barbarea vulgaris W. T. Aiton	barbica	0/3/1	leaves/salads, spreads, garnishes	/	[2,12,85]
	Camelina sativa (L.) Crantz.	riček, toter	3/0/0	seeds/bread	/	[60]
	Cardamine L.	penuša, konopnica	2/2/12	aerial parts/salads, spreads	/	[12,21]
	Cardamine amara	grenka penuša	0/0/1	aerial parts/spreads	/	/
	Cardamine bulbifera	brstična konopnica, mlaja	0/0/2	aerial parts/salads, soups, spreads	/	/
	Cardamine enneaphyllos (L.) Crantz	deveterolistna konopnica	0/0/1	aerial parts/salads	/	/
	Capsella bursa-pastoris (L.) Medik.	divja repica, bobulica, divji srčeki, torbica, plevelka, lažnica, luščec, pucalica, poljska preslica, škofove kapice, škrobotec	2/2/6	leaves/salads, spreads, garnishes	/	[21,60,85]
	Diplotaxis DC.	dvoredec, rukulja	3/3/11	leaves/salads, spreads, garnishes	Primorska	[43,62,69,85]
	Eruca sativa Mill.	rukvica	6/2/21	leaves/salads, spreads, garnishes	Primorska	[36,50,62,69,82,83]
	Lepidium L.	draguša	0/1/0	aerial parts, seeds/as a spice, soups, salads	/	[28]
	Lunaria rediviva L.	srebrenka	0/0/1	leaves, flowers/salads, spreads	/	/
	Nasturtium officinale W. T. Aiton	navadna kreša, bobovec, drezga, kreša, korešča, potočarka, režnik, studenčnica, vodni dihalnik	2/3/7	shoots and leaves/salads, spreads, sauces, meat dishes	/	[31,43,60,73,85]
	Sinapis arvensis L.	gorjušica	0/0/1	aerial parts, seeds/as a spice, soups, salads	/	/
	Sisymbrium officinale (L.) Scop.	dihnik, rukulja, lažnica, rumena železnica, svinjek	0/2/1	leaves/soups	/	[43,85]
	Sisymbrium officinale (L.) Scop.	dihnik, lažnica, svinek, rukulja, rumena železnica, svinjek	0/3/0	leaves/salads, spreads, garnishes	/	[2,12,43]
Campanulaceae	*Campanula* L.	repušica, zajka, zvončica, ležnjačič	0/3/0	leaves, roots/soups, salads, vegetable dishes	/	[43,85]
Cannabaceae	*Celtis australis* L.	koprivovec, kostilja, koprivca, ladonja, kostela, koščela, fanfarika	0/4/1	fruit/raw, beverages	Primorska	[43,82,84,85]
	Humulus lupulus L.	hmelj, falon	4/3/17	young shoots/salads, vegetable and egg dishes	Štajerska, Primorska	[21,52,60,62,63,85]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Capparaceae	*Capparis spinosa* L.	kapra, kapar	0/2/0	flower buds, fruits, leaves/fermented, fish dishes, salads	Primorska	[43,85]
Caprifoliaceae	*Lonicera caerulea* L.	planinsko kosteničevje	0/0/1	fruits/beverages, fruit dishes	Gorenjska	/
	Valeriana officinalis L.	baldrijan, špajka	0/0/1	young leaves/salads	/	/
	Valerianella Mill.	motovilec	2/5/15	leaves/salads, beverages	/	[31,36,46,63,65,66]
Caryophyllaceae	*Silene vulgaris* (Moench) Garcke	pokalica, mehurjasta lepnica	2/2/5	young shoots and leaves/soups, vegetable, egg and meat dishes	Primorska	[27,32,50,59,69,85]
	Stellaria L. (especially *S. media* (L.) Vill, and *S. neglecta* Weihe)	zvezdica, kurja črevca	5/2/17	young shoots/salads, soups, vegetable dishes	Gorenjska, Ljubljana	[55,82,85]
Cornaceae	*Cornus mas* L.	drnulja, dren	4/14/9	fruits/beverages, jams, desserts	Primorska	[22,42,45,60,63,84,85]
Crassulaceae	*Sedum album* L.	bela homulica, homulca	0/0/1	leaves/salads, spreads	/	/
	Sempervivum tectorum L.	uhlek, ušesnik, uhlec, gromnik, gromotresk, netresk, strešnik	0/3/0	leaves/salads, vegetable dishes, beverages	Primorska	[43,82,85]
Cupressaceae	*Juniperus communis* L.	čepin, čopin, smrčika, brinjkola, kleka, smrekva, brinje, brina, navadna brina	29/18/16	fleshy cones/spirits, soups, garnishes, meat dishes	Primorska	[2,12,22,29,32,41,42,45,52,55,57,60,64, 70,84,85]
	Juniperus oxycedrus L.	rjava brinkola, črni brin, brinje	2/4/3	fleshy cones/spirits	Primorska	[65,82,84,85]
Dioscoreaceae	*Tamus communis* L.	blušč, bljušt	3/3/10	young shoots/egg dishes	Primorska	[43,64,65,82,85]
Dryopteridaceae	*Dryopteris filix-mas* (L.) Schott	prava glistovnica, glistna podlesnica	0/0/1	young shoots/soups, egg dishes	/	/
Eleagnaceae	*Hippophae rhamnoides* L.	rakitovec, pasji trn	0/0/1	fruits/beverages, fruit dishes	/	/
Equisetaceae	*Equisetum arvense* L.	konjski rep, hvost, fašec, vošč, štukovac, žabna, rabozel	2/6/2	aerial parts/beverages	Gorenjska, Primorska	[12,42,54,60]
Ericaceae	*Arbutus unedo* L.	jagodičnica, planika, magunja	1/4/0	fruits/spirits	Primorska	[43,69,84,85]
	Rhododendron hirsutum L.	gričevnik, kosmati sleč, hudičela, ravš, ravšje	0/0/1	flowers/teas	/	/
	Vaccinium myrtillus L.	borovje, črnica, črna jagoda, risnica	35/43/79	fruits/beverages, jams, desserts	/	[2,21,25,29,31,33,40–42,45,47,50,52–54,56,58,60,63,66,69–71,74,78,80,84]
	Vaccinium vitis-idaea L.	belke, gorenk, gramzelše, netečje, omanjščevina, mešičevje, močnica, rdeča malenca, rdeče črnice	24/7/16	fruits/beverages, jams, desserts, egg and meat dishes, salads, garnishes, sauces	Štajerska, Koroška	[21,23,29,31,41,42,45,51,52,54,60,66,78, 84]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Fabaceae	*Anthyllis vulneraria* L.	boljunec, medvejka, mačkina detelja, mačje tace, uročnik, zajčja detelja	1/0/8	aerial parts/beverages	Gorenjska	[42]
	Lathyrus L.	grahor, grašica, divji grah, lot	0/1/0	seeds, tubers/cooked, roasted	/	[12]
	Robinia pseudoacacia L.	robinija, akacija	6/15/19	flowers/beverages, desserts, fruit and egg dishes	Primorska	[36,37,45,50,62,66,67,69,75,84,85]
	Trifolium L.	detelja	1/1/1	inflorescences/spirits	/	[42,82]
	Trifolium pratense L.	travniška detelja	0/0/1	inflorescences/spirits	/	/
	Trifolium montanum L.	gorska detelja	0/0/1	inflorescences/nonalcoholic beverages	/	/
Fagaceae	*Castanea sativa* Mill.	kostanj, domači kostanj, kostanje, kostanjevec, kostanjek, kostanja	79/94/87	fruits/spreads, desserts, soups, fruit and meat dishes	/	[2,27,31,32,36,38,41,42,45,50,51,55,59–61,63–65,78,84,85]
	Fagus sylvatica L.	bukva, hiba	2/7/19	young leaves and seeds/salads, beverages, oil	Gorenjska, Primorska, Notranjska	[55,62]
	Quercus L. (especially *Q. robur* L., *Q. pubescens* Willd. and *Q. petraea* (Matt.) Liebl.)	hrast, pitnek, pisanec, drobljak, grelc, gnilec, gnjel, gnjilec, ličnik, nitnik, nitnjak	0/10/1	fruits/beverages, pastries, desserts	/	[2,12,43,82–85]
Gentianaceae	*Centaurium* Hill (especially *C. erythraea* Rafn)	tavžentroža, cintaaver, čintara, glistnik, gorčica, griževec, grenka trava, centaver	3/4/12	aerial parts/beverages, desserts	Štajerska	[42,60,85]
	Gentiana lutea L.	cijan, encijan, gencijan, košutnik, gorčica, svedr. Lecjan, srčenjak, sviščˇ, goreuca	2/1/4	roots/spirits	Gorenjska, Primorska, Štajerska	[60,85]
Grossulariaceae	*Ribes* L.	kosmulja, grozdičje, ribez, ribezelj	1/3/0	fruits/beverages, desserts, fruit dishes	/	[39,55,68,69]
Hypericaceae	*Hypericum perforatum* L.	šentjanževa roža, ivanovka, krčnica, krčna zel, janževka, jezusova kri, grilacec	2/0/3	aerial parts/spirits	Ljubljana	[42]
Iridaceae	*Crocus vernus* (L.) Hill	podlesk, uscanka, žafran, kroketi	0/1/1	corms/raw	Primorska	[83]
	Iris Tourn. ex L.	perunika	0/2/0	rhizoma/boiled, roasted	/	[43,82]
Juglandaceae	*Juglans regia* L.	oreh, arh, laški oreh	236/127/27	seeds and young leaves/spreads, desserts, soups, fruit, vegetable and meat dishes, pastries, beverages	Primorska	[21–24,27,28,30–32,35,36,38,41,42,44,45,50,51,55,59–61,63–66,68,69,78,80,84]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Lamiaceae	*Betonia officinalis* L.	petonka, bitunica, gušar, rani list, ranjak	0/2/0	leaves/beverages, spreads	/	[12,85]
	Calamintha L.	čober, čuber, šetrajnik	0/5/0	aerial parts/beverages, vegetable dishes	Primorska	[2,12,43,82,85]
	Clinopodium vulgare L.	čepič, čepac	0/2/0	leaves/spreads, salads	/	[12,85]
	Glechoma hederacea	popenec, povojček, srednjak, stračič, divji perpin, vrednjak, zlata ketnica, prisadna zel	0/4/2	leaves and flowers/desserts, soups, salads	/	[2,12,43,85]
	Hyssopus officinalis L.	ožep, ožepek	0/3/2	aerial parts/beverages, meat dishes	Primorska	[12,83,85]
	Lamium L.	mrtva kopriva, lisavka, pezičevje, žibrt, pivka, prisadence, prisadnik, maronica, žibrat	0/2/7	flowers/salads	Gorenjska	[12,55]
	Melissa officinalis L.	aselnica, črniva, čebeloperka, maternjak, medenka, medeni list, melisa, srčno zelje, rojevnica, osenika	19/6/36	leaves/desserts, beverages, egg and vegetable dishes	Primorska	[21,27,35,36,38,39,42,44,45,52,57,60,62,63,67,69–71]
	Mentha L.	meta, minca, metvica	51/16/47	leaves and inflorescences/desserts, beverages, egg, meat, fruit and vegetable dishes	Primorska	[22,27,29,39,41,42,45,46,50–52,58,59,61,63,64,69,85]
	Mentha pulegium L.	polaj	2/0/0	leaves/meat dishes	Primorska	[59]
	Origanum vulgare L.	dobra misel, bolmet, čober, divji majaron, tošta, zavrta	9/4/19	leaves and inflorescences/beverages, soups, salads, garnishes, egg, meat and vegetable dishes, teas	/	[42,43,52,58–61,70,85]
	Prunella L.	črnoglavka	0/0/1	young shoots, leaves/soups, salads	/	/
	Salvia officinalis L.	čistec, kadulja, prava kadulja, žajbelj, žlahtni žajbelj	15/9/50	leaves/beverages, spirits, sauces, garnishes, egg, milk and meat dishes	Primorska	[22,30,32,41,44,45,51,52,59–61,63,64,66,67,69,71,84,85]
	Salvia pratensis L.	travniška kadulja, čistec, kadulja	2/1/2	leaves/egg dishes, soups	Koroška, Primorska	[22,27,85]
	Salvia rosmarinus Spenn.	rožmarin, pravi rožmarin	22/8/57	aerial parts/soups, vegetable and meat dishes, teas, vinegar, spiced oil	Primorska	[21,27,29,32,36,41,42,44,45,50–52,57,60,69–71,77,84,85]
	Satureja L. (especially *S. montana* L.)	šetraj, čober, šatraj, šetrajka	9/5/11	aerial parts/soups, meat and vegetable dishes	Primorska, Notranjska	[22,42,43,52,59,64,70,82,85]
	Teucrium chamaedrys L.	vrednik, učnica, komandl, mrzlični koren, krčnica	0/0/1	leaves/egg dishes	Gorenjska	/
	Teucrium montanum L.	trava iva, gorska urhovka	0/1/0	leaves/soups, meat and fish dishes	Primorska	[85]
	Thymus L.	poljska materina dušica, babja dušica, divji timijan, dušje, mačešica, materinka, preprišč, prežilka, bukvica	17/9/42	aerial parts/beverages, soups, garnishes, teas, egg, meat, fruit and vegetable dishes, desserts	/	[22,32,41,42,45,50,52,58–61,63,66,67,69,70,82,85]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Lauraceae	*Laurus nobilis* L.	lovorika, lovor, plemenita lovorika	16/9/46	leaves/soups, sauces, meat and fish dishes	/	[22,31,32,38,41,42,44,45,50,52,58–60,64,66,70,78,82,85]
Lythraceae	*Trapa natans* L.	vodni oreh, kostanjevec	0/1/0	seeds/roasted	/	[43]
Malvaceae	*Althaea officinalis* L.	ajbiš, beli slez, beli popelj	2/2/3	aerial parts/beverages	/	[12,42,85]
	Malva L.	črni klobuk, divji papel, divji slez, slezena, sleznica, divji *slezenovec*, divja, slezena, divja škura, škuvra, škurja, škurva	2/3/5	aerial parts/beverages	Primorska	[69,77,85]
	Tilia L.	lipovec, lipa	9/7/38	flowers/beverages, desserts	Primorska	[22,25,27,29,42,46,53–56,60,66,67,69,71,72,77,82]
Moraceae	*Ficus carica* L.	figa, smokva, smirnska jagoda	20/9/54	fruits/desserts, fruit dishes, pastries	Primorska	[29,44,46,62,64,67–69,84]
Myrtaceae	*Myrtus communis* L.	mirta, murta, marta, martina, mrčela	0/2/0	fruits/raw, spirits	Primorska	[84,85]
Oleaceae	*Fraxinus excelsior* L.	belijesen	2/0/0	young leaves/soups		[22]
	Fraxinus ornus L.	črni jesen, jasenica	0/1/0	sap/desserts, beverages	Primorska	[85]
	Olea europaea L.	divja oljka, maslina, ulika, oliva	0/2/0	fruits/raw, fermented	Primorska	[84,85]
Oxalidaceae	*Oxalis* L. (mainly *O. acetosella* L.)	zajčja deteljica, božji kruhek, cicelj, kisla detelja, rezka detelja, zajčja sol	0/2/4	leaves and flowers/salads, garnishes, fruit dishes	/	[2,12]
Papaveraceae	*Chelidonium majus* L.	aselca, bradavičnik, ceduljka, drafna trava, cengulja, krvnik, dražnica, krivi zelje, rdeči mleček, skrobla, zlata korenina, kačji mleček	0/0/2	leaves/spirits	/	/
	Papaver rhoeas L.	prpelica, gospodičnica, križec, divji mak, pumpala, roštalca, putpelica	0/0/1	petals/as a dye for syrups	/	/
Pinaceae	*Abies alba* Mill.	hoja, hojka	0/1/3	young shoot tips/spirits and syrups	/	[12]
	Larix decidua Mill.	macesen, viharnik	1/1/3	young shoot tips/spirits and syrups	/	[42,55]
	Picea abies (L.) H. Karst.	smreka	8/5/39	young shoot tips/spirits and syrups	/	[27,42,55,66,68,70,71,80]
	Pinus L. (especially *P. sylvestris* L., *P. nigra* J. F. Arnold, and *P. mugo* Turra)	bor, borovec, rušje, košutje	3/2/11	young shoot tips and young cones/spirits and syrups	Gorenjska, Primorska	[2,12,42,69]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Plantaginaceae	*Plantago* L.	mačica, mokovec, trpotec, pripotnik, škripotec	5/4/19	leaves and inflorescences/salads, beverages, egg, meat and vegetable dishes	/	[27,29,45,55,77,85]
	Plantago lanceolata L.	celec, kozja rebrca, ovčji jezik, ozki protek, krpotec, suličasti trpotec, žebinec, iljak, žilnik	2/3/10	leaves and inflorescences/salads, egg, meat and vegetable dishes	/	[42,60,85]
	Veronica L. (especially *V. beccabunga* L. and *V. anagallis-aquatica* L.)	jetičnik, bobovnik, jeterčnik, sorej, veronka, lehtica, bodčec, unje, velnica, lobovnjak, vodni repincelj	0/0/2	leaves, shoots/salads, soups, vegetable dishes	/	/
Poaceae	*Arundo donax* L.	kanela, trstika, kana, trska, rozga	0/3/1	young stalks/beverages	Primorska	[2,82,85]
	Phragmites australis (Cav.) Trin. ex Steud.	trst, trstika, bičje, mečiček, ščevar, ševar, vodna trska, trstika	0/1/1	young stems and leaves/desserts, bread	/	[85]
Polygonaceae	*Polygonum* L.	adreselj, drnoselj, glistnjak, kurji jezik, moljava, norava, pernica, ptičji dresen, rakovica, svinjska kaša, trdina, tristovec, troskovec, vrbnica, žabja solata	0/1/2	leaves, shoots/spreads, soups	/	[85]
	Rumex L.	kislica, kisavec, smuk	11/6/40	leaves/salads, soups, spreads, sauces, garnishes, egg and meat dishes	Štajerska	[21,27,31,32,41,45,46,51,60,63,72,85]
	Rumex acetosa L.	kisavec, ajdovec	0/1/1	leaves/salads, soups, spreads, egg dishes	/	[43]
	Rumex alpinus L.	alpska kislica, planinska kislica	0/0/1	young leaves/vegetable dishes	Gorenjska	/
Polypodiaceae	*Polypodium* L.	sladka koreninica, medenična praprot, oslad, sladič, sladka praprot, sladki koren, sladka steljica, šentjanževa korenina	1/2/5	rhizoma/beverages	/	[22,72]
Portulacaceae	*Portulaca oleracea* L.	tolščak, portulak	2/3/3	young shoots/salads, soups, vegetable dishes	Primorska	[43,45,69,85]
Primulaceae	*Primula vulgaris* Huds.	trobentica, ovčica, brkončica, jeglič, golšica, gospodična	5/8/29	young leaves and flowers/salads, beverages, soups, vegetable dishes	/	[21,27,30,50,51,60,69,77,83,85]
Ranunculaceae	*Caltha palustris* L.	jurjevka, šenčurka, kurešnica, paludnica, studenčnik, zlatenica	0/0/1	petals/to dye butter	/	/
	Clematis vitalba L.	vezela, bulida, škrobot, trtovičje, leza, trtorina, vezelje	0/2/0	young shoots/egg dishes	Primorska	[43,82]
	Ficaria verna Huds.	lopatica, bradavičnik, motika	0/0/1	young leaves/soups, vegetable dishes	/	/
Resedaceae	*Reseda* L.	katanec, reseda, rezeda	0/0/1	leaves/spreads, salads	/	/
Rhamnaceae	*Paliurus spina-christi* Mill.	drača, diraka, derak	0/1/0	fruits/raw, bread	Primorska	[84]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Rosaceae	*Alchemilla* L.	hribska resa, rosnik, plenička, božja plahtica, hlebec	1/5/3	aerial parts/salads, spirits	Gorenjska	[2,12,42,55]
	Amelanchier ovalis Med.	skalna hrušica	0/0/1	fruits/beverages, fruit dishes	/	/
	Crataegus Tourn. ex L. (3 species)	beli trn, glag, glagon, glogovec, glaginje, glozje, medvedove hruške	2/6/18	fruits/beverages, jams	Notranjska, Gorenjska, Primorska	[42,55,84,85]
	Fragaria L.)	gozdna jagoda, smokvica, trstek, troskva	38/28/91	fruits/beverages, jams, desserts	/	[22,25,28,29,32,33,42,44,46,47,51,54,56, 60,66,67,69,79,84,85]
	Geum urbanum L.	blažič	0/0/1	roots/spirits	/	/
	Malus sylvestris (L.) Mill.	lesnika	2/5/9	fruits/vinegar, beverages, desserts	Gorenjska, Primorska	[2,69,71,78,80,84,85]
	Prunus avium L. var. *sylvestris* (Kirschl.) Dierb.	češnja drobnica, črešnja, tičarica	3/6/19	fruits/beverages, fruit dishes, desserts, spirits	Gorenjska, Primorska, Dolenjska	[55,60,71,74,84,85]
	Prunus cerasifera Ehrh.	cibora, ringlo, mirobalana, vinjika, divja sliva	0/1/0	fruits/fruit dishes, desserts, beverages	Primorska	[84]
	Prunus mahaleb L.	rešelika	0/4/5	fruits/beverages, fruit dishes, desserts	Primorska	[43,82,84]
	Prunus padus L.	čemš, čremka, črensa, čremž	0/0/1	fruits/beverages	/	/
	Prunus spinosa L.	črni trn, grmulja, divja slivica, oparnica, trnika, trnovec	7/16/20	fruits/beverages, fruit dishes, desserts, spirits, vinegar	/	[26,42,44,55,63,68,69,84,85]
	Pyrus pyraster (L.) Burgsd.	divja hruška, drobnica	0/4/3	fruits/beverages, desserts, fruit dishes	Gorenjska, Primorska	[26,55,72,85]
	Pyrus amygdaliformis Vill.	mandljevolistna hruška	0/4/0	fruits/raw, beverages	Primorska	[43,82,84,85]
	Rosa L.	šipek, babji zob, bavec, divja roža, goščavka, pasja gartroža, srboritka	16/13/52	fruits/beverages, jams, desserts, soups	Primorska	[27,32,41,42,44,46,60,63,67–69,74,80,84,85]
	Rubus L.	robida, črnina, kopina, črna malina, kopinjak, kopinjek	19/26/87	fruits/beverages, jams, desserts, spirits	/	[25,31,32,41,44,45,55,69,76,80,84,85]
	Rubus idaeus L.	malinjek, malinje, muraga, planinka, rdeča kopina, maljoga, žlahtna malenca	52/26/72	fruits/beverages, jams, desserts, sauces, soups, vinegar	/	[23,27,31,32,38,41,42,44,45,54,55,58,60, 63,66,74,78–80,85]
	Sanguisorba minor Scop.	zelena svitlica	0/0/1	young leaves/soups, spreads	/	/
	Sorbus aria (L.) Crantz	mokovica, mokovec, mokalica	2/7/6	fruits/fruit dishes, pastries, desserts, beverages	Gorenjska, Notranjska	[44,55,68,70,82,84,85]
	Sorbus aucuparia L.	rebika, rebičje, jerebičje, gorska smrdivka, jerebikovec, nedeljski les, smrdlika	3/7/13	fruits/jams, spirits, wine, teas, garnishes	Gorenjska	[12,42,44,55,82,84,85]
	Sorbus chamaemespilus (L.) Crantz.	pritlikava nešplja, nešpljica	0/0/1	fruits/raw, spirits	Gorenjska	/
	Sorbus domestica L.	skorš, skurša	4/5/3	fruits/spirits, fruit dishes	Primorska	[44,64,69,77,82,84,85]
	Sorbus torminalis (L.) Crantz	brek, breka	1/2/10	fruits/jams, spirits, teas, fruit dishes	Primorska	[44,69,84]

Table 1. *Cont.*

Botanical Family (APG IV System)	Scientific Name	Slovenian Vernacular Names **	Data Quantity C/E/S *	Parts Used/Typical Dishes	Regional Affiliation	Written Sources—References
Rubiaceae	*Asperula* L.	perla, bulomajster, dišeča strašnica, medenica, prehlajenka, prvenec, rožna perlica, siriščina, želvenica	0/0/1	flowers/beverages, spirits	/	/
	Galium aparine L.	plezajoča lakota	0/0/1	young shoots, fruits/spredas, beverages	/	/
	Galium odoratum (L.) Scop.	dišeča lakota, dišeča perla	2/0/3	inflorescences/beverages	/	[60,63]
	Galium verum L.	divji lan, dremovka, *lakota*, mlekoseda, mrtva torica, obročkovina	2/0/1	inflorescences/beverages	/	[42]
Rutaceae	*Dictamnus albus* L.	jasenjak, beli jasen, diptam, jesenov koren	0/2/0	flowers, roots/spirits	Primorska	[12,85]
	Ruta L. (especially *R. graveolens* L.)	rutica, ruta, vendrica, verant, rudo, rutvača, rutvica	0/1/2	leaves/meat dishes, spirits	/	[85]
Sapindaceae	*Aesculus hippocastanum* L.	konjski kostanj, jelš	2/0/5	seeds/beverages	Primorska	[42]
Scrophulariaceae	*Verbascum* L.	lučnik, papeževa sveča, svečnik	0/0/1	flowers/spirits	/	/
Smilacaceae	*Smilax aspera* L.	oponec, ostri smilaks	0/3/1	young shoots, roots/egg and vegetable dishes	Primorska	[12,43,85]
Solanaceae	*Physalis alkekengi* L.	rdeča punčica, mošnjičnik, pokalin, scalnik	0/0/1	fruits/desserts, fruit dishes	/	/
Staphyleaceae	*Staphylea pinnata* L.	kloček, divji orešek	0/0/1	seeds/raw	Notranjska	/
Taxaceae	*Taxus baccata* L.	tis, tisa	0/0/1	arillus/desserts	/	/
Urticaceae	*Parietaria* L.	krišina, cerkvina, ščirica, ščinjerica, ščirika	0/2/1	leaves, young shoots/soups, salads, egg dishes	Primorska	[43,85]
	Urtica L (especially *U. dioica* L.)	kopriva, koprica, ožarnica, pečenica, žagarica, žgavnica, žgoča kopriva, živa kopriva, ožigavica, pokriva	58/20/51	leaves and young shoots/salads, soups, spreads, sauces, garnishes, egg, meat and vegetable dishes	Primorska	[21,27,30–32,34,36,41,50–52,60,62,64,65,67–69,71,77,78,84,85]
Violaceae	*Viola* L.	vijolica, babji stolček, ljubica, fijolica	3/5/7	leaves and flowers/salads, desserts, beverages, vegetable dishes	Štajerska, Primorska	[42,51,64,69,82,85]
Vitaceae	*Vitis vinifera* L.	divja loza, trs	0/2/0	fruits/raw, dried, spirits	Primorska	[84,85]

* The cumulative data combining the selected recipes from traditional cookbooks (C), the mentions from the ethnobotanical literature (E) and the responses acquired in the online and field survey (S). ** Vernacular names of plants drawn from the ethnobotanical literature were supplemented with those used by informants.

The most frequently represented family was Asteraceae, with 28 taxa, including several genera in which several species have been used traditionally. These include *Achillea*, *Taraxacum*, *Leontodon*, *Tragopogon*, *Leucanthemum* and *Artemisia*. Furthermore, Rosaceae, with 22 taxa, is also a well-represented family. Within this family, people have used several species from the genera *Rubus*, *Rosa*, *Prunus*, *Sorbus*, *Fragaria*, *Crataegus* and *Alchemilla*. Apiaceae is represented by 16 taxa and Lamiaceae by 18 taxa. The most important edible species and genera from Apiaceae are *Anthriscus*, *Carum carvi*, *Pimpinella*, *Pastinaca sativa* and *Foeniculum vulgare*, while within Lamiaceae *Mentha*, *Salvia*, *Thymus*, *Satureja* and *Lamium* are most often included in traditional dishes. There were also quite a few taxa from Brassicaceae, (17 taxa), Amaranthaceae (10 taxa), Amaryllidaceae (6 taxa), Fabaceae (6 taxa), Pinaceae (4 taxa), Polygonaceae (4 taxa), Ericaceae (4 taxa), and Boraginaceae (4 taxa). Less frequently represented families with nutritionally important species include Ericaceae with the species *Vaccinium myrtillus*, Fagaceae with the species *Castanea sativa*, Betulaceae with the species *Corylus avellana*, Juglandaceae with the species *Juglans regia* and Urticaceae with the species *Urtica dioica*. Figure 5 shows the taxa that ranked among the 10 most frequently used taxa in the survey and/or among the cookbook recipes and/or other ethnological references.

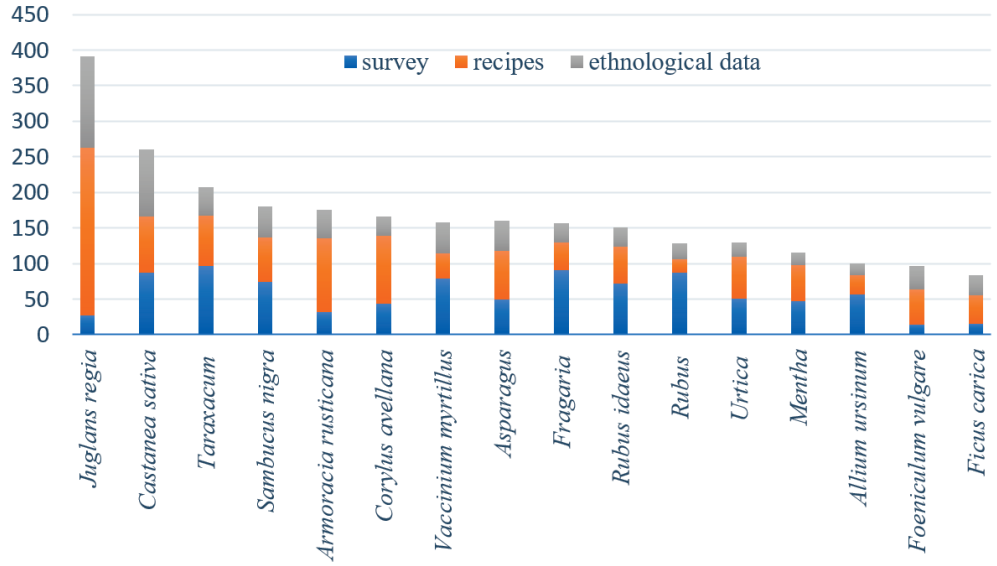

Figure 5. Distribution of acquired data for taxa of wild or subspontaneously growing edible plants used most frequently according to our study.

As shown in Figure 6, according to the traditional cookbooks, the ethnological literature and the field survey, most recipes use either fleshy or starchy fruits or seeds and belong to the category of fruit dishes and desserts. The largest share of this category can be attributed to the use of walnuts (*Juglans regia*, 236 traditional recipes and 27 mentions the survey) and hazelnuts (*Corylus avellana*, 96 traditional recipes and 43 mentions in the survey) in desserts and, in part, to the use of chestnuts (*Castanea sativa*), figs (*Ficus carica*), raspberries (*Rubus idaeus*), wild strawberries (*Fragaria* spp.) and bilberries (*Vaccinium myrtillus*) (see also Table 1). The use of plants in other categories was more uniform; only milk (dairy) dishes and spreads seem to be rare modes of traditional wild plant use in Slovenia.

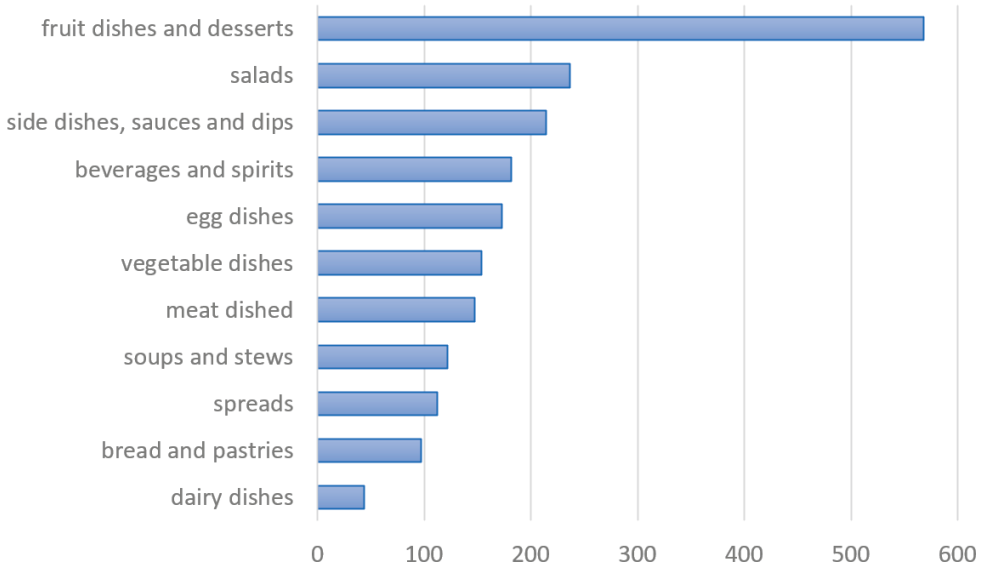

Figure 6. The relative frequency of types of dishes made from wild edible plants (including the data from the literature review and mentions in the survey).

The combined analysis of the literature and the survey data has shown that asparagus (*Asparagus* spp.) has traditionally been used in soups and various vegetable and egg dishes. On the other side, horseradish (*Armoracia rusticana*) is used in meat dishes, dips, and garnishes, while the leaves of dandelions (*Taraxacum* spp.) are the most common wild ingredient of salads. In the category of meat dishes, the most important role was attributed to spices, such as rosemary (*Salvia rosmarinus*), laurel (*Laurus nobilis*), thymes (*Thymus* spp.), savories (*Satureja* spp.), juniper berries (*Juniperus communis*), and starchy chestnuts. Walnuts and mints (*Mentha* spp.) are most often used when baking bread and pastries. Laurel (*Laurus nobilis*), caraway (*Carum carvi*) and nettles (*Urtica dioica*) were found to be typical for soups and stews. On the other hand, the flowers and berries of black elders (*Sambucus nigra*), the roots of yellow gentians (*Gentiana lutea*), and bilberries, raspberries and walnuts are the most popular traditional ingredients in non-alcoholic beverages and spirits. For egg dishes, we found many recipes with elderflowers, nettles and yarrows (*Achillea* spp.), as well as with asparagus, lemon balm (*Melissa officinalis*) and mints. The survey has revealed that people often put also other wild plants in egg dishes, for instance pellitories (*Parietaria* spp.), hop shoots, elder flowers, halophytes, wild garlic (*Allium* spp.), fennel, and sometimes even chamomiles (*Matricaria* spp.). Due to the variety in the preparation of the dishes, fitting of the dish to more than one category sometimes occurred. In such cases, we developed a personal standard that we tried to follow. For example, the dish called "štruklji" could be included in "fruit dishes and desserts" category or to bread and dough dishes. Since it is more or less sweet or not sweet at all—it depends on the recipe—we decided to include all the "štruklji" dishes in the bread and dough dishes. Vegetable dishes are all meat-free dishes with vegetables as important ingredients but not eaten as salads.

The plants used were boiled, blanched, stewed or roasted, often also baked in an oven or raw with additives, such as sour cream, sugar, salt or vinegar, and seldom fried (Figure 7). In the past, they were usually not frozen, which is not surprising considering that freezers have been introduced only in recent decades to our country. In some recipes, two or more categories were combined (e.g., raw and baked), for example, when it was stated that a part of the plant should be baked and a part left raw to be added to the dish at the end. This is a special case in some cakes (such as bilberry or strawberry cake), where you first bake the biscuit and then add filling with raw fruits.

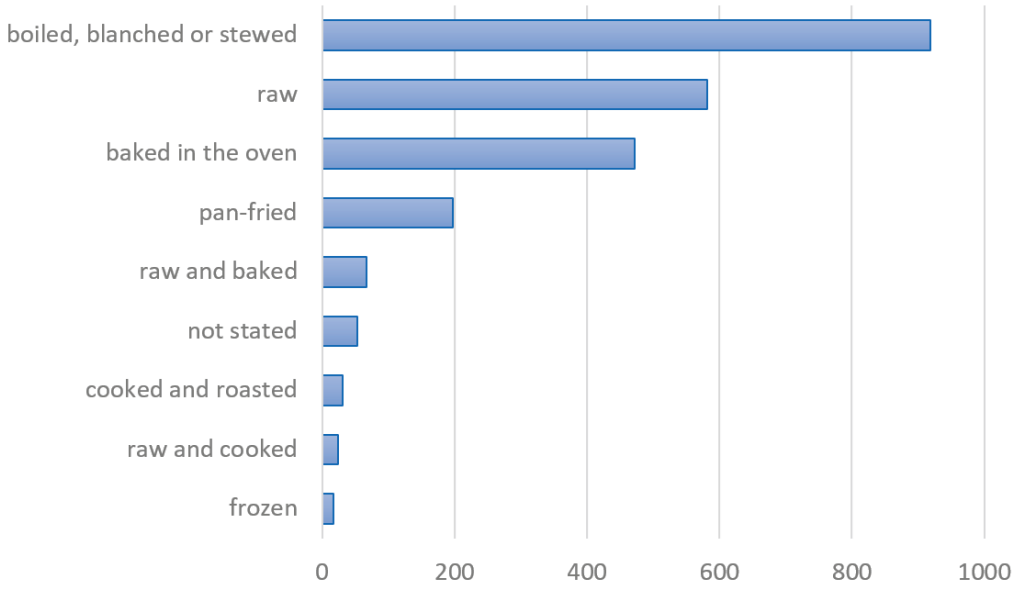

Figure 7. The relative frequency of the recipes containing wild edible plants according to the basic methods of preparation (including the data from the literature review and mentions in the survey).

3. Discussion

3.1. Comparison of the Survey Data with Those Derived from the Literature

Common walnut (*Juglans regia*), horseradish (*Armoracia rusticana*), mints (*Mentha* spp.), fennel (*Foeniculum vulgare*) and the common fig (*Ficus carica*) were used significantly more often in the recipes than in the survey (Figure 5). Apart from mints, all the mentioned plants are also relatively often represented in other ethnological references, such as ethnological books and articles (see written resources in Table 1). This can be attributed to the fact that these plant species are cultivated very often, and it was often not possible to determine from the recipes or other ethnological references whether they used a wild-growing or a cultivated plant source. The survey respondents were specifically asked to enter only plants that were harvested wild; therefore, based on the low representation in the surveys, we conclude that cultivated plants of common walnut, horseradish and figs have been used mainly in Slovenia. Nevertheless, subspontaneously growing trees of common walnuts are often found in lowland forests in all regions of Slovenia, and people include their fruits in their diet. Fennel and horseradish are also either cultivated or spontaneously growing on ruderal and segetal surfaces in the majority of Slovenia. Horseradish plants grow especially abundantly in fields and in their vicinity, and their roots have also been harvested, especially during Easter. This was a common practice in the past in Slovenia [2,81], which was also confirmed by our informants, but it seems that people currently predominantly rely on cultivated sources. Similarly, people in the Primorska region have combined wild-growing and cultivated fennel in their dishes [81–85].

On the other hand, wild strawberries (*Fragaria* spp.), wild garlic (*Allium ursinum*), goosefoots (*Chenopodium* spp.), wormwoods (*Artemisia* spp.), chamomiles (*Matricaria* spp.), hawthorns (*Crataegus* spp.), plantains (*Plantago* spp.), common primrose (*Primula vulgaris*), hop shoots, chickweeds (*Stellaria* spp.), black locust (*Robinia pseudoacacia*) flowers, and blackberries (*Rubus* spp.) were mentioned significantly more often in the survey than in the ethnological references and recipes (Figure 5 and Table 1). We might attribute the low representation of wild strawberries in the recipes to the fact that their fruits lose their original consistency, taste and aroma very quickly and are thus most often eaten raw. Furthermore, wild strawberry picking is very time consuming, and plants are most often gathered for immediate personal use. The same applies to the use of blackberries. However, although strawberries and blackberries were not mentioned as frequently in the ethnological references as we might expect, they still ranked in the top quarter of the most frequently mentioned wild plants in this type of data source. To our surprise, wild garlic

was very rarely mentioned in recipes and other ethnological references and even in newer, less traditional written sources. Therefore, we conclude that it is not used much and that it represents a new age hit in the diet of the Slovenian population [10,11,83].

Chestnut (*Castanea sativa*), dandelions (*Taraxacum* spp.), black elder (*Sambucus nigra*), blueberries (*Vaccinium myrtillus*), common hazel (*Corylus avellana*), asparagus (*Asparagus* spp.) and red raspberry (*Rubus idaeus*), as well as nettles (*Urtica* spp.), were well represented in all three types of data sources (Figure 5 and Table 1). This means that these plants have played an important role in the diet of the population in the past as well as in the present [39,43,83–85].

3.2. Traditional Use of Wild Edible Plants—A Regional Perspective

Figure 2 shows that approximately 25% of all the written sources included in this study described the recipes and eating habits of Primorska. We can see the reasons for such a marked deviation of Primorska partly in the size of the province itself but above all in the clearly more varied diet, oriented toward wild food. This is linked to the influences of the cuisines of neighboring countries (Italy and Croatia) and to the typical submediterranean climate with high plant species diversity, which includes those not growing in other parts of Slovenia. In Primorska, for example, people have traditionally used young shoots of wild asparagus, especially the species *Asparagus acutifolius*, butcher's broom (*Ruscus aculeatus*) and common purslane (*Portulaca oleracea*) in their soups and vegetable dishes [12,43,62,64,69,84,85]; leaves of common chicory (*Cichorium intybus*), wall rockets (*Diplotaxis* spp.), pellitories (*Parietaria* spp.), glasswort (*Salicornia europaea*), sea purslane (*Halimione portulacoides*), sea beet (*Beta vulgaris* subsp. *maritima*), fennel (*Foeniculum vulgare*), mountain savory (*Satureja montana*) and rock samphire (*Crithmum maritimum*) in salads, soups, egg dishes and beverages (43,62,69,77,82,84,85]; and cornel (*Cornus mas*), strawberry tree (*Arbutus unedo*), checker tree (*Sorbus torminalis*) and true service tree (*Sorbus domestica*) fruits in jams, spirits and fruit dishes [2,12,43,44,77,84,85]) (see also Table 1).

The fact that most of the respondents were from Ljubljana and Štajerska (Figure 3) is probably the result of their large population concentration. Namely, almost 800,000 people live in Ljubljana, Celje, Maribor and the areas closely associated with them, i.e., almost 40% of Slovenians. The large share of respondents from Primorska, Gorenjska and Dolenjska (Figure 3) can be attributed partly to their dense population and large area and, possibly, to the fact that our survey reached these three regions more efficiently through the internet and interpersonal exchange than, for instance, Notranjska, Prekmurje and Koroška. As shown in Figure 3, the representativeness of these data, at least in regard to the quantity of the acquired data for different regions, is reasonably good.

Certain plant species, i.e., black elder inflorescences and fruits, horseradish roots, chestnut seeds and caraway fruits, are used in similar ways throughout the country, while some of them are used in a regionally characteristic way (Table 1). For instance, the literature often mentions the use of whitebeam (sect. *Sorbus aria*) fruits as an additive in bread baking in the past, especially during shortages in Notranjska [55,68,85], while in Štajerska (Styria) they used to bake wheat bread with added hops [52,68] and even false flax (*Camelina sativa*) seeds (see Table 1). Koroška (Carinthia) has been influenced by Austrian eating habits, such as including the fruits of lingonberry (*Vaccinium vitis-idaea*) in their jams, meat dishes and liqueurs [66]. One of the traditional Carinthian sources mentions the use of meadow sage (*Salvia pratensis*) instead of common sage (*Salvia officinalis*) [21]; however, the traditionality of the use of meadow sage in Carinthia would require obtaining more information. In Gorenjska, Notranjska and Primorska, people included hawthorn (*Crataegus* spp.) and rowan (*Sorbus aucuparia*) fruits in jams and other fruit dishes [44,55,85], which was confirmed by local informants from Dolenjska and Prekmurje, who do not stand out in terms of the frequency of use of certain taxa.

3.3. Transfer of Knowledge about the Use of Wild Edible Plants between Generations

Knowledge about the use of wild-growing plants is transmitted between generations predominantly through oral traditions (see Figure 4). The survey showed that more than 40% of the respondents received information about the use of wild plants through their parents, while 26% of the respondents learned about them from friends, relatives, and acquaintances (Figure 4). An interesting component, perhaps suitable for further research, is also the transfer of knowledge between children (from child to child) and between children and grandparents (from grandparent to grandchild). Grandparents have ample time, knowledge, and experience, and they often look after their grandchildren and take them for walks. In this way, many interesting plants can be introduced that were once used. Grandparents (especially grandmothers) were previously found to be an important source of traditional knowledge for their grandchildren both in Slovenia and globally [81,86,87]. Parents, of course, teach their children to use wild plants by collecting and preparing plants themselves, which many people continue even when they grow up. We believe that childhood experience is the most important, not only because of cognitive plasticity pertaining to childhood but also because of the positive attitude toward nature in general that the child develops in this way. About 25% of the respondents wrote that they do not collect wild-growing plants introduced to them in adulthood, they only considered the knowledge they had gained in childhood. An additional quarter of them considered the introduction of new plants into their diet as risky and reported that they always require practical confirmation by an experienced user or expert. We see that parents are therefore the most important transmitters of this kind of information. Specialized books on this topic (14%), cookbooks, magazines, and newspapers (12%) contributed much less to the knowledge of wild plants, while the internet and television were negligible sources in this regard (Figure 4).

3.4. Traditional Dishes Made from Wild Plants

Based on the data collected in the literature review and in the field survey, it has been shown that Slovenians have traditionally used wild edible plants in four ways: (*i*) as fleshy and starchy fruits and seeds, either raw or in desserts, pastries and bread; (*ii*) as leaves and young shoots in soups, stews, sauces and egg dishes; (*iii*) as spices for cooked and baked vegetables and meat dishes; and (*iv*) as an ingredient of beverages (see Table 1 and Figures 6 and 7). Sometimes it was difficult to draw a line between medicinal and edible use, as in the case of linden or elderberry tea. Sometimes people drink it to improve their health, but they might do so only for thirst [12,88].

Different fruits have been included in raw fruit dishes, desserts and starchy fruits, such as bilberries (*Vaccinium myrtillus*), wild strawberries (*Fragaria* spp.) and blackberries (*Rubus* spp.), and furthermore, fruits of the true service tree (*Sorbus domestica*), blackthorn (*Prunus spinosa*), common barbery (*Berberis vulgaris*), cornel (*Cornus mas*), rosehips (*Rosa* spp.), chestnut (*Castanea sativa*) and red raspberry (*Rubus idaeus*) (Table 1). Common hazel (*Corylus avellana*), common walnut (*Juglans regia*) and common fig (*Ficus carica*) fruits were eaten just as often raw as in various baked desserts. The leaves of mints and fruits of walnuts and whitebeams were the most characteristic for bread dishes and pastries. Mints are an ingredient in the preparation of bread and sweet-salty pastries, such as “metovka” and ”štruklji” [21,68–70], and whitebeam and walnut fruits as an ingredient in bread and ”potica” [44,45,68,70,84,85] (Table 1).

The most common taxa in the salad category were wild garlic (*Allium ursinum*), corn salads (*Valerianella* spp.), harden rocket (*Eruca sativa*), wall rockets (*Diplotaxis* spp.), common primrose (*Primula vulgaris*) and dandelions (*Taraxacum* spp.). In egg dishes, nettles (*Urtica* spp.), lemon balm (*Melissa officinalis*), black locust (*Robinia pseudacacia*), yarrows (*Achillea* spp.), bladder campion (*Silene vulgaris*) and feverfew (*Tanacetum parthenium*) were often included [32,62,67,85]. Mostly, the egg dishes involved the preparation of the so-called ”frtalja”—an omelette with a plant material as the main ingredient, eggs and flour only serving as a binder. Young shoots of asparagus (*Asparagus* spp.) and common hops

(*Humulus lupulus*) were typically used to prepare various vegetable dishes. Cranberries (*Vaccinium vitis-idaea*), the roots of the common horseradish (*Armoracia rusticana*) and fruits of the European crab apple (*Malus sylvestris*) were typical for the preparation of side dishes, sauces, vinegar and dips [12,43,85].

As expected, spices are most often used in the preparation of meat dishes in a similar way as in other Mediterranean countries [16,18,89]. These spices are common sage (*Salvia officinalis*), common juniper (*Juniperus communis*), thymes (*Thymus* spp.), true laurel (*Laurus nobilis*), rosemary (*Salvia rosmarinus*), mountain savory (*Satureja montana*) and fennel (*Foeniculum vulgare*) [43,84,85].

Bilberries, fruits and flowers (or inflorescences) of black elder (*Sambucus nigra*), cornel (*Cornus mas*) fruits, flowers of lindens (*Tilia* spp.) and leaves of plantains (*Plantago* spp.) were typically used to prepare different types of drinks, such as teas, smoothies and raw juices. The roasted roots of chicory (*Cichorium intybus*) were mainly used as a substitute for coffee, while the spruce tips and the inflorescences of dandelions were used for syrups. Wormwood (*Artemisia* spp.) and juniper (*Juniperus* spp.) berries were mostly used in the preparation of spirits.

3.5. Slovenian Wild Cuisine: From Traditional Use to Modern Perspectives

Before the 19th century, Slovenian people used certain types of wild plants on a wider scale, which were later replaced by other cultivated plants. This applies, for example, to chickpeas (*Lathyrus* spp., especially *Lathyrus sativus*), and different types of sorrel (*Rumex* spp.) [2,12,28,90]. Our ancestors enriched their diet, based on cereals and legumes, with weed species that thrived on cereal fields and ruderal habitats; for instance with poppy seeds and greens of wild plants of genus *Brassica*, peppercresses (*Lepidium* spp.), hedge mustards (*Sisymbrium* spp.), goosefoots (*Chenopodium* spp.) and amaranths (*Amaranthus* spp.) [12,19,28,68,90]. In the 17th and 18th centuries, some wild or cultivated plants gradually stopped being used; probably because they were replaced by tastier ones. Alexanders (*Smyrnium* spp.) were completely replaced by celery in European cuisine by the 18th century. Our field survey has shown, that although perfoliate alexanders (*Smyrnium perfoliatum*), still grows in dry karst grasslands in Slovenia, its edibility is nowadays not known even to local people. The use of bitter wild herbs, such as ground-ivy (*Glechoma hederacea*), common heather (*Calluna vulgaris*) and wormwoods (*Artemisia* spp.) in beer production had a similar fate. Slovenians have used almost exclusively hops (*Humulus lupulus*) with spice beer in the last two or three centuries, but in accordance to the findings of our survey the traditional bitter herbs, especially ground-ivy, wormwoods and even minths have gained some recognition among younger beer brewers in the last 20 years.

The interviews with older informants revealed that only a few decades ago the coffee substitutes were still sometimes prepared from the roasted roots of common chicory (*Cichorium intybus*), seeds of vetchlings (*Lathyrus* spp.) and chestnut (*Castanea sativa*), and acorns of various oak species in our country mainly from the durmast oak (*Quercus petraea*) and the pedunculate oak (*Quercus robur*). This practice is also well known from the ethnobotanical literature [2,28,69]. Very tasty and valued oil was pressed from the beech nuts. During the Second World War and in the following years, hundreds of thousands of kg of beech nuts were collected annually for this purpose in Slovenia (100 kg yields about 10–12 L of oil) [2,55,68].

Until the Second World War and for some time after it, wild plant gathering and mushroom picking was a very important additional or even the only source of seasonal income, especially among the people of lower social classes and small farmers [47,53,56,74,79]. In the last decades, in conjunction with socio-economic development, the general need for wild plant gathering gradually declined [56,74].

Due to changes in the way of life, certain plants that used to be consumed mainly by children, e.g., cornel, barbery and blackthorn fruits, are nowadays used much less often. On the other hand, some practices, such as the collection of the fruits of wild caraway (*Carum carvi*), were almost entirely lost due the degradation of the lowland grasslands.

Nowadays, people gather wild plants for food and medication primarily for their personal use and not for sale [10,11,80]. From the online and field survey, we found out that the once popular fruits of cornel (*Cornus mas*), true service tree (*Sorbus domestica*), elderberry (*Sambucus nigra*), and wild caraway (*Carum carvi*), as well as the leaves of the corn salads (*Valerianella* spp.), have been partly replaced by wild garlic (*Allium ursinum*), salad burnet (*Sanguisorba minor*), yellow cresses (*Roripa* spp.), amaranths (*Amaranthus* spp.), knotweeds (*Polygonum* spp.), garlic mustard (*Alliaria petiolata*), avens (*Geum* spp.), rampions (*Phyteuma* spp.), bellflowers (*Campanula* spp.), oxtongues (*Picris* spp.), galant soldiers (*Galinsoga* spp.) and stinking aposeris (*Aposeris foetida*), as well as other plants introduced to us by the authors of books on edible wild plants [10–13,83]. The use of wild plants that grow in large numbers and have a great taste is very common among people and has also gained recognition in haute cuisine [12,13,91–93].

Nevertheless, the interviews with the older informants from different parts of the country confirmed that many old wild recipes are still alive among people, such as the use of roots of broad-leaved sermountain (*Laserpitium latifolium*) in spirits in Posavje and Kozjansko (Figure 2, regions 11 and 12), the use of fruits of common whitebeam (*Sorbus aria*) and hawthorns (*Crataegus* spp.) in jams in certain parts of Notranjska, the use of the checker tree (*Sorbus torminalis*) fruits in the preparation of fruit dishes in the Dragonja river valley, and the use of the common glasswort (*Salicornia europaea*) and seepweed (*Suaeda maritima*) shoots in soups and salads by inhabitants of the Sečovlje salt flats, Izola and Strunjan [12,82]. The shepherds on Velika planina alpine pastures use peculiar ingredients to make their mountain refreshing tea; for instance, thymes, lady's mantles (*Alchemilla* spp.), common kidneyvetch (*Anthyllis vulneraria*) and even hairy alpenrose (*Rhododensron hirsutum*), named "gričevnik", and mountain everlasting (*Antennaria dioica*), called "griževnik". The inhabitants of Čičarija still sometimes use the fruits of the Christ's thorn (*Paliurus spina-christi*) as an ingredient in teas and bread [84]. On the other hand, the knowledge about the use of mountain lovage (*Ligusticum mutellina*), sweet cicely (*Myrrhis odorata*) and spignel (*Meum athamanticum*) in spirits and as a spice for vegetable dishes, which were popular in the past by the inhabitants of the Julian Alps surrounding Bohinj and Kranjska Gora, is becoming obsolete. Similarly, the people forgot the practice of including raw corms of spring crocus (*Crocus vernus*), called "kroketi", in their diet, a habit present in certain parts of Primorska in the beginning of the 20th century.

3.6. Protection Strategies for the Conservation of the Vulnerable Edible Plant Species

Many edible and medicinal plant species could be endangered by harvesting [14]. Picking fruits or above-ground parts of the shoots of perennials in moderate quantities is seldom problematic, unless it includes rare and endangered species. In this category, there are many species that grow near water, e.g., water nut (*Trapa natans*), on the fens, e.g., bogbean (*Menyanthes trifoliata*), bog bilberry (*Vaccinium uliginosum*) and lingonberries (*Oxycoccus* spp.), on moist meadows, e.g., pennyroyal (*Mentha pulegium*) and great burnet (*Sanguisorba officinalis*), in dry habitats, e.g., hyssop (*Hyssopus officinalis*), common sage (Salvia officinalis), snowy mespilus (*Amelanchier ovalis*, houseleeks (*Sempervivum* spp.), European nettle tree (*Celtis australis*, common smilax (*Smilax aspera*) and butcher's-broom (*Ruscus aculeatus*), or in salt coastal marshes, e.g., rock samphires (*Chrithmum maritimum*), common glasswort (*Salicornia europaea*), saltworts (*Salsola* spp.) and sea beet (*Beta vulgaris* subsp. *maritima*). From the nature conservation point of view, the collection of the underground parts of perennial plants can be much more problematic, even unacceptable [12,43,83,85], since they cannot survive without them. In addition, the extensive collection of flowers or whole parts of annual plants could pose a threat to their populations [12,14,43].

Some plant species are endangered simply because they are present only in a narrow geographical area (so-called endemics) or because wherever they occur, they form very rare populations. Such species can be driven to extinction by even one major reckless human intervention [12,83]. As already mentioned, species that thrive in threatened habitats, such as marshes, bogs and dry grasslands, are also under great pressure. In this

respect, the most important conservation measures are oriented towards habitat protection by the minimization of tourism and agriculture in these regions. Plant species in these habitats should not be harvested. The same applies to protected species, whose gathering is sometimes possible to the extent specified in the legal documents governing that area.

Therefore, when collecting, we should always ask ourselves about our purpose for collection only as much as we need and in places where there are enough plants [12]. When harvesting, we always adhere to the principle that we only take the parts of the plant that we need, we do not tear or pull them all over. This especially applies to the collection of underground parts, flowers and seeds, as in this case their regenerative capacity is lower than in the case of the collection of leaves, shoots and twigs. When picking flowers or inflorescences, we should leave at least half of them on the plant, and the same applies to the pods. It will be useful if some of the seeds and fruits are scattered around the surrounding area or even buried in the ground in suitable places [12,83]. In each plant population, only a small proportion of specimens may be taken in one season.

4. Materials and Methods

In this ethnobotanical research, we collected information about the use of wild edible plants from ethnological sources and selected traditional cookbooks, and conducted an online and field survey, that included informants from different parts of Slovenia.

We reviewed data from the literature, such as ethnobotanical articles, traditional cooking and ethnobotanical books and local internet sites or databases (see Table 1 and References). Only reliable traditional cookbooks were taken into consideration, while the newer cookbooks addressing new and fashionable cuisine inspired by international sources were excluded. The recipes from the traditional cookbooks with no confirmation of use among local people were not included in the analysis.

We focused only on wild plants that were used as food, i.e., for salads, sauces, garnishes, drinks and seasoning or aromatizers. This means that we did not collect data on the use of wild plants for medicinal purposes. When plants were referred to only with vernacular names, the identification of taxa was performed using glossary terms at the end of the cookbooks (when they existed), ethnobotanical books, and/or the data available in different databases, such as the database in the article of Praprotnik [94] or "Leksikon rastlinskih bogastev" [95].

The data obtained from the literature review were supplemented with those derived from the online and field survey. The survey questionnaire was initially distributed personally via an e-mail to reach some of the informants. Afterwards, in 2009, the survey was put on "Kulinarična Slovenija", the largest culinary portal at that time. In 2023, the survey questionnaire was also sent to the professional higher education study program students at the Faculty of Health Sciences in Novo mesto and to general practitioners from all parts of Slovenia.

In addition to some basic demographic questions, a combination of closed-type and open-type questions were included in the survey questionnaire. The questions were as follows (in case of the closed-type questions possible answers are also stated):

1. How often do you gather edible wild plants? (one choice: regularly; occasionally, i.e., several times per year; seldomly, i.e., twice a year or less; never).
2. Which wild plants do you gather on a regular basis? Include also beverages, such as teas and spirits, if they are not used for medicinal purposes.
3. Please, name any other wild plants that you remember collecting or trying at any time. You can use the list of 120 edible plants to assist your memory.
4. How did you get information about the edible wild plants you use? (multiple choices: from my parents; from friends, relatives, and acquaintances; in specialized books; in cookbooks and newspapers; on the internet; on television; other)
5. From how many sources do you inquire about the edibility of a specific plant species before introducing it into your diet? (one choice: one source is enough, either written

or oral; always use multiple sources, also ethnobotanical books and internet; always require a confirmation from an experienced person).

6. For what purpose do you include the wild edible plants into your diet? (multiple choices: due to their good taste; because they are free; due to their high mineral and vitamin content; because gathering is combined to a walk in the nature; out of necessity in case of hunger; other).

At the end of the survey, 120 edible plants were listed (with a Slovenian name) to assist the respondents. Sometimes the taxa could be determined at the species level and in other occasions only at the level of genus. If the answer was ambiguous regarding either the taxonomy, the culinary use or the traditionality, the data were not included in the analysis. Sometimes, we could not identify plant taxa from vernacular names, listed by respondents, such as "hrastovka" or "dragoncelo".

Furthermore, in-depth unstructured interviews regarding the wild edible plant use were conducted with some experienced informants (their average age was 78.4 years), i.e., herbalists, wild food experts, botanically oriented tourist guides, older sustainable farmers, wild food vendors in markets etc., from different regions of Slovenia.

Since certain parts of Slovenia can be regarded as cultural–historical entities and have specific biological and geographical characteristics, we divided Slovenia into generally known regions. These include Dolenjska, Gorenjska, Primorska, Notranjska, Koroška, Štajerska and Prekmurje (Figure 8). Due to the degradation of the environment in Ljubljana, its central location and because an increasing number of people from all over Slovenia are immigrating into the capital city, bringing their own customs with them, we have considered it and its suburbs special areas.

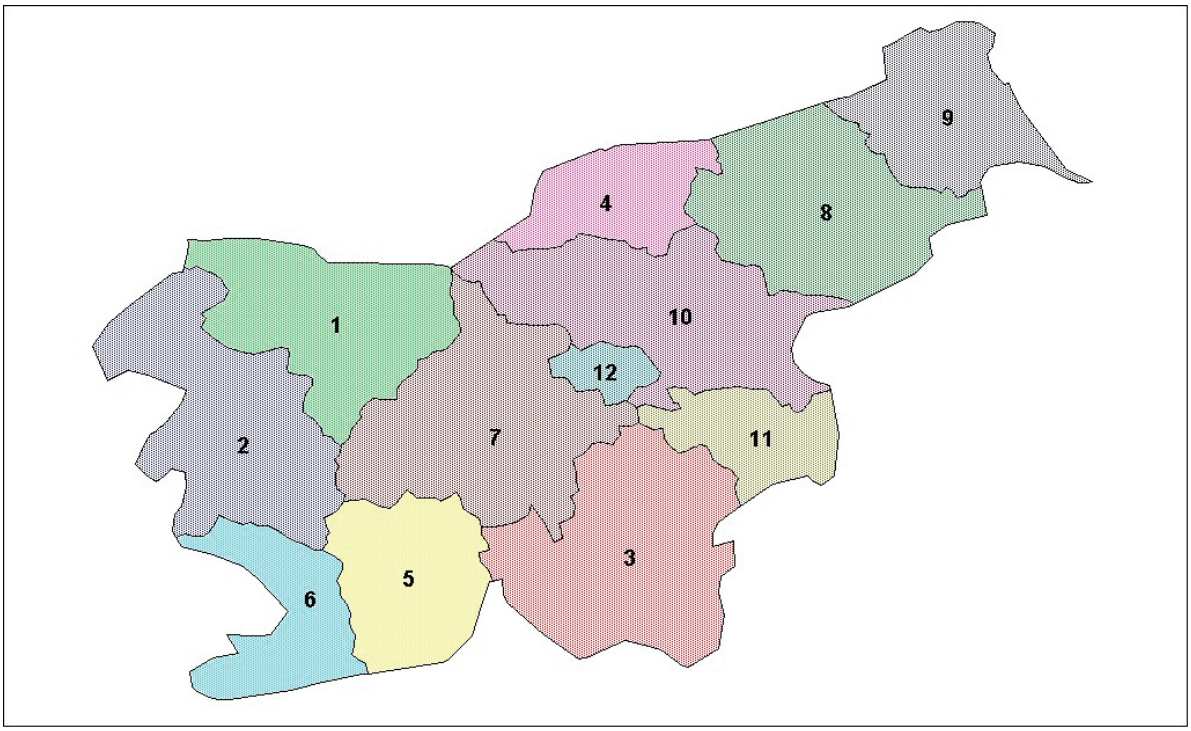

Figure 8. The depiction of Slovenian regions as used in this study: Dolenjska (3 and 11), Gorenjska (1), Primorska (2 and 6), Notranjska (5), Koroška (4), Štajerska (8, 10 and 12), Prekmurje (9) and Ljubljana with its suburbs (7).

5. Conclusions

Wild plant gatherings for food and fodder have always been a part of people's lives in our country. In the newspapers and books from the 19th and 20th centuries, we can find many interesting facts about the selection of wild plants used among

Slovenians [26,28,63,68–71,83,90], while the literature for previous centuries is less well preserved. Different sources of information (traditional cookbooks, ethnological books, surveys, and interviews) provide different information about the types of wild plants and their use in food. Selected traditional cookbooks, ethnological books and interviews provided good insight into the past use of wild plants and an online and field survey into their past and current state of their use. During the course of this study many older informants were interviewed giving information about the use of wild plants in the decades after the Second World War. They were also a good source of information about the reliability of the traditional use of the recipes in the cookbooks.

Slovenians are still connected to a considerable extent with forests and meadows and some of their products, which are sometimes provided in large quantities. Our connection with wild plant food has also been proven by the survey, as almost 46% of respondents collect wild plants often or at least several times a year, which is comparable to the results of similar wild food ethnobotany surveys conducted in Europe [16,18,19,91]. There are slightly fewer (approximately 29%) who collect these plants only once or twice a year or occasionally (14%). Nevertheless, those who consider wild plants to be an important part of their daily diet and therefore collect them very often (12% of respondents) are also rare. Interestingly, the popularity of some wild plants in the diet of our people has changed over time. Tens of new wild plant species have been introduced widely by the authors of books on edible wild plants [10–13]. Our survey has shown that the use of plants that grow in large numbers, that are easily accessible and also tasty, e.g., bilberries, wild strawberries, chestnuts, dandelions and wild garlics, is very common among Slovenian people. This is probably positive from the health perspective and is sustainable, since their populations are abundant and could thus not be easily endangered. However, many other plants are more or less ignored, remaining in the domain of those who are more in touch with nature, enthusiasts and experimenters (see species mentioned only once or twice in Table 1).

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Ethnobotanical Documentation of the Uses of Wild and Cultivated Plants in the Ansanto Valley (Avellino Province, Southern Italy)

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Abstract: With approximately 2800 species, the Campania region has the richest vascular flora in southern Italy and the highest number of medicinal species reported in the Italian folk traditions. The study area is inserted in a wide rural landscape, still retaining a high degree of naturalness and is studied for the first time from an ethnobotanical point of view. By analyzing local traditional uses of wild plants in the Ansanto Valley area, the present study aims to contribute to the implementation of ethnobotanical knowledge concerning southern Italy. To gather ethnobotanical knowledge related to the Ansanto Valley, 69 semi-structured interviews were carried out through a snowball sampling approach, starting from locals with experience in traditional plant uses (key informants). A number of 117 plant species (96 genera and 46 families) were documented for traditional use from a total of 928 reports, of which 544 were about medicinal plants. New use reports on the utilization of plants for medicinal (5) and veterinary applications (8) in the Campania region and the whole Italian territory were outlined from our investigations. *Sedum cepaea* is reported as a medicinal plant for the first time in Italy and in the whole Mediterranean basin.

Keywords: ethnobotany; traditional plant use; ethnomedicine; medicinal plant; ethnoveterinary; wild food plants; Italy

1. Introduction

Throughout human history, plants and their derivatives have held significant and purposeful roles in various aspects of human existence. Plants have a significant impact on human nutrition and health and their utilization for medicinal purposes dates back to a time before recorded history, with practices passed down for centuries and in constant evolution [1]. We may consider ethnobotanical knowledge as a part of local ecological knowledge [2]. The traditional ecological knowledge (TEK) of local communities can provide insight into the cultural and ecological importance of different plant species, as well as the potential for sustainable use [3]. In the last years, numerous field ethnobotanical studies have been performed to document the folk uses of plants, with the aim of contributing to the knowledge and conservation of a part of the traditional cultural heritage [4,5]. In particular, Pieroni [6] emphasizes the pressing need for systematic ethnobotanical investigations in southern Europe, particularly in regions that have retained their relative isolation due to historical and geographical factors and where industrial progress has not yet resulted in a complete erosion of their cultural traditions. Currently, traditional indigenous knowledge continues to persist in several regions of the Mediterranean basin, mainly preserved by the elderly living within the surviving rural communities of developed countries [7,8]. Recently, many researchers analyzed the persistence of traditional uses of plants and their products in Italy (e.g., [9–12]) and particularly in the Mediterranean southern regions

(e.g., [13–15]). Due to its natural geographic, climatic, and soil conditions, the Campania region exhibits richness in terms of plant diversity and has the richest vascular floras in southern Italy, with approximately 2800 species and subspecies recorded so far [16]. As underlined by Monari et al. [8], Campania has the highest number of medicinal species reported in the Italian folk traditions.

The present study focused on a particular area of the Campania region known as the Ansanto Valley, an impressive place with fascinating geophysical characteristics due to the boiling mud lakes and vents emitting volcanic-like exhalations. Here, the Mefite d'Ansanto arises as the largest non-volcanic natural emission of low-temperature CO_2-enriched gases ever measured on Earth, with an estimated total gas flux of about 2000 tons per day [17]. At the same time, the site is nestled in a rural landscape, still retaining a high degree of wilderness [18]. In the last few centuries, deforestation has led to several landslides, which, in turn, have led to the discovery of several archaeological remains from a sanctuary sacred to the goddess Mephitis, dating back to the 1st century BC [19]. Recent studies indicate that the potent selection pressure imposed by the extreme environment of the Mefite area can influence population differentiation and adaptation in plants [20]. This study area has never been previously investigated from an ethnobotanical point of view.

Against this background, the present study aims to analyze local traditional uses of wild plants in the Ansanto Valley area, encompassing medicinal, culinary, veterinary, cosmetic, and domestic applications, thereby contributing to the development of ethnobotanical knowledge in Campania and southern Italy. Furthermore, by comparing the available literature data on ethnobotanical studies in southern Italy and in the whole Mediterranean basin, we aim to distinguish new and already described records of the use of a particular plant species in the study area.

2. Results and Discussion

We compiled an inventory of 117 taxa (a full list with remarks is given in Table S1) from 96 genera and 46 families. Based on the interviews, 928 use reports were for all taxa. The use-report number superseded the taxon number because taxa often had more than one use and the same use could be mentioned by more than one informant. They mostly concerned medicinal applications with a percentage of UR equal to 58% of the total UR number, followed by food uses (29%) (Figure 1). These data are in line with other studies on a regional scale (e.g., [14,15]) describing results obtained in similar ethnobotanical research in southern Italy. Asteraceae was the most representative family, counting 18 plant species, followed by Lamiaceae and Rosaceae with 11 and 10 species, respectively (Figure 2a). These families have consistently emerged as the most frequently utilized in folk traditions for medicinal purposes in southern Italy (e.g., [15,21,22]) and in the whole Mediterranean basin (e.g., [23–27]). These families are highly diverse and abundant in Europe, providing a wide range of plant species with various properties and uses. The most cited species are *Malva sylvestris* L. (57 URs), *Matricaria chamomilla* L. (54), and *Cichorium intybus* L. (51) (Figures 1b and 2b).

Over 40% of all the plant species recorded from the interviews fell in multiple application categories. This is likely due to the optimization of natural resources as a consequence of a close connection of the people with the local environment [28]. In particular, use reports described a seamless link between plants used for medicinal and culinary purposes, a frequently observed phenomenon [29] that spans across the globe, contributing to the development of functional food and nutraceuticals.

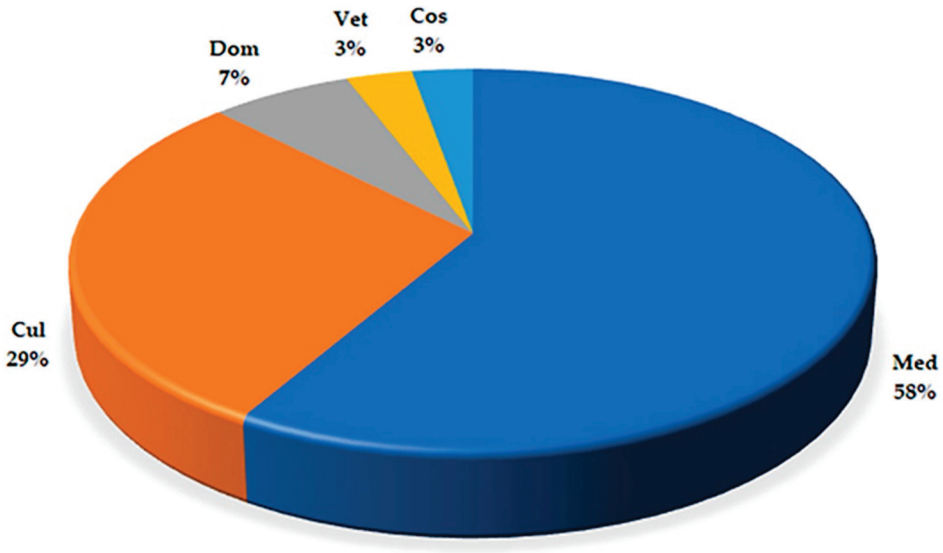

Figure 1. Percent use categories (n = 927) among the 116 taxa recorded in the study area (Med: medicinal uses; Cul: food uses; Dom: craft and domestic uses; Cos: cosmetic uses; Vet: veterinary uses).

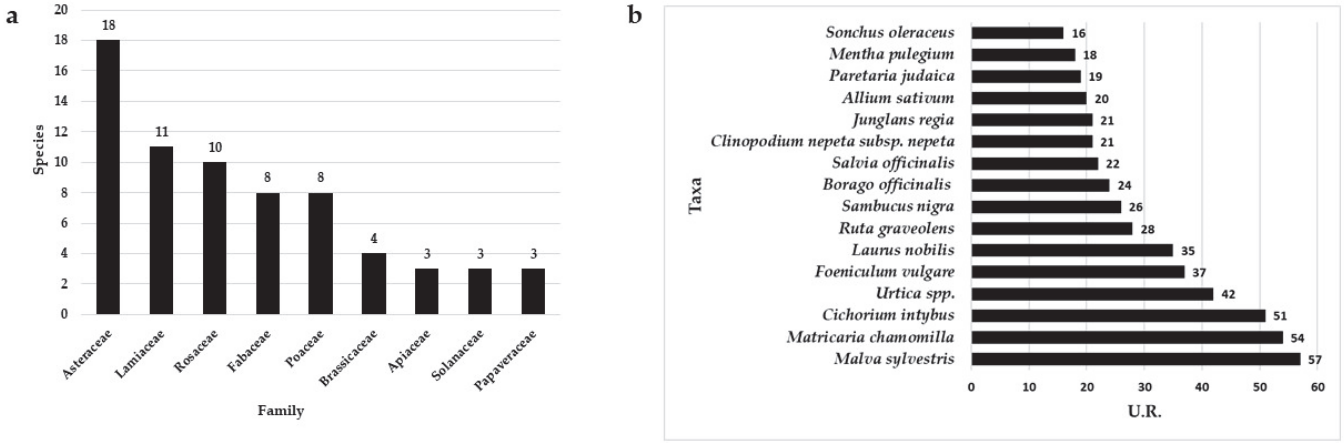

Figure 2. Number of species per family (**a**) and number of use reports per species (**b**).

2.1. Medicinal Plants

In total, 544 use reports were recorded for medicinal plants. The plant parts most frequently used for medical purposes were the leaves (42%), followed by the flowers (16%), fruits (15%), stems (7%), and seeds. Leaves are often abundant, easily accessible, and rich in bioactive compounds like essential oils, alkaloids, and flavonoids, which may possess medicinal properties. Many traditional remedies involve the use of the leaves due to their wide availability and ease of use. Even the flowers contain diverse bioactive compounds and are employed in traditional medicine for their potential health-enhancing properties. However, flowers are available in smaller quantities than leaves and may pose a challenge in terms of usability. The aerial parts and the whole plants accounted only for a small percentage (4% each), and the remaining parts accounted for 8% overall. Plant use by oral and topical administration and by inhalation accounted for 59%, 36%, and 5%, respectively. Different preparations and processes of administration of medicinal plants for internal use were mentioned, with raw (32%) or boiled (14%) vegetable parts, decoction (28%), and maceration in oil and alcohol (7%) being the most cited. For topical uses, the direct administration of raw or boiled vegetable parts, decoction, and maceration in oil and alcohol were the most cited. *Malva sylvestris* L. (55 URs), *Matricaria chamomilla* L. (53 URs), and *Ruta graveolens* L. (28 URs) were the most cited plant species for medicinal uses (Figure 3a). Ailments pertaining to the gastrointestinal system recorded the highest

number of use reports (149 URs), followed by those related to the respiratory (120) and musculoskeletal (82) systems (Figure 3b).

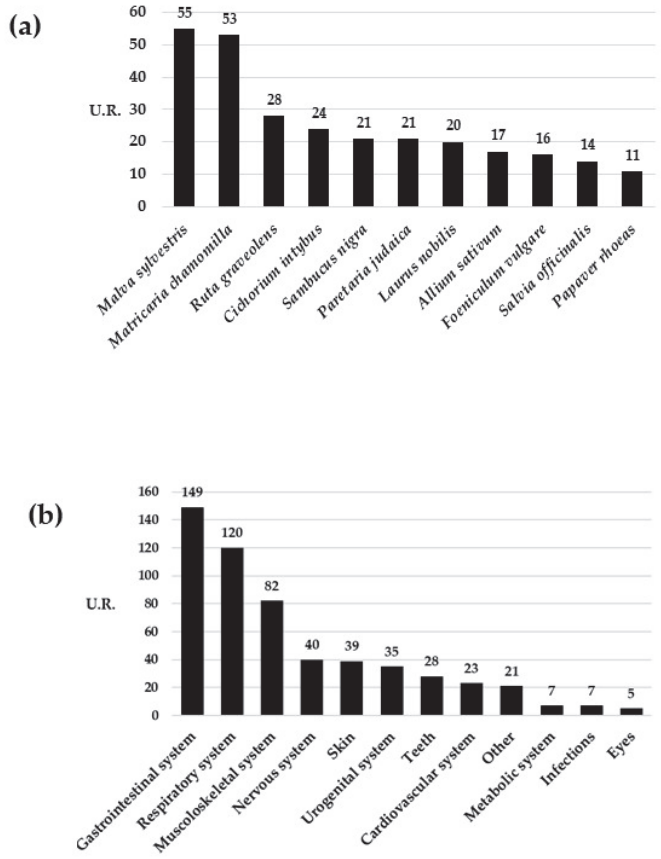

Figure 3. Number of use reports for each of the most cited species (**a**) and number of use reports for each ailment's category (**b**).

For the most reported species as medicinal remedies, life form, chorology, and comparative uses in Italian traditional medicine are discussed below. Plants are listed following the alphabetic order of the plants' scientific names.

Garlic (*Allium sativum* L.) is a species of bulbous flowering plants native to southern and central Asia. Garlic is among the oldest cultivated food plants and is still used also for medical purposes [30]. In the study area, garlic is mainly used as an intestinal disinfectant against intestinal worms (5 URs), to regulate blood pressure (4 URs), for stomach and bellyache treatments (5URs), as an antimicrobial (2 UR), and topically for insect bites (5 URs). In traditional medicine, it is usually used for various diseases, such as hypertension [31–33], as vermifuge [34,35], an antimicrobial or antiviral [36,37], and as a treatment for insect bites [38,39]. In the Italian folk phytotherapy, garlic is also widely used for healing wounds and burns [40,41].

Common chicory (*Cichorium intybus* L.) is a perennial herbaceous plant native to temperate Europe, Asia, and Africa, and it has now been introduced worldwide. In the study area, common chicory is mainly used as a liver depurative (8 URs) and diuretic (4 URs). Common chicory is widely used in popular medicine as a depurative of the liver [42,43], intestines, and blood [38,44,45] or to regulate blood pressure in the case of hypertension [46,47]. The aerial parts of C. intybus were also used for their diuretic [35,38,48] and digestive properties [49].

Fennel (*Foeniculum vulgare* Mill.) is a hardy, perennial herb native to the Mediterranean basin and is widely naturalized throughout the world. In the Ansanto valley, fennel fruits are mainly used for bellyache treatments (5 URs) and as a digestive (3 URs). Decoctions of

its fruits are widely used in folk medicine as a digestive [50–52] and carminative [53–55] and against colds and the flu [28,56].

Bay laurel (*Laurus nobilis* L.) is a broadleaf evergreen tree native to southern Europe. In the study area, bay laurel leaves' decoction is used mainly as a digestive (3 URs) and against the flu (3 URs). Bay laurel leaves' and fruits' decoctions are widely used to treat a broad range of diseases, mainly for gastrointestinal [11,43,45] and respiratory ailments [47,48,57], and for dysmenorrhea treatments [50,58,59]. Laurel decoction is also used as a mild sedative [47,53,60].

Common mallow (*Malva sylvestris* L.) is a perennial or annual herb native to western Europe, north Africa, and south Asia and is widespread almost throughout the world. Our respondents reported decoctions of common mallow as a useful treatment for bellyaches (14 URs), the flu, colds, and coughs (11 URs), and against stomach aches or as a digestive (10 URs). In traditional pharmacopeia, common mallow is used to treat various ailments, such as those at the respiratory [41,61], gastrointestinal [33,59,62], and urinary [50,63] systems, and to treat toothaches [57,64] and skin diseases [42,49].

Chamomile (*Matricaria chamomilla* L.) is an annual herbaceous plant native to south-eastern Europe and south-western Asia, and it is now widely distributed throughout the world. Chamomile, in the study area, is reported for bellyaches (URs) and stomach aches (12 URs), as a sedative (7 URs), and for dysmenorrhea treatments (4 URs). Besides its well-known sedative effects [62,65,66], chamomile is reported to be an effective herbal remedy as a spasmolytic and carminative [47,67,68], for dysmenorrhea disorders [29,49,69], respiratory ailments [70–72], and against eye inflammations [46,53,71].

Corn poppy (*Papaver rhoeas* L.) is an annual flowering plant native to the temperate areas of Europe, North Africa, and West Asia, and it is naturalized all around the world. Corn poppy in the Ansanto valley is mainly reported as a useful treatment of insomnia for children (11 URs). In folk pharmacopeia, it is mainly used as a sedative and to treat insomnia [15,21,73].

Rue (*Ruta graveolens* L. and the similar *R. chalepensis* L.) are subshrubs native to southern Europe, and it is widely cultivated as an ornamental plant in various parts of the world. Rue, in the study area, is mainly used against the flu, colds, and coughs (5 URs), for stomach ache treatments (5 URs), and topically against toothaches (4 URs). Rue is used for gastrointestinal [6,49,68] and respiratory [14,58] ailments. In the Italian ethnobotanical literature, rue is also widely cited as an anthelmintic [74–76], but this use was not reported by the people interviewed in the study area.

Sage (*Salvia officinalis* L.) is an evergreen subshrub that originated in the Mediterranean area and naturalized in many areas around the world. Sage, in the study area, is reported mainly against halitosis (4 URs), sore throats (3 URs), and topically for toothaches and to whiten teeth (3 URs). *S. officinalis* is commonly used as an herbal remedy against the flu and other respiratory diseases [13,28,49] and as a digestive [35,77,78]. Leaves are also used, raw or as a decoction, to wash and whiten teeth and for gingivitis treatments [42,62,67].

The elderberry (*Sambucus nigra* L.) is a deciduous shrub native to Europe, and it was introduced into various parts of the world, including eastern Asia, northern America, New Zealand, and the southern part of Australia. Elderberry is mainly reported by our respondents for flu, cold, and cough treatments (8 URs). *S. nigra* flowers are widely used in folk phytotherapy for the treatment of bronchial diseases [7,45], colds and coughs [10,50,63], as a laxative, or for abdominal pains [50,61,62]. As a topical application, the flowers are used for burn treatments [32,74], wounds [66], and rheumatic pains [49,79,80]. Elderflowers are also widely recognized for their health benefits, which encompass protection against degenerative illnesses such as cardiovascular and inflammatory diseases, cancer, and diabetes [81].

Some use reports recorded in the study area were new for Campania and southern Italy. They are listed below, following the alphabetical order of the species.

Agrimonia eupatoria L. is reported to be used for burn treatments, as its local name "evera de lu cuotto" (literally, herb of the burn) suggests. In southern Italy, uses of Agri-

monia eupatoria have been documented for wound topical treatments [48], while in the Campania region, *A. eupatoria* was reported only for internal uses as an antispasmodic or anti diarrheal [82,83]. Within the entire Mediterranean region, this species is documented mainly for internal applications, such as for sore throat treatment, as an expectorant, as a hepatic anti-inflammatory, an antispasmodic, or against gastrointestinal diseases [27,84–86], and for wound treatments [87] or to treat snake bites [88] for external uses.

Bellis perennis L. is used in the study area for healing pimples. In Campania, this plant is reported for its internal use as a febrifuge [14], while in southern Italy, it is used as an external analgesic [59]. In Italy, B. perennis is used as an eyewash [89], for sore treatments [35], or for preventing uterine bleeding during or after labor [8]. In Kosovo, it is used for the treatment of skin infections [90], and in Turkey, it is used as a sedative and an antispasmodic [91] or as a diuretic [92]. In Croatia, it is used for stomach diseases [93].

Ecballium elaterium (L.) A.Rich. is used in the study area for sinusitis, cold, conjunctivitis and otitis treatment. In Campania, this species is reported only as a purge for the Cilento area [83]. In southern Italian folk phytotherapy, it is used internally as an emetic or externally against toothaches [89,94,95]. In Spain, it is used for treating skin inflammations [96], and in Libya, it is used for hepatitis treatments [97]. The use of this species for the treatment of sinusitis, as reported from the study area, is well known also in the Croatian islands [4] and Turkey [98,99].

Parietaria judaica L. was indicated from our surveys as a hepatomegaly treatment. This medical use is new for Campania and for other southern Italian regions, as this plant is generally reported to be used internally to treat other types of diseases, mainly related to the kidney [32,56,58]. Only in Spain is *P. judaica* reported for the treatment of liver disorders [100,101]. In reports from other European countries, it is used for various ailments but never concerning liver pathologies [2,4,102,103].

Sedum cepaea L. resulted to be used for healing wounds and for burn treatments by eight informants. Before our survey, this species was never reported in Italy and in the whole Mediterranean basin as a medicinal plant.

The use of *Borago officinalis* L. as an antirheumatic and *Petasites hybridus* (L.) G. Gaertn., B. Mey. & Scherb for pimple treatments were unknown in all Italian popular phytotherapy, with the sole exception of some alpine areas [49,63], which are about 900 km far from our study area.

The use of *Cannabis sativa* L. fibers mixed with eggs and sugar to make bandages was already reported in Campania but only for the Cava de' Tirreni area (Salerno province [14]), which is quite distant from the study area in terms of geographical position and vegetational and cultural context.

2.2. Food Plants

We recorded 271 use reports describing the use of 43 plant species for culinary practices. *Cichorium intybus* L. was the most cited wild food species (22 URs), followed by *Clinopodium nepeta* (L.) Kuntze subsp. nepeta (21), *Borago officinalis* L., (17), *Foeniculum vulgare* Mill. (17), *Laurus nobilis* L. (15), *Sonchus oleraceus* L. (12), and *Beta vulgaris* subsp. *maritima* L. (12). Twenty-eight plant species were used as vegetables in pizzas and soups or were eaten raw in salads. A typical local dish is the so-called yellow pizza (or "blonde pizza", "pizza sciatizza", or "pizza and minestra") that is based on wild or cultivated vegetables such as *Beta vulgaris* L. subsp. *maritima* (L.) Arcang., *Brassica rapa* L., and *Brassica oleracea* L. Namely, the terms "yellow" or "blond" refer to the use of durum wheat which gives the dough its characteristic golden color. In addition to cultivating commonly used aromatic herbs like basil and parsley, the informants indicated that they often collect wild plants to use as spices. In fact, 18 out of 43 plant species were reported for this culinary use. In some cases, food plants are also eaten for their nutraceutical properties, and many species are also commonly utilized as herbal medicines to alleviate a variety of health conditions.

2.3. Cosmetic Plants

We recorded 26 use reports for cosmetic uses in the study area. Skin (6 URs) and hair treatments (19 URs) are the most cited uses. The use of *Salvia officinalis* L. as a hair darkener is new for Campania and the whole of Italy, while the use of *Hedera helix* L. for the same treatment is new for the Campania region but was already reported for other Italian regions (e.g., [52]). The use of *Malva sylvestris* L. leaves boiled with butter as an anti-wrinkler has been previously documented in Italy, but only for the Abruzzo region [7]. The use of olive oil derived from frying river fishes to promote hair re-growth appears to be a rather extravagant practice and has never reported in Italy nor elsewhere before our survey.

2.4. Plants for Domestic and Craft Uses

The plant species mentioned by the informants as craft plants to make brooms or baskets, such as *Sorghum bicolor* (L.) Moench, *Panicum miliaceum* L., *Genista tinctoria* L., *Arundo donax* L., or *Salix alba* L., pertain to the traditional material culture of the study area. Although synthetic materials have replaced natural ones, many craft plants are still in use today. Handmade baskets or brooms made with, for example, *Arundo donax* or *Salix alba*, are commonly found in local markets. Although some species were reportedly used to make ink, this practice seems to have disappeared, along with the traditional use of smoking wild plants. New for Italy is the use of *Camellia sinensis* (L.) Kuntze and *Rosa canina* L. to dye fabrics.

2.5. Plants for Veterinary Uses

Twenty-eight use reports were recorded in total concerning plants for veterinary uses, as feed, or for the treatment of various ailments. The new records for southern Italy are the following: *Achillea millefolium* L. is used as a decoction, is administered against the intestinal parasites of calves, and is cited in Campania only for topical uses against ovine, cattle, and horse scabs [58]. Borago officinalis L. is used raw in feed as a galactagogue for cows. *Cynodon dactylon* (L.) Pers. is used in horse and rabbit feed to make their coat shinier and to increase the immune system. *Hypericum perforatum* L. is used as a decoction to free cow rumen. *Malva sylvestris* L. is used as a decoction, with bran and cornmeal, to promote the expulsion of the placenta. *Marrubium vulgare* L. is topically used for skin infection treatments. *Rubus ulmifolius* Schott stems as a decoction against the coryza of hens. *Sambucus nigra* L. decoction is topically used against mastitis and coat infections.

2.6. Plants for Ritual Uses

Although magical and religious practices are progressively disappearing in the study area, as reported by interviewed people, some ritual uses related to plants are worthy of interest. Olive oil, for example, is part of a ritual practice to defeat "Rizubula" (or "Rizibea", a facial swelling of unidentified etiology). A hen's feather is dipped in olive oil and the following litany is recited: "quando Gesù Cristo jeva camminando la trovava una donna pè n'anzi. Donna che vai facendo? Io sono la Rizibula che vò camminando e me ne vado addò la carne umana facia arraggia come a nu cane. Donna questo nun ò fà, cu nu bastone t'aggià bastonà. Non mi bastonà! Nu proverbio te voglio mparà: ruoglio de oliva e penna de gallina, Rizibea vattenni via!", which can be roughly translated to "when Jesus Christ was walking he found a woman in front of him. Woman what are you doing?. I am the Rizibula and I go walking and I go where I make human flesh angry like a dog. Woman don't do this, I have to beat you with a stick. Don't beat me! I want to teach you a proverb: olive oil and chicken feather, Rizibea go away!". Another ritual example concerns the healing of warts, in which there is no direct application of the plant: crosses are engraved on the nodes of the *Triticum durum* (Desf.) wheat stems and then placed on the ground and watered; as the knots rot, the warts will heal.

2.7. The Role of Mefite in the Study Area

The mephitis plays a crucial role for the inhabitants of the study area. The presence of very high concentrations of CO_2 and sulfur in the air make this place accessible only with many precautions. All metal objects, even if placed many hundreds of meters away from the source of exhalations, are subject to corrosion. Both air and mud from the bottom of the Mefite are traditionally used for therapeutic purposes. Some interviewed people reported, for example, that exhalations are used for sore throats and whooping coughs. The muds are used to treat skin diseases, including burns and wounds, and for making beauty masks. In periods of sulfur shortage, treatments against the fungal diseases of vines were made by applying, on the leaves, the water gathered in the Mefite. Traditionally, shepherds from the area or neighboring regions brought their sheep and dogs to the Mefite to treat them with Mefite waters or muds against mange, scabies, rabies, and ticks. From the milk of sheep grazing grass near the Mefite area, and, for this reason, since it contains high concentrations of sulfur products, a cheese is produced locally known as "Carmasciano", recognized for its peculiar characteristics as a PAT (Traditional Agri-food Product) by the Italian Ministry of Agricultural, Food, and Forestry Policies [104].

3. Materials and Methods

Study Area

The survey area is the Ansanto Valley, located in a territory of the Avellino province known as Irpinia (40°58′ N, 15°08′ E, ~720 m a.s.l.; Campania region, southern Italy), (Figure 4).

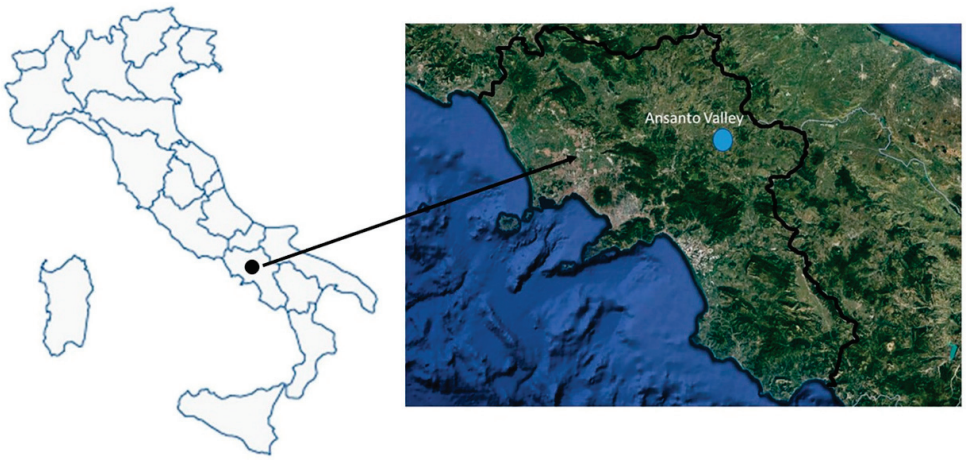

Figure 4. Geographical position of the Ansanto Valley (AV, Italy) (source: Google Earth, earth.google.com/web/ (accessed on 25 July 2023)).

The Ansanto Valley is a large intermontane territory, close to the hilly mountainous chain of the Apennines, whose borders, include the municipal territories of Rocca San Felice, Gesualdo, Sturno, Frigento, Villamaina, and Torella dei Lombardi. The territorial context of the Ansanto Valley is still characterized by a rural economy, which preserves a millenary landscape fabric. Within this area there are a few Mefite pools of geothermal manifestations, consisting of boiling mud and cracks in the ground from which lethal gaseous concentrations of CO_2 arise, along with sulfuric emissions which enrich the area with sulfur, resulting in a distinctive smell of hydrogen sulfide in the air [17]. The landscape at Mefite is marked by striking physical features, with vibrant mineral deposits creating colorful terraces around the geothermal features (Figure 5). The land use is mainly characterized by oak forests, meadows, olive groves, and cultivated fields.

Figure 5. From left to right: Aerial view of the Ansanto Valley. Detail of the Mefite d'Ansanto area (Photos courtesy of Luigi Zollo).

4. Ethnobotanical Methodology

Fieldwork was conducted form June 2021 to October 2022 in the municipality of Rocca San Felice and in the surrounding villages of Villamaina, Gesualdo, and Frigento. For the interviews, we selected local experts (key informants) who still retain traditional knowledge of wild plant uses due to their family traditions, occupations, age, or personal interests. Key informants were therefore individuals who could provide valuable information, insights, or perspectives related to the research objectives and who have connections or relationships with the target population under study. Using a snowball sampling approach [105], we requested the informants to indicate further individuals that were likely to provide valuable insights or information related to the research focus and were in representation across different categories such as age, gender, socioeconomic status, or geographic location. Semi-structured interviews were carried out to acquire information on plants (common or scientific names) and their use for medicinal, food, veterinary, cosmetic, and craft purposes, supplemented by informal walks in the field. To prevent any possibility of missing information, two interviewers (one woman and one man) collected data separately. The first interviewer conducted the semi-structured interview, and the second interviewer was responsible for data collection only. Prior to conducting each interview, following the guidelines of best practices in ethnopharmacological research [106,107], the research objectives were explained to the informant and verbal consent was obtained. In total, 69 informants were interviewed, namely 37 women and 32 men, whose age ranged from 26 to 97 years (68 on average).

The identification of the plants indicated by the informants was conducted in the field or in a laboratory, based on dichotomous keys and morphological characteristics reported in Pignatti [108], by using a stereomicroscope and light microscopy if needed. Plant nomenclature followed the World Flora Online [109], and angiosperm families were organized according to the APG IV classification [110]. Abbreviations of authors were standardized as indicated in Brummitt and Powell [111], as recommended by Rivera et al. [112]. Herbarium specimens were deposited in the herbarium of Portici (Department of Agricultural Sciences, University of Naples Federico II) with codes from AV-001 to AV-104, alphabetically ordered.

As indicated by Heinrich et al. [106], and by Weckerle et al. [113], we only presented primary data in our results with the total number of use reports (URs) which represent the number of individual citations of a plant taxon. We set up a database including the taxon (with family), local name, parts used, preparation, administration, use recorded, and the total number of URs. To categorize the diseases treated with plants indicated from the interviews, we adopted a symptom-based nosological approach commonly employed in ethnobotanical research (e.g., [114–116]).

A comparative analysis was carried out on the medicinal uses of plants on the basis of the available literature dealing with popular phytotherapy in Italy. Only URs in a number of three or more per plant species were taken into consideration. To compare our results with those reported in the Italian literature, Web of Science, Scopus, and Google Scholar were

used as databases, using "Italy", "ethnobotany", "ethnobotanical", "ethnopharmacology", and "medicinal plants" as key words and "OR" as the connector. Additional papers were selected from references cited in the collected papers. The criteria for article selection were defined a priori to avoid personal biases. We searched both national and international journals published from 1967 to 2021. Publications were filtered for the English and Italian languages, duplicates, document type (no patents), and full-text availability. Books and papers not subject to peer review were not taken into consideration.

5. Conclusions

This study provides a comprehensive overview of ethnobotanical knowledge in the Ansanto Valley, revealing the diverse utilization of plant species for medicinal, food, cosmetic, domestic, craft, veterinary, and ritual purposes. The traditional uses of plants reflect the deep-rooted cultural heritage and the significant role of plants in the lives of the local communities. The documentation of novel ethnobotanical findings further enriches our understanding of traditional plant uses in this region, emphasizing the importance of preserving and promoting this valuable knowledge for future generations. The findings of this study can serve as a basis for further research and the development of policies and programs for the conservation and sustainable use of plant resources in the study area and beyond.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/plants12213690/s1, Table S1. Traditionally used plants in the areas of Ansanto Valley (U.R.: Use Reports; Cos: cosmetic uses; Cul: culinary uses; Med: medicinal uses; Vet: veterinary uses).

Author Contributions: R.M.: conceptualization; data curation; formal analysis; funding acquisition; writing—original draft. M.M.: data curation; investigation. G.B.: supervision. S.C.: data curation; investigation. A.D.P.: writing—review and editing; data analysis. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: All the relevant data used for the paper can be found in Table S1.

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Ethnobotanical Insights into Medicinal and Culinary Plant Use: The Dwindling Traditional Heritage of the Dard Ethnic Group in the Gurez Region of the Kashmir Valley, India

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Abstract: This ethnobiological study addresses the complicated relationship between the Dard ethnic group and their natural environment in the Gurez region of the Kashmir Valley. The study documents their traditional knowledge of the use of plant species for medicinal and culinary purposes. A total of 87 plant species from 41 different families were cataloged, with the Asteraceae family (15 species) and the Lamiaceae family (12 species) being the most commonly used. These plants were found to be used to treat 20 different ailments, with menstrual cramps being the most common (12 species). The fidelity values for these plants ranged from 11.10 to 71.42, demonstrating their importance in traditional medicine. In addition, 17 plant species were found to be useful for gastronomic purposes, with *Juglans regia* being the most valuable (use value of 0.73). The study also evaluated the conservation status of these plants and found that seven of them are considered critically endangered, ten endangered, and four endangered according to the IUCN classification. This study offers insights into the Dard people's deep connection to their natural environment and has significant implications for policy formulation, cultural conservation, and sustainable use of endemic species, as well as potential applications in pharmaceutical research for therapeutic compounds.

Keywords: Dard; ethnopharmacology herbal tradition; ethno-food; traditional medicinal praxis

1. Introduction

Humans have known of the therapeutic properties of plants since the beginning of their evolutionary history, as reflected in their prehistoric and later cultural heritage [1–3]. In all ethnic communities, conventional medicine is considered the sum of knowledge. Human talents and cultural practices of a society based on its beliefs, experiences, and theories are used to treat or improve health [4]. Modern medicines produced by chemical synthesis are far more accessible in developed countries, although in many cases they are based on a molecule of natural origin (plant or animal) [5]. Nevertheless, developed countries increasingly value the direct use of herbs in conjunction with modern medical treatments, especially herbs with a scientific basis for treating minor illnesses [6]. Developing countries continue to rely on the use of medicinal herbs, and this is despite the fact that traditional knowledge is being

lost in many societies [7]. Traditional medicine systems are extremely effective in treating various common seasonal diseases [8]. However, this traditional knowledge gathered in traditional medicine and ethnopharmacology is declining and has been severely threatened in recent decades. Numerous ethnobiologists believe that this valuable knowledge could be extinguished by the end of time [9]. Plants as traditional remedies are a real option for health care in developing countries, especially for rural communities [10].

About 2.5 million years ago, the human lineage transitioned from a predominantly vegetarian lifestyle [11]. The Himalayan region, known for its ecological richness, hosts more than half of India's biodiversity and is characterized by a large number of rare and endemic species that are an important source of food [12]. Ethnobiology has evolved considerably in recent decades, moving from mere documentation to practical application and sustainable management of traditional knowledge systems. This evolution is in line with Article 8 (j) of the Convention on Biological Diversity (CBD), which explicitly recognizes traditional knowledge (TK) as a cornerstone for the sustainable development of food systems in a given geographic context [13]. Traditional plant gathering is critical to the creation of new local gastronomies and the sustainability of food systems in remote tribal communities [14,15]. Food scouting, the identification, classification, and exchange of a range of food resources within indigenous communities, is enabled by ethnobiological studies [15,16]. According to such studies, indigenous peoples have a great treasure of lost plant and ecological knowledge that needs to be documented in a timely manner to build sustainable food and healthcare systems [17–19].

Ethnopharmacology is defined as the interdisciplinary scientific study of traditionally used indigenous drugs and biologically active agents [20–22]. A first step is to present the use of extracts in a particular disease without investigating a possible causal relationship with the contained ingredients/active ingredients [22]. To date, ethnopharmacology has contributed significantly to the study of indigenous and traditional medicinal knowledge and the biodiversity component with which this knowledge is associated [3]. Ethnomedicine is a traditional ethnic approach to treating health problems using plants or other natural sources [23,24]. In the Kashmir Valley, a spectrum of ethnic communities has been ethnobotanically studied, although the use of plants for medicinal and dietary purposes by the "Dard" ethnic group remains relatively unexplored. Several factors could explain the limited research efforts in this population group. These include their residence in remote, high-altitude areas with inadequate road infrastructure, cultural constraints that discourage women from participating in studies, and diminished confidence due to regional geopolitical challenges. Against this background, this study was designed to systematically document ethnomedical knowledge in the Gurez (Kashmir Valley) of India. The objectives of the study were as follows: (A) to document the plant species used to control various ailments and (B) to record the plant species consumed as preferred foods at different stages of pregnancy. This research will help collect baseline data from the Gurez region of the Kashmir Valley for pharmaceutical companies to identify new compounds with significant therapeutic properties.

2. Results and Discussion

2.1. Ethnobotanical Inventory

In the present study, a total of $n = 87$ species were recorded, divided into $n = 41$ families. Asteraceae was the dominant family with $n = 15$ species, followed by Lamiaceae ($n = 12$), Fabaceae, Rosaceae ($n = 4$ each), Amaranthaceae, and Malvaceae ($n = 3$ each) (Figure 1). The dominance of Asteraceae can be attributed to their rapid acclimation and adaptation to dry sites due to their large ecological amplitude [25]. Based on growth habit, species were classified into trees, herbs, and shrubs, with herbs ($n = 76$) taking potential precedence, followed by trees ($n = 7$) and shrubs ($n = 4$) (Table 1). The predominance of herbs can be attributed to their frequent distribution, ease of collection, and rich phytochemistry [26]. The present study is the first comprehensive investigation of ethnobotanical findings on the use of plant species for medicinal and dietary purposes within the Dard ethnic group. The data obtained in the study are shown in Table 1, and some pictures of the species are shown in Figure 2.

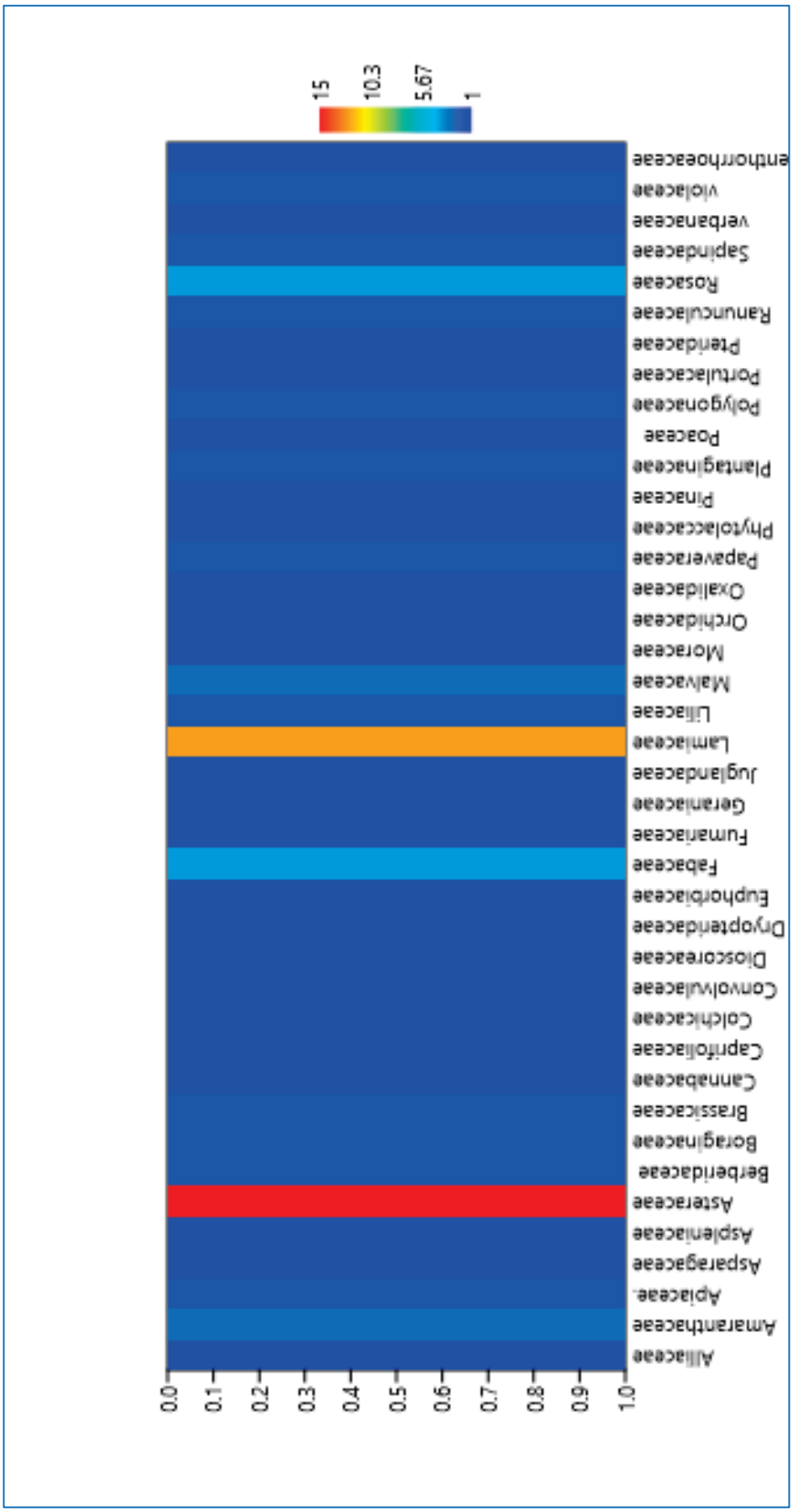

Figure 1. Matrix plot showing the species family relationship of the documented species in Kashmir Himalaya.

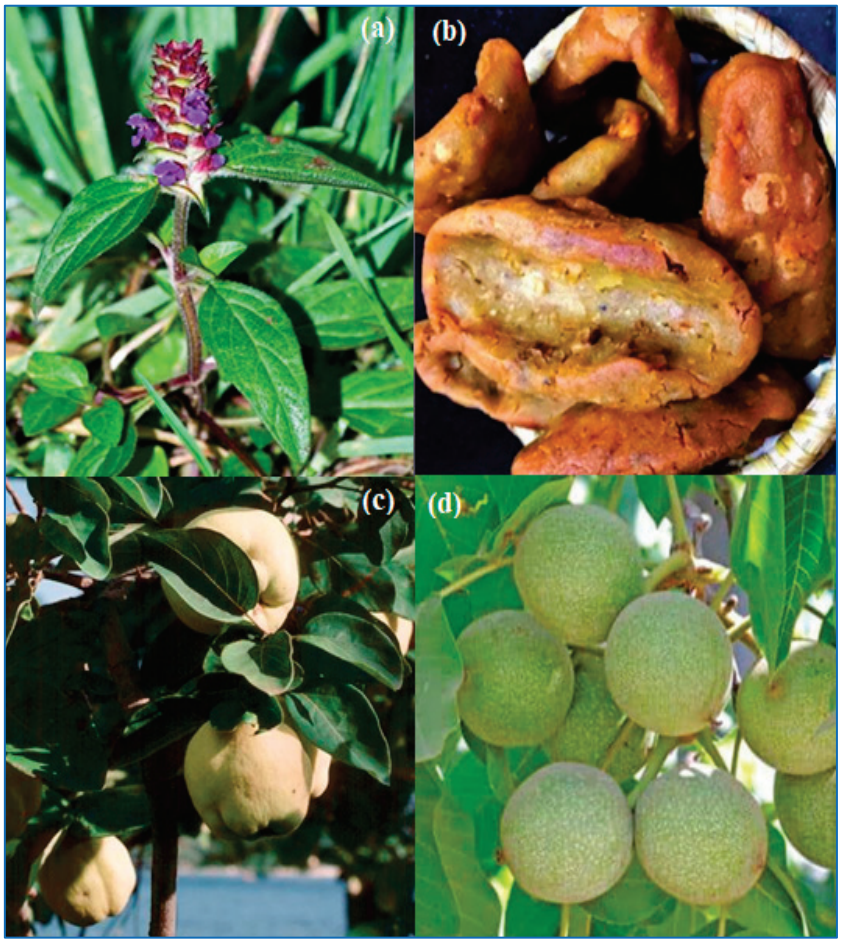

Figure 2. Some pictures taken during the study period in Kashmir Himalaya (**a**) *Prunella vulgaris*; (**b**) Yaja (made from walnut flour); (**c**) *Cydonia oblonga*; (**d**) *Juglans regia*.

2.2. Ethnopharmacological Profile

The use of plant taxa for a variety of ailments is common in different cultures around the world. In the present study, we documented n = 20 diseases treated with the documented species (Figure 3a). Most (n = 12) of the species (*Artemisia absinthium*, *Cannabis sativa*, *Dioscorea deltoidea*, *Fumaria indica*, *Juglans regia*, *Notholirion thomsonianum Aucklandia costus*, *Saussurea simpsoniana*, *Trifolium pratense*, *Erigeron canadensis*, *Cynodon dactylon*, *Podophyllum hexandrum*) were used for menstrual disorders, followed by delivery problems (n = 7; i.e., *Asparagus filicinusa*, *Geranium wallichianum*, *Hemerocallis fulva*, *Achyranthes aspera*) and labor pain (n = 7; *Salvia sclarea*, *Dactylorhiza hatagirea*, *Dyspania botrys*, *Glycyrrhiza glabra*, *Ocimum basilicum*, *Bidens pilosa*, *Persicaria hydropiper*) (Figure 3a). The use of the above species against the selected diseases can be attributed to the strong belief in traditional knowledge. The local Dards believe that sources from nature have healing properties because they are blessed with divine stature that mankind cannot even think of. The results are in line with many other studies [23,27,28] from the nearby Himalayan region, which show that plant taxa still play an important role (health care) even in modern times. It is important to mention that poor medical facilities in the region and being cut off from the other parts of the state due to heavy snowfall make people invest their minds in nature to maintain their health. Table 1 provides a detailed overview of the use of the documented taxa against a variety of diseases. The Pearson correlation coefficient highlights the strength and direction of the relationship between the diseases and the documented species; p-values are shown below (Figure 3b).

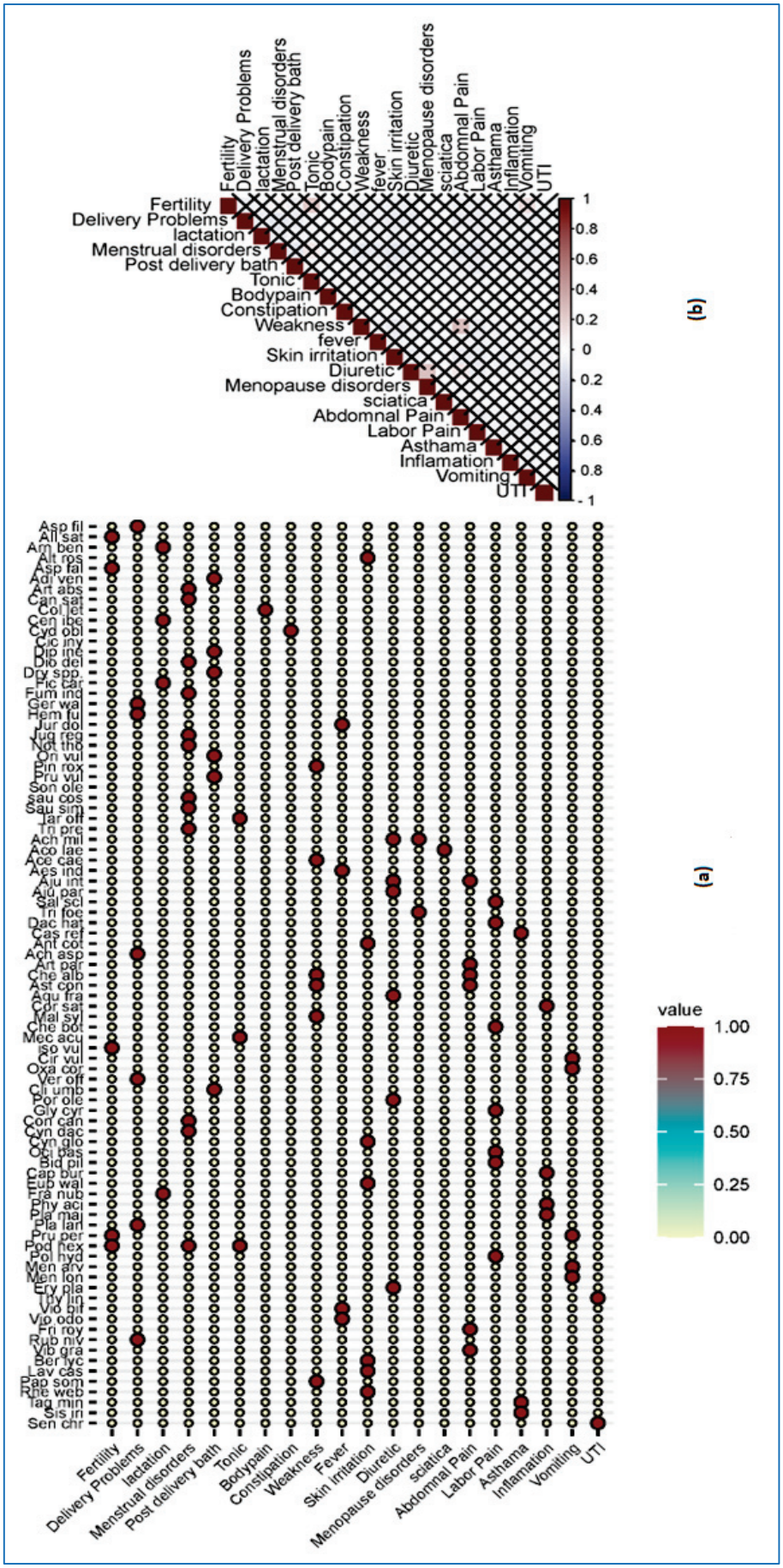

Figure 3. (**a**) Balloon plot showing species used against different diseases; (**b**) Cladogram showing Pearson correlation between plant species and ailments. The full names of the species are given in Table 1.

Table 1. Taxonomic inventory and ethnomedicinal use of documented species of the ethnic community (Dard) in Kashmir Himalaya.

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Asparagus filicinus Buch.-Ham. ex D.Don (Asparagaceae) LAB.203	Asp fil	Fern (Parglas)	Herb	Seed	Seeds are boiled in water to produce decoction, given in the last month of pregnancy.	Body pain	3	11	27.27	TH
Astragalus confertus Benth.ex Bunge. (Fabaceae) LAB.515	Ast con	Hairy-leaved milk vetch (Vetch)	Herb	Roots	Roots are dried and powdered and consumed with mint and water.	Abdominal pain	3	8	37.50	DD
Aquilegia fragrans Benth. (Ranunculaceae) LAB.516	Aqu fra	Fragrant columbine (Jangli kuth)	Herb	Roots	Roots are crushed to powder and given orally.	Diuretic	2	6	33.33	CR
Allium sativum L. (Amaryllidaceae) LAB.204	All sat	Garlic (Rhoon)	Herb	Stem	Stem is consumed raw.	Menstrual issue	15	24	62.5	LC
						Fertility problems	8		33.32	
Arnebia benthamii (Wall.ex G.Don) I.M.Johnst (Boraginaceae) LAB.205	Arn ben	Himalayan Arnebia (Kahzabaan)	Herb	Whole plant	The roots are crushed and boiled in water. The decoction is taken orally.	Lactation problem (Hypogalactia)	4	11	36.36	CR
Alcea rosea L. (Malvaceae) LAB.206	Alt ros	Hollyhocks (Sazeposh)	Herb	Flower	The flowers are boiled to prepare decoction taken orally.	Skin irritation	3	14	21.42	LC
Asplenium falcatum Lam. (Aspleniaceae) LAB.207	Asp fal	Holly fern (Dade)	Herb	Whole plant	The plant is cooked and used as a vegetable.	Fertility problems	2	13	15.38	VU
Adiantum venustum D.Don. (Pteridaceae) LAB.208	Adi ven	(Himalayan maiden fern) (Kakbai)	Herb	Whole plant	Whole plant is crushed and boiled in water.	Used for bath after delivery	1	7	14.28	EN
Artemisia absinthium L. (Asteraceae) LAB.209	Art abs	Wormwood (Tethwan)	Herb	Leaves	Dried leaves after soaking in hot water are dried and then made into tablets, taken orally.	Prevent excessive menstrual bleeding	6	14	42.85	EN

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Achillea millefolium L. (Asteraceae) LAB.501	Ach mil	Devil's nettle (Pahel ghass)	Herb	Whole plant	Leaves are made into decoction and consumed empty stomach.	Menopause disorders	3	14	21.42	LC
Aconitum laeve Royle. *(Ranunculaceae)* LAB.502	Aco.lae	Grape-leaved monkshood (Patrees)	Herb	Roots	Roots are dried, powdered, and consumed with milk.	Sciatica	3	11	27.27	EN
Acer caesium Wall. ex. Brandis. *(Sapindaceae)* LAB.503	Ace.cae	Himalayan Maple (Chhad)	Tree	Leaves	Leaves are boiled in water and taken orally.	Weakness	2	6	33.32	LC
Aesculus indica (Wall.ex Cambess) Hook (Sapindaceae) LAB.504	Aes ind	Indian Horse-Chest nut (Handoon)	Tree	Leaves	Extract from leaves is consumed with lukewarm water.	Fever	2	8	25	LC
Ajuga intregrifolia Buch.-Ham. (Lamiaceae) LAB.505	Aju int	Bracted Bugleweed (Jani Adam)	Herb	Whole plant	Decoction is obtained from fresh plant and consumed empty stomach to remove toxins from the body by acting as a diuretic.	Diuretic	7	13	53.84	-----
Ajuga parviflora Benth. (Lamiaceae) LAB.506	Aju par	Small-Flowered Bugleweed (Jangli Jani-e-Adam)	Herb	Leaves	Extract of leaves is mixed with a glass of water and sugar, taken orally early morning, which in turn causes frequent urination.	Diuretic	2	6	33.32	VU
Anthemis cotula L. (Asteraceae) LAB.511	Ant cot	Stinking Chamomile (Fakghass)	Herb	Whole plant	Whole plant is made into a paste and applied topically.	Skin irritation	3	8	37.5	LC
Achyranthes aspera L. (Amaranthaceae) LAB.512	Ach asp	Chaff flower (Puthkanda)	Herb	Root	Roots are crushed to powder and given orally with water in the last month of pregnancy.	Delivery issue	5	13	38.46	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Artemisia parviflora Roxb.ex D.Don (Asteraceae) LAB.513	Art par	Himalayan Worm Wood (Tethwan)	Herb	Whole plant	Extract is obtained and given orally.	Abdominal pain	5	9	55.55	DD
Aucklandia costus Falc. (Asteraceae) LAB.229	Auc cos	Costus (Kouth)	Herb	Root	Roots are crushed into a powder and drunk with water.	Menstrual issue	3	7	42.85	CR
Berberis lycium Royle (Berberidaceae) LAB.550	Ber lyc	Indian Barberry (Kawdach)	Shrub	Whole plant	Ripened barriers are applied topically.	Skin irritation	3	16	18.75	TH
Bidens pilosa L. (Asteraceae) *LAB.532*	Bid pil	Begger'stick (Kumber)	Herb	Leaves	Leaves are made into decoction and given orally.	Labor pain	2	6	33.32	NE
Cannabis sativa L. (Cannabaceae) LAB.210	Can sat	Hemp, Gallow Grass (Bhang)	Herb	Leaves	The leaves are crushed and made into powder, mixed with cow ghee to make paste taken orally.	Menstrual pain	1	7	14.28	VU
Colchicum luteum Baker (Colchicaceae) LAB.211	Col let	Meadow Saffron (Veir koem)	Herb	Stem	The stem is crushed to form a paste and applied to feet.	Relieve body pain in fresh mothers	2	9	22.22	TH
Centaurea iberica Trevir.ex Spreng. (Asteraceae) LAB.212	Cen ibe	Iberian Star thistle (Kreaxeh)	Herb	Leaves	Fresh leaves after crushing are mixed with egg and then cooked to prepare an omelet.	Lactation problem (hypogalactia)	1	8	12.5	NT
Cydonia oblonga Mill. (Rosaceae) LAB.213	Cyd obl	Quince (Bum chount)	Tree	Seeds	Seeds are made into infusion, taken orally.	Constipation	4	9	44.43	LC
Cichorium intybus L. (Asteraceae) LAB.214	Cic iny	Chicory (Posh handh)	Herb	Leaves	Leaves are cooked.	Easy delivery	2	11	18.18	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Cuscuta reflexa Roxb. (Convolvulaceae) LAB.510	Cus ref	Gaint Dodder (Kukli-Poot)	Herb	Whole plant	Decoction is prepaid by boiling the whole plant, kept overnight, and consumed orally.	Asthma	2	9	22.22	LC
Chenopodium album L. (Amaranthaceae) LAB.514	Che alb	Bathua (Konh)	Herb	Leaves	Decoction of leaves is prepared by boiling.	Abdominal pain	3	10	30	LC
Coriandrum sativum L. (Apiaceae) LAB.517	Cor sat	Cilantro (Daniwal)	Herb	Whole plant	Decoction.	Inflammation	2	8	25	-------
Clinopodium umbrosum (M.Bieb) Kuntze. (Lamiaceae) LAB.525	Cli umb	Shady calamint (Kunal)	Herb	Aerial part	Aerial parts are boiled in water for half an hour, the obtained water is cooled and used.	Post-delivery bath	3	15	20	NE
Cynodon dactylon (L.) Pers (Poaceae) LAB.529	Cyn dac	Bermuda Grass (Dramun)	Herb	Leaves	The fresh leaves are dried, crushed into powder, and consumed in small quantity with water.	Menstrual disorders	5	11	45.45	NE
Cynoglossum wallichii G.Don. (Boraginaceae) LAB.530	Cyn wal	Forget Me Not (Cheur)	Herb	Roots	Roots are made into a paste and applied topically.	Skin irritation	3	9	33.33	CR
Capsella bursa-pastoris Medik. *LAB.533*	Cap bur	Shepherd's purse (Kralmond)	Herb	Leaves	Leaves are made into a paste and applied topically.	Inflammation	2	8	25	LC
Dipsacus inermis Wall. *(Caprifoliaceae)* LAB.215	Dip ine	Himalayan Teasel (Wopal haakh)	Herb	Leaves	Leaves are crushed and boiled.	Used for bath after delivery	2	7	28.57	NT

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Dysphania botrys (L.) Mosyakin & Clemants (Amaranthaceae) LAB.519	Dys bot	Sticky goosefoot (Kukli-hakh)	Herb	Whole plant	Decoction.	Labor pain	5	13	38.46	LC
Dioscorea deltoidea Wall. (Dioscoreaceae) *LAB.216*	Dio del	Yam (Kala ganda)	Herb	Stem	Stem is crushed and tonic is prepared.	Menstrual cramps	1	7	14.28	EN
Dryopteris juxtaposita Christ (Dryopteridaceae) *LAB.217*	Dry jux	Wood Ferns (Gautheer)	Herb	Leaves	Leaves are crushed and boiled.	Used for bath after delivery	2	6	33.32	LC
Dactylorhiza hatagirea (D.Don) Soó (Orchidaceae) *LAB.509*	Dac hat	Himalayan Marsch Orchid (salam panj)	Herb	Tuber	Tuber is crushed to powder and given orally with lukewarm water.	Labor pain	5	13	38.46	EN
Dolomiaea macrocephala DC. ex Royle (Asteraceae) LAB.222	Dol mac	Dhoop Lakkad (Dupha/Thandi Jaid)	Herb	Root	Roots are boiled, made into a decoction, and taken orally.	Fever	2	8	25	EN
Euphorbia wallichii Hook.f. (Euphorbiaceae) LAB.534	Eup wal	Wallich Spurge (Guri-dud)	Herb	Leaves	Infusion is prepared and consumed orally.	Skin irritation	6	14	42.85	LC
Erigeron canadensis L. (Asteraceae) LAB.528	Eri can	Horseweed (Shallut)	Herb	Whole plant	Decoction is prepared by boiling the whole plant for 15–20 min, cooled and taken orally.	Menstrual disorders	2	14	14.28	NE
Eryngium planum L. (Apiaceae) LAB.543	Ery pla	Sea Holly (Dawha Mool)	Herb	Roots	Dried roots are crushed to increase urine output and thus purify the blood.	Diuretic	2	10	20	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Fragaria nubicola Lindl. ex Lacaita (Rosaceae) LAB.535	Fra nub	Indian Strawberry (Ringrish)	Herb	Rhizome	Infusion is prepared and consumed orally.	Lactation problem	2	11	18.18	NE
Ficus carica L. (Moraceae) LAB.218	Fic car	Fig (Anjeer)	Tree	Fruit	Fruits are dried crushed, made into powder, and taken orally with milk.	Lactation problem	3	8	37.5	LC
Fumaria indica (Hausskn.) Pugsley (Fumariaceae) LAB.219	Fum ind	Fumitory (Shahtaur)	Herb	Whole plant	The whole plant is crushed and a decoction is prepared.	Menstrual issue	2	9	22.21	EN
Fritillaria cirrhosa D.Don (Liliaceae) LAB.547	Fri cir	Himalayan Fritillary (Sheethkhaar)	Herb	Roots	Fresh roots are crushed and mixed with water and consumed orally.	Abdominal pain	2	13	15.38	EN
Geranium wallichianum D.Don (Geraniaceae) LAB.220	Ger wal	Rattan jot (Ratanjot)	Shrub	Root	Roots are made into tea.	Premature delivery	1	5	20	CR
Glycyrrhiza glabra L. (Fabaceae) LAB.527	Gly cyr	Black sugar/Sweet wood (Shangir)	Herb	Seeds	Seeds are crushed to form a paste which is applied topically in the lumbar region of the back.	Labor pain	4	15	26.26	LC
Hemerocallis fulva (L.) L. (Xanthorrhoeaceae) LAB.221	Hem ful	Common-dayLily (NA)	Herb	Whole plant	The whole plant is crushed and boiled to form a tonic.	Weakness	1	6	16.66	LC
Isodon rugosus (Wall.) Codd (Lamiaceae) LAB.521	Iso vul	Wrinkled Leaf Isodon (Sulikath)	Herb	Leaves	Raw leaves are consumed.	Fertility disorder	2	7	28.57	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Juglans regia L. (Juglandaceae) LAB.223	Jug reg	Walnut (Doen Kul)	Tree	Fruit	Consumed raw.	Fertility issue	7	13	53.84	LC
Jacobaea analoga (DC.) Veldkamp (Asteraceae) LAB.556	Jac ana	Ghopga (Boungh)	Herb	Whole plant	Decoction is prepared and consumed orally.	Urinary tract infection (UTI)	2	13	15.38	NE
Malva cachemiriana (Cambess.) Alef. (Malvaceae) LAB.551	Mal cac	Kashmir Mallow (Sazposh)	Herb	Seed	Decoction is prepaid and consumed orally.	Skin irritation	2	13	15.38	EN
Malva sylvestris L. (Malvaceae) LAB.518	Mal syl	Common mallow (Gur-Sochal)	Herb	Flowers	Decoction.	Weakness	2	8	25	LC
Meconopsis aculeata Royle (Papaveraceae) LAB.520	Mec acu	Blue poppy (Gul-e-Neelam)	Herb	Whole plant	Powdered and consumed with water.	Tonic	3	8	37.50	NE
Mentha arvensis L. (Lamiaceae) LAB.541	Men arv	Corn Mint (Chala Pudna)	Herb	Leaves	Leaves are dried and made into powder, consumed orally in small quantities.	Vomiting	3	8	37.50	LC
Mentha longifolia (L.) L. (Lamiaceae) LAB.542	Men lon	Horse Mint (Jangli Pudina)	Herb	Leaves	Leaves are dried and made into powder, consumed orally in small quantities.	Vomiting	2	6	33.33	LC
Notholirion thomsonianum (Royle) Stapf (Liliaceae) LAB.224	Not tho	Rosy Himalayan Lily (Sathra)	Herb	Stem	Stem is crushed and extracted.	Menstrual issue	3	11	27.27	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Nepeta cataria L. (Lamiaceae) LAB.522	Nep.cat	Catnip (Brair-Ghass)	Herb	Leaves	Leaves are dried and made into powder which is given orally in small quantities.	Vomiting	4	11	36.3	LC
Origanum vulgare L. (Lamiaceae) LAB.225	Ori vul	Oregano (Babur)	Herb	Whole plant	The whole plant is boiled in water.	Used for bath after delivery	2	13	15.38	LC
Oxalis corniculata L. (Oxalidaceae) LAB.523	Oxa cor	Creeping wood sorrel (Chuk-chin)	Herb	Leaves	Leaves are dried and made into powder which is given orally in small quantity.	Vomiting	3	11	27.27	NE
Ocimum basilicum L. (Lamiaceae) LAB.531	Oci bas	Basil (Baber)	Herb	Leaves	Infusion is made from fresh leaves and consumed orally.	Labor pain	3	8	37.50	------
Pinus roxburghii Sarg. (Pinaceae) LAB.226	Pin rox	Chir Pine (Chad)	Tree	Seeds	Seeds are roasted.	Weakness	5	12	41.66	LC
Prunella vulgaris L. (Lamiaceae) LAB.227	Pru vul	Self-Heal (Kalvuth)	Herb	Whole plant	The whole is boiled in water, and obtained water is used for bathing.	Fever Body pain	6	9	66.65	LC
Portulaca oleracea L. (Portulacaceae) LAB.526	Por ole	Common Purslane (Nuner)	Herb	Leaves	Leaves are made into a decoction and consumed orally.	Diuretic	3	11	27.27	NE
Phytolacca acinosa Roxb. (Phytolaccaceae) LAB.701	Phy aci	Indian Pokeweed (Haputbrand)	Herb	Fruit	Fruits are crushed, squeezed, and applied topically.	Inflammation	2	7	28.57	NE
Plantago major L. (Plantaginaceae) LAB.536	Pla maj	broadleaf plantain Waybread (Bod Gull)	Herb	Leaves	Decoction is made from fresh leaves and consumed orally.	Inflammation	1	7	14.28	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Plantago lanceolata L. (Plantaginaceae) LAB.537	Pla lan	Narrow Leaf Plantain (Gull)	Herb	Leaves	Leaves are cooked and consumed frequently in the last month of the pregnancy.	Delivery issue	2	9	22.22	VU
Prunus persica (L.) Batsch (Rosaceae) LAB.538	Pru per	Peach (Chenan)	Tree	Leaves	Infusion is made and consumed orally.	Fertility disorder	2	8	25	NE
Podophyllum hexandrum Royle (Berberidaceae) LAB.539	Pod hex	Himalayan May Apple (Banvagan)	Herb	Whole plant	Infusion is made and consumed orally.	Fertility disorder	1	6	16.66	EN
Persicaria hydropiper subsp. *microcarpa* (Danser) Soják (Polygonaceae) LAB.540	Per hyd	Water Pepper (Marchuwagun Ghass)	Herb	Whole plant	Infusion is made and consumed orally.	Labor pain	3	10	30	LC
Papaver somniferum L. (Papaveraceae) LAB.552	Pap som	Opium (khash-khaash)	Herb	Seed	The seeds are crushed into powder and consumed in small quantities with milk.	Weakness	3	9	33.33	NE
Rheum webbianum Royle (Polygonaceae) LAB.553	Rhe web	Indian Rhubarb (Pambchalan)	Herb	Roots	Crushed roots are mixed with ash and applied topically.	Skin irritation	3	15	20	NE
Rubus niveus Thunb. (Rosaceae) LAB.548	Rub niv	Hill Raspberry (Chhanch)	Shrub	Roots	Roots are shade dried and made into powder, consumed with milk in the last month of pregnancy.	Delivery problem	2	15	13.33	NE
Sonchus oleraceus L. (Asteraceae) LAB.228	Son ole	Sow Thistle (Kulwauth)	Herb	Leaves	Leaves are cooked.	Weakness	1	5	20	LC

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Saussurea simpsoniana (Fielding & Gardner) Lipsch. (Asteraceae) LAB.230	Sau sim	Phen Kamal (Koth)	Herb	Whole plant	Whole plant is crushed and boiled in water taken orally.	Menstrual issue	3	7	42.85	CR
Salvia sclarea L. (Lamiaceae) LAB.507	Sal scl	Clary sage (Buder-Tund)	Herb	Whole plant	Decoction is obtained and given orally.	Labor Pain	3	8	37.5	LC
Sisymbrium irio L. (Brassicaceae) LAB.555	Sis iri	London Rocket (Chari lachij)	Herb	Seeds	Decoction is prepared and consumed orally.	Asthma	4	11	36.36	LC
Taraxacum officinale F.H.Wigg. (Asteraceae) LAB.231	Tar off	Dandelion (Handd)	Herb	Leaves	Young leaves are cooked.	Easy delivery	5	7	71.42	LC
Trifolium pratense L. (Fabaceae) LAB.232	Tri pre	Red Clover (Bee-Bred)	Herb	Leaves	Leaves are crushed, dried, made into powder, and consumed with milk.	Menstrual issue	1	9	11.10	LC
Trigonella foenum-graecum L. (Fabaceae) LAB.508	Tri foe	Fenugreek (Meth)	Herb	Seeds	Seeds are crushed into powder and consumed with water.	Menopause disorders	2	8	25	-----
Thymus linearis Benth. (Lamiaceae) LAB.544	Thy lin	Himalayan Thyme (Van Jawain, Marchi)	Herb	Whole plant	Juice is extracted from the whole plant and consumed orally.	Urinary tract infection (UTI)	3	12	25	CR
Tagetes minuta L. (Asteraceae) LAB.554	Tag min	Wild Marigold (Gutt posh)	Herb	Leaves	Juice is extracted and consumed orally.	Asthma	2	15	13.33	NE

Table 1. *Cont.*

Scientific Name (Family) Voucher Number	Abre	Common Name (Local Name)	Habit	Part Used	Ethno-Medicinal Uses					IUCN Status
					Preparation	Ailments	Np	F_C	FL	
Viola biflora L. (Violaceae) LAB.545	Vio bif	Alpine Yellow Violet (Gulnakash)	Herb	Leaves	Decoction is prepared and consumed orally.	Fever	2	14	14.28	NE
Viola odorata L. (Violaceae) LAB.546	Vio odo	Sweet Voilet (Nunposh/Banfsha)	Herb	Flowers	Decoction is prepared and consumed orally.	Fever	4	15	26.26	LC
Verbena officinalis L. (Verbanaceae) LAB.524	Ver off	Common Verbena (Hatmool)	Herb	Whole plant	Whole plant is crushed to powder and given orally with water in the last month of pregnancy.	Delivery issue	2	9	22.22	NE
Viburnum grandiflorum Wall. ex DC. (Adoxaceae) LAB.549	Vib gra	Cranberry Bush (Kilmish)	Shrub	Roots	Roots are boiled in water and consumed orally.	Abdominal pain	2	11	18.18	NE

LC: Least Concern; CR Critically Endangered; EN: Endangered; NT: Near Threatened; VU: Vulnerable; TH: Threatened; DD: Data Deficient. Np: Number of informants reporting species used for specific disease; FL: Fidelity level; FC: Frequency of Citation; Abre: Abbreviation.

2.3. Fidelity Level (FL)

In the present study, the species most preferred for the treatment of specific ailments were identified by calculating FL. According to Farooq et al. [29], the species that are most commonly used medicinally in certain areas have a maximum FL. In calculating FL for our results, it was found to be 11.10 to 71.42 (Table 2). The highest value was calculated for *Taraxacum officinale* (71.42) for easy delivery, followed by *Allium sativum* (62.5) for conception problems, *Juglans regia* (53.84) for fertility problems, and *Cydonia oblonga* (44.43) for constipation. The lowest value was calculated for *Trifolium pretense* (11.10) for irregular menstruation. In the Kashmir Himalayas (in most ethnic groups such as Kashmiri, Gujjar, Pahari), *Taraxacum officinale* is considered an important traditional medicine given to woman for easy childbirth and other gynecological problems [15]. The phytochemistry of *Taraxacum officinale* also confirms the presence of various essential chemical constituents such as sesquiterpenes, lactones, fatty acids, carotenoids, tannins, carbohydrates, phenolic acids, flavonoids, phytosterols, sugars, triterpenes, calcium, proteins, and minerals which are important for the new woman or new mothers [30].

2.4. Part Used

The use of the different parts of the plant for ethnomedicinal purposes showed statistically significant differences (χ^2 = 90.587, df = 7, $p < 0.001$) in the respective applications. Leaves were the most commonly used, accounting for 30% of the total use. Notable species associated with this preference were *Artemisia absinthium*, *Centaurea iberica*, *Cichorium intybus*, *Dipsacus inermis*, *Dryopteris juxtaposita*, *Sonchus oleraceus*, *Taraxacum officinale*, and *Trifolium pretense*. After that, the whole plant accounted for 25% of use with species such as *Arnebia benthamii*, *Asplenium falcatum*, *Adiantum venustum*, *Fumaria indica*, *Hemerocallis fulva*, *Origanum vulgare*, *Prunella vulgaris*, and *Saussurea simpsoniana*. The roots of the "whole plant" followed with a usage rate of 17%, with species such as *Arnebia benthamii*, *Colchicum leteum*, *Fumaria indica*, *Geranium wallichianum*, *Jurimea dolomiaea*, *Aucklandia costus*, *Aconitum laeve*, *Achyranthes aspera*, *Astragalus confertus*, *Aquilegia fragrans*, *Cynoglossum wallichii*, and *Ocimum basilicum* being important in this context. Principal component analysis (PCA) [Figure 4] also confirmed the distinction between the "whole plant", leaves, and roots, while the remaining plant parts were grouped together. The predominant use of leaves can be attributed to their ease of collection and the belief in the presence of various phytocomponents [31]. In addition, leaves are commonly used in traditional medicine to alleviate a variety of ailments [32].

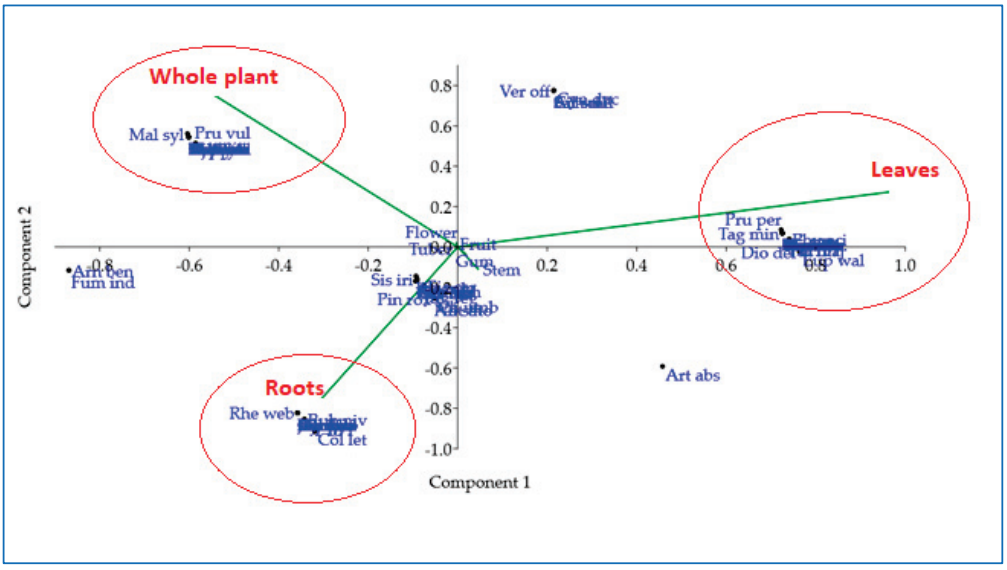

Figure 4. Principal component analysis (PCA) biplot of the different parts of the plant used.

2.5. Gastronomic Usage

Indigenous communities living in the Himalayan region have traditional cultural practices for using local edible plant species [33]. From the documented species, only $n = 17$ (herbs $n = 13$; trees $n = 4$) were recorded for gastronomic use, belonging to $n = 14$ families, representing 56.6% of the total documented species. Asteraceae (17%) was the dominant family, followed by Lamiaceae (11%) (Figure 5a). The above species are further divided into wild and cultivated species. The wild species ($n = 13$) outweighed the cultivated ones ($n = 4$) (Table 2). This clearly shows the importance of wild species in the region. Haq et al. [15] studied the importance of wild foods in the Kashmir-Himalayan region shared by India, Pakistan, and China and found that wild foods are a boon in the rural areas of the region and people there are very attached to them due to their proximity to nature and lack of urbanization. Leaves ($n = 7$) were the most commonly consumed, followed by young shoots, roots ($n = 3$ each), seeds, and fruits ($n = 2$ each). Azhar et al. [34] reported the predominance of the leaves in traditional medicine from southern Punjab, Pakistan. Similar results were reported by Mir et al. [35] from the Himalayan region of Kashmir. Figure 5b shows the parts with gastronomic uses and the corresponding species. A complete list can be found in Table 2.

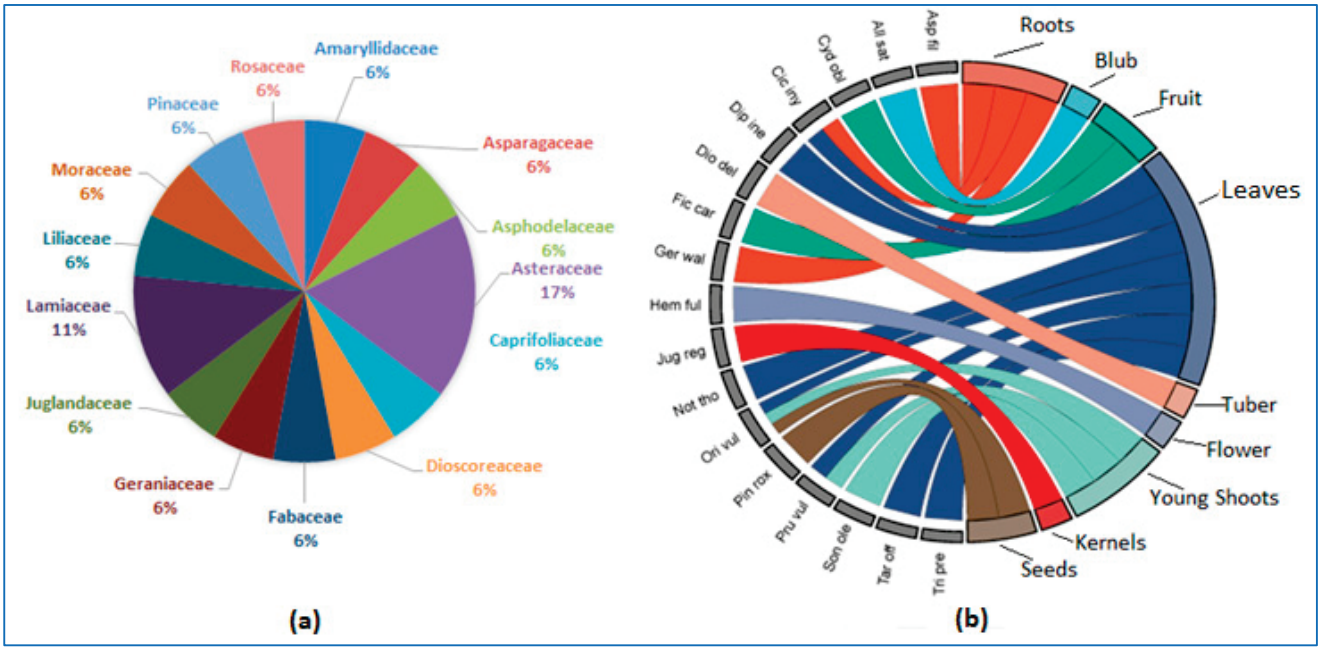

Figure 5. (**a**) Percentage of families with gastronomic assignment. (**b**) Chord diagram showing the different parts of the documented species for gastronomic use.

Table 2. Plant species consumed by the Dard community in the Kashmir Valley with respect to pregnancy.

Botanical Name (Abbreviation)	Species Consumed			Preparation	Habitat
	Before Pregnancy	During Pregnancy	After Pregnancy		
Asparagus filicinus (Asp fil)	Y	Y	Y	Young roots are selected and made into soup.	Wild
Allium sativum (All sat)	Y	Y	N	Bulbs are peeled, cleaned, and cooked with other vegetables. Raw bulbs are consumed as a salad.	Cultivated
Cydonia oblonga (Cyd obl)	Y	Y	N	The fruits are boiled in water with a little sugar added and eaten in the evening.	Cultivated
Cichorium intybus (Cic int)	N	Y	Y	The leaves are picked, cleaned, and cooked without species and peppers.	Wild
Dipsacus inermis (Dip.ine)	N	N	Y	The leaves are picked, cleaned, and cooked without species and peppers.	Wild
Dioscorea deltoidea (Dio del)	Y	N	N	Tubers are boiled and then cooked without species.	Wild
Ficus carica (Fic car)	Y	Y	Y	Fruits are consumed raw, also cooked.	Cultivated
Geranium wallichianum (Ger wal)	N	Y	N	The roots are cooked in desi cow ghee.	Wild
Hemerocallis fulva (Hem ful)	Y	Y	Y	The flowers are eaten raw, but also cooked. The petals are thick and crunchy, which makes them very pleasant to eat.	Wild
Juglans regia (Jug reg)	Y	Y	Y	The seeds are extracted and used to make chutney, but they are also air-dried and eaten raw. In addition, they are also used in kawa (a traditional tea) mixed with various recipes to enhance the flavor. It is also a possible source of cooking oil.	Cultivated
Notholirion thomsonianum (Not tho)	Y	N	N	Leaves are boiled and then cooked.	Wild
Origanum vulgare (Ori vul)	N	N	Y	Fresh oregano leaves are cooked. Dried leaves are used as a flavoring agent for different dishes.	Wild

Table 2. *Cont.*

Botanical Name (Abbreviation)	Species Consumed			Preparation	Habitat
	Before Pregnancy	During Pregnancy	After Pregnancy		
Pinus roxburghii (Pin rox)	N	N	Y	Seeds are roasted and eaten.	Wild
Prunella vulgaris (Pru vul)	N	N	Y	The leaves are used for making soup, stews, salad and boiled as a pot herb.	Wild
Sonchus oleraceus (Son ole)	N	Y	Y	The outer shell is removed and cooked like asparagus.	Wild
Taraxacum officinale (Tar off)	Y	Y	Y	The leaves are cleaned and cooked.	Wild
Trifolium pratense (Tri pra)	Y	Y	Y	'The leaves are cooked or used as a garnishing agent in salads.	Wild

2.6. Use Value (UV)

When analyzing the results documented for species consumed as food before pregnancy (after marriage), during pregnancy, and after pregnancy, the UV ranged from 0.10 to 0.73 (Figure 6). The highest value was calculated for *Juglans regia* (0.73), followed by *Allium sativum* (0.67), *Prunella vulgaris* (0.54) and *Taraxacum officinale* (0.53). Species with the highest use values (UVs) had the highest level of awareness, while species with lower UVs had a correspondingly lower level of awareness. *Juglans regia* has many uses in cooking. It is often mixed with other species such as mint to make chutney. It also plays an important role in the preparation of a traditional hot beverage known as "kawa". Many people extract oil from it, which in turn is used in cooking for special recipes such as *yaja* (made from rice flour), as shown in Figure 2b. In addition, the seeds are often incorporated into various dishes such as *biryani* and *salt tea* to give them a better flavor profile.

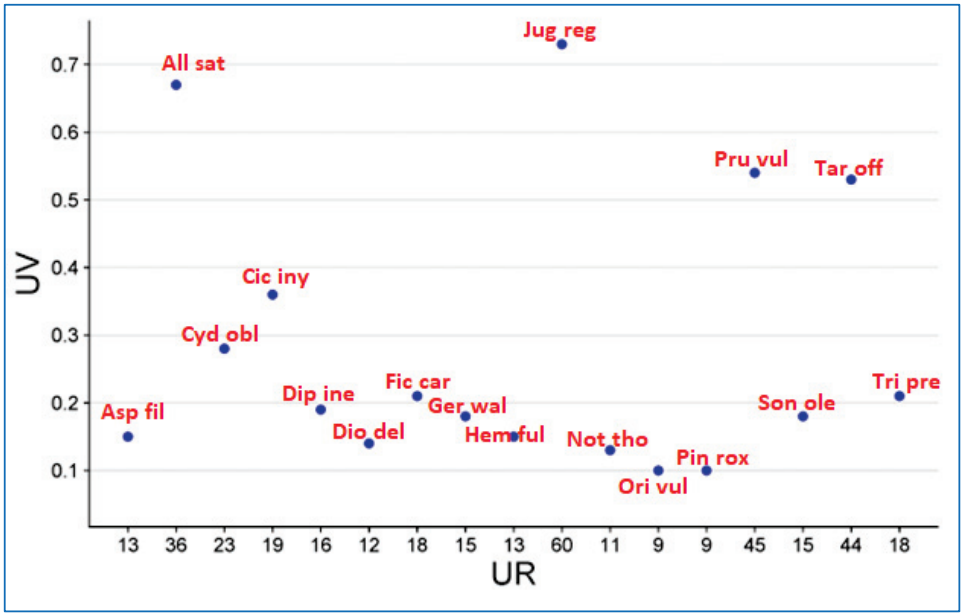

Figure 6. Association between use value (UV) and use reports for the species with gastronomic assignment. The full name of the species is given in Table 3.

They are also a possible source of cooking oil. *Allium sativum* is also consumed as a spice, especially in combination with a variety of vegetables to enhance flavor. It is believed to nourish the gastrointestinal tract, and due to its aromatic nature, locals prefer to consume garlic because they believe it has the potential to warm the body in the cold, long winter. According to [36], *Allium sativum* has been successfully used as food and medicine in human societies since ancient times. *Prunella vulgaris* is mainly consumed as soup and is said to restore strength after childbirth, with some olive oil added to the soup to lubricate the digestive tract for good absorption. *Taraxacum officinale* is also considered a nutrient-rich food, as it contains a variety of components that are vital for pregnant women. The presence of chemical constituents such as carbohydrates, calcium, proteins, and minerals makes the species a potent gastronomic candidate [30].

In the present study, we analyzed the use of plant species based on the preference (during, after, and before pregnancy) and seasonal availability for gastronomic use. The results (Table 2) show that $n = 3$ species *(Pinus roxburghii*, *Dipsacus inermis*, *Origanum vulgare*) were the only ones preferred "*after pregnancy usage*" followed by $n = 2$ species (*Notholirion thomsonianum*, *Dioscorea deltoidea*) "*before pregnancy*", and only $n = 1$ (*Geranium wallichianum*) "*during pregnancy*". When the frequently consumed (during, after, and before pregnancy) were examined, a total of $n = 6$ species *(Ficus carica*, *Trifolium pratense*, *Hemerocallis fulva*, *Asparagus filicinus*, *Juglans regia*, and *Taraxacum officinale)* were detected.

2.7. Novelty of the Study

By comparing our research results with previous studies conducted in the nearby region [8,18,19,26,31,33], we discovered new applications in the field of ethnomedicine. For example, we found that the seeds of *Asparagus filicinus* are used to relieve physical ailments caused by postpartum weakness. Similarly, the roots and stems of *Geranium wallichianum* are used to treat preterm labor and breastfeeding. In addition, *Alcea rosea* shows effectiveness in treating skin irritation, while *Arnebia benthami* (used in its entirety) is known for its usefulness for breastfeeding problems of new mothers. It is worth noting that certain pious people, referred to as Pir and Baba, get enchanted with *Arnebia benthamii* before using it to treat breastfeeding problems. It is also important to note that only one previous study [26] reported the use of plant species in the Dard community. The Jaccard similarity index is 11.49, but no similarity was found between the species used in the present study. In addition, the sample size of the previous study is very small (n = 35) compared to that of the present study (n = 82), and the study area is different.

2.8. Effective Use and Livelihood

In the Kashmir Valley, agriculture and related sectors are the main source of livelihood for the majority of the population [7]. Our research efforts have led to the identification of a variety of plant species, including *Prunus persica*, *Allium sativum*, *Ficus carica*, *Juglans regia*, *Mentha arvensis*, and *Ocimum basilicum*, all of which have a significant impact on the local economy due to their substantial contribution to food habits.

Juglans regia, for example, is known for its high economic value and has led to a thriving cottage industry in which numerous individuals extract the tree's seeds and export them to various regions of the country, resulting in significant economic gains. *Allium sativum* is considered an indispensable spice in the region's culinary repertoire and remains readily available in local markets. *Prunus persica* is mainly dried and exported to other parts of the country. *Ocimum basilicum* is highly valued in the region, mainly because it facilitates fast-breaking, and its availability in the market contributes significantly to the local economy. In addition, the systematic processing of *Mentha arvensis* plays a central role in the production of various local spices and dips, which brings significant economic benefits to the region.

2.9. Conservation Status

In the IUCN conservation assessment of the documented species, n = 7 species (*Aquilegia fragrans*, *Arnebia benthamii*, *Cynoglossum wallichii*, *Geranium wallichianum*, *Aucklandia costus*, *Saussurea simpsoniana*, *and Thymus linearis*) are classified as critically endangered (CR), n = 10 species (*Adiantum venustum*, *Artemisia absinthium*, *Aconitum leave*, *Dioscorea deltoidei*, *Dactylorhiza hatagirea*, *Fumaria indica*, *Fritillaria cirrhosa*, *Jurinea dolomiaea*, *Malva cachemiriana*, *and Podophyllum hexandrum*) as endangered (EN), and n = 4 species *(Asplenium falcatum*, *Ajuga parviflora*, *Cannabis sativa*, and *Plantago lanceolata*) as part of the vulnerable category (VU) (Table 1). Many species with medicinal importance are threatened on a large scale due to the extensive use of their required parts. Because of their medicinal importance, these species have developed an economic value for which many people overcollect, which has promoted the decline of species throughout the Himalayan region [37]. At the same time, the global phenomenon of urbanization is driving development initiatives that include road expansion and building construction, increasing the influx of people and consequently creating the potential for new threats.

Gopi et al. [38] reported that nearly 15,000 plant species used in traditional medicine worldwide fall into the category of endangered species and therefore require immediate conservation and mitigation measures to ensure their survival. Many ethnic groups have potential ecological knowledge that, if used scientifically, can contribute to the sustainable use of biological species, which in turn will contribute to the conservation of eroding green wealth. Currently, there is more and more discussion around the world about community-

based conservation that incorporates not only includes the species, but also the concerns (local values, local beliefs) of local people.

3. Materials and Methods

3.1. Study Area

Gurez, also known as Gurais (Figure 7), is located in the Himalayan region, about 123 km north of Srinagar (Jammu and Kashmir, India). The valley is located near the Pakistan Line of Control and is at an elevation of about 2438 m above sea level. The area is cut off from the outside world for almost six months of the year due to heavy winter snowfall (2 m). Nearly 30,000 people live in the area, distributed among fifteen communities. The Kishanganga River flows through the area and provides irrigation. The different physical characteristics provide many habitats and microhabitats where a variety of plant species thrive, while oak, Betula, Cedrus, and Pinus are also important species in the forests, whose vegetation begins in late summer [19]. The Gurez Valley is characterized by a rugged mountainous landscape. Climatic conditions in the valley follow a temperate pattern influenced by a variety of topographic features that result in relatively mild summers and severe winters. The warmest and coldest seasons in this region are July and December, respectively. In addition, the valley records its highest rainfall during the months of March and April [7].

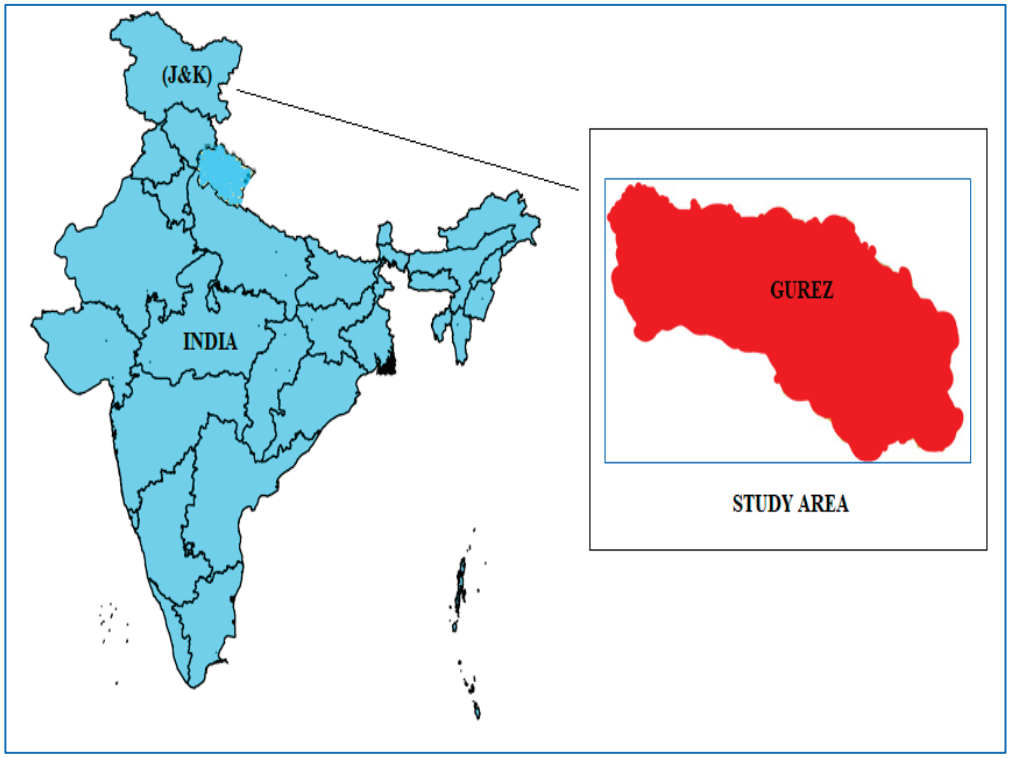

Figure 7. Map of the study area (Gurez), Jammu and Kashmir (J&K), India.

According to the last census, most of the people are Muslims (83.98%), followed by Hinduism (14.24%), Sikhism (1.16%), Christianity (0.36%), and Buddhism (0.05%) [39]. Ethnic tribes currently living there include Gujjar, Bakarwal, and Kashmiri. Also living in the valley houses are the Dards, who are cut off from their mainland Astore, Gilgit, and Chilas by the Line of Control.

3.2. Socio-Economic Background of Dard

Dards are the earliest coterie, believed to be the most ancient people of the Aryans who arrived in the Indian subcontinent nearly two thousand years ago. *Kalhana*, a Kashmiri historian (1145 AD) who wrote the "*Rajatarangini*", also describes them as the descendants

of the Aryan race [40]. They spread across the Himalayas, usually choosing to settle in the Hindu Kush mountains until they spread to the lower areas of the Himalayas. Herodotus, a famous Greek poet, mentioned the Dard-Shins in 430 BC, confirming the presence of the Dards in the Himalayan region. In Jammu and Kashmir (J&K), the majority of this community currently lives in the Gurez sub-district of Bandipora (administrative district of Jammu and Kashmir) [41]. The spoken language is Shina, and other languages include Urdu and Kashmiri. The area (Gurez) is economically backward and has few modern facilities. The people (Dard) depend largely on natural resources such as forests for food and firewood; they also engage in livestock rearing, cottage industries, and trade. In the social ranking, the community is divided into four categories (Renue: ruling class, Shins: religious group, Yashkun: farmers/peasants, Dum: lower group).

3.3. Demography of Informants

A total of 82 people were selected for the interview, 63 of whom were men and 19 of whom were women. The predominance of men over women was due to cultural constraints. Prior to recording, frequent visits were made to the study to ensure the participation of local people. Documented species of medicinal and gastronomic importance were collected from March to October 2022; a complete summary of the collection is provided in Table 3. Documentation followed the method (snowball technique) used by Haq et al. [23]. Prior to each interview, verbal consent was obtained and the code of ethics was followed (International Society of Ethnobiology, Code of Ethics, 2006) [42]. Interviews were conducted in the native language with the assistance of a translator. The ethnicity of the informant and language information were not disclosed, as required by the Nagoya Protocol. We conducted the interviews with informants of all ages, genders, and occupations. Semi-structured questions were used to capture traditional knowledge [24]. The most knowledgeable people were elderly, and the bulk of respondents (45.12%) were illiterate (Table 3). At least one qualified informant helped to verify the samples and helped with preparing the herbarium at each research site. Flora POWO 2023 was used to authenticate plant names [43].

Table 3. Demographic status of the respondents from study area.

Demographic Features	Number	Percentage
Ethnic Group	**Dard**	
Language	(Shina)	
Education		
Illiterate	37	45.12
Primary education	19	23.17
Secondary education	17	20.73
Higher education	9	10.97
Age range		
Young (18–26)	15	18.29
Middle (27–55)	26	31.70
Old (56–75+)	41	50.00
Profession		
Farmers	12	14.63
Skilled/semi-skilled workers	15	18.29
Grower/agricultural workers	12	14.63
Herders	18	21.95
Government employees	5	6.09
Housewives	8	9.75
Shopkeepers	12	14.63
Gender		
Male	63	76.82
Female	19	23.17
Religion	Islam	100

3.4. Data Analysis

We used a matrix plot employing Paste 4.03 to show the distribution of species among the families. A balloon plot was utilized to represent the species used against different diseases. A cladogram showing the Pearson correlation between plant species and diseases was used (https://www.bioinformatics.com.cn/en?p=5, accessed on 2 October 2022). A chord diagram with a pie chart was used to evaluate the number of plant parts with gastronomic uses by using the circle package in R studio. The same tool was used to show the relationship between UR and UV [24]. Paste software (4.03) was used for principal component analysis (PCA) to show the frequently used plant parts of the documented species against a variety of diseases.

3.4.1. Fidelity Level (FL)

FL was used to calculate the percentage of respondents who reported similar use of the species [24]. We calculated it using the following formula.

$$FL\ (\%) = \left(\frac{Np}{Fc}\right) \times 100 \quad (1)$$

Np is the number of informants reporting the use of a species to treat a particular disease, and Fc (frequency of mentions) is the number of informants reporting the use of a species to treat a particular disease.

3.4.2. Use Value (UV)

To evaluate the proportional value of species use, we used use value indices using the following formula [24].

$$Uv = \frac{\Sigma Ur}{N} \quad (2)$$

"Ur" represents the number of use reports of the use of a particular species, and "N" represents the total number of respondents.

4. Conclusions

The current study attempted to acquire information about a little-studied ethnic community (Dard) for the use of plant taxa to treat health disorders and to identify species consumed (before, during, and after pregnancy) as primary food. Living in harsh climatic conditions, the said ethnic community has gained the knowledge of how to use the flora for their primary needs (medicine and food). Unfortunately, traditional knowledge (TK) is primarily limited to the elderly due to the lack of interest among the younger generation. This lack of interest is due to urbanization forcing the people to change their mode of living, i.e., young people migrate to Srinagar (capital city) for education, many for labor, and many have invested in small-scale shops. Hence, the inheritance of TK has been met with a potential pause in the ethnic group. In this regard, it is imperative to document the eroding traditional knowledge before it is completely lost. Many plant species used are on the IUCN's list of critically endangered, endangered, and vulnerable species; in this regard, local people require proper education to aid in conservation and long-term sustainability. Furthermore, species new to the ethnomedicinal literature should be considered for bioprospecting for the possible discovery of some potent novel molecules with strong medical implications. The current study gives a baseline for understanding the importance of native plant species in the daily lives of the Dard community, which will benefit the local government in developing strategies to help the community's development. In addition, this study gathers basic information from the Kashmir-Himalayan region that hopefully can be used by pharmaceutical companies to discover new compounds with remarkable therapeutic properties.

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Article

Sweet Basil between the Soul and the Table—Transformation of Traditional Knowledge on *Ocimum basilicum* L. in Bulgaria

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Abstract: The study tracks the utilization of *Ocimum basilicum* L. (sweet basil)—a garden plant popular for its ritual and ornamental value in the past, that is currently applied in various forms and ways as medicine, food, insect repellent, etc.—in Bulgaria. Previous data for Bulgarian rural home gardens showed a significant number of preserved local landraces; however, it remained unclear how people perceive the large varietal diversity of this species and how the traditions related to its use are preserved. We combined a literature review on the cultural value of sweet basil and the breeding of local genetic resources with an online questionnaire, directed to adult laypeople, that sought to access different aspects of past (recalled) and present use and related knowledge. The identification skills of the participants were tested using images of local plant landraces and foreign varieties. Responses from 220 participants showed that potted "Genovese"-type individual was most frequently identified as sweet basil (89.9%), followed by two examples of local landraces in flower. Participants who grow sweet basil or used it in more varied ways had significantly better identification skills. *Ocimum basilicum* was most frequently reported as food, while ritual/symbolic use was preserved while devalued during the Communism regime (1945–1989). Food and religious uses were negatively associated in the past, but presently, the tendency is completely reversed. Preferences for the informal exchange of seeds and seed-saving practices were discussed.

Keywords: species identification; plant blindness; awareness disparity; food plants; essential oils; local landraces; plant varieties; medicinal plants; linalool

1. Introduction

The diverse profile of plant–people interactions reflects socio-economic development and cultural backgrounds, both currently rapidly changing as a consequence of global climate and political shifts [1–3]. Plant genetic resources developed by local communities (i.e., landraces, heirloom, old or farmers' varieties) gain more and more attention in order to support the adaptation potential and sustainability of agriculture [4–6]. However, farmers and communities that maintain them continue to be under constant pressure to conform with shifts in market requirements and agricultural and land policies, as well as to cope with the consequences of growing rural area depopulation and climate change while upholding their cultural preferences [5]. Despite the arduous endeavors of many local and international initiatives, combined in situ and ex situ conservation efforts to preserve these resources currently remain "unplanned and uncoordinated", struggling to attract enough attention to much-needed actions that concern both crops and their wild relatives [6–9]. The majority of edible plants have other uses, usually more than one, e.g., over 70% of them are also used for medicinal purposes [10]. It is generally accepted that societies/communities which are more reliant on natural resources are more deeply involved with nature [11,12]. However, these societies show less attention to endangered (often

rare) wild plants compared to the interest toward common plants and those used for food, medicine, ritual purposes, etc. [11,13]. Wealthier countries, on the other hand, have been deemed less and less connected with plants mainly due to urbanization, modernization, and industrialization, especially in agriculture and forestry [14]. Yet, it remains debatable what kind of interventions would overcome plant blindness (awareness disparity) as the goals and outcomes of biological education across societies vary considerably and most of the studies on species literacy and plant identification skills among different age groups and professions are disproportionately centered on university students, mostly in Northern America and some European countries (e.g., Scandinavia, Spain, Great Britain, Baltic countries, etc.) [3,15–20].

Numerous studies present data on the preserved cultural importance of plants and their communities, habitats, plant-related landmarks, landscapes, and various services they provide [21–31]. Although it is not easy to track the origins and transformation of the related (local) knowledge, it remains crucial for the prevention of biodiversity and habitat loss and adaptation to climate change [32–35]. Traditional knowledge was also shown to support the implementation of (agro) biodiversity conservation measures, and in recent years, the research data in the field have been increasing [36–38]. Thus, it is important to explore the motivations related to the preservation and persistence of culturally relevant (plant) biodiversity and associated knowledge [39–43]. The transformation of plant-related traditional knowledge in Europe has been reported mainly with respect to its abandonment and its potential role in changing attitudes towards the responsible use of biodiversity in local entrepreneurial activities [1,39,44–49]. Research on past and present modes of utilization as well as factors that influence the transmission of this knowledge is focused more on wild plants [10,50–52], and currently, only a few European countries hold systematic knowledge on traditional landraces [53,54]. Recent projects that target the transformation and preservation of biocultural knowledge in Europe also stress its homogenization, especially in regions like the Balkans and Eastern Europe, where prolonged sociopolitical instability during the early 20th century and the following Communist internationalistic policies severely affected rural livelihoods and intergenerational cultural transmission [55–58]. Hence, some authors even consider the domestication of edible plants, otherwise collected from wild populations, as an attempt to support food-insecure communities [59].

We track the biocultural fate of *Ocimum basilicum* L. (Lamiaceae) in Bulgaria as a representative example of the transformation of the knowledge and importance (meanings) related to this popular and easily cultivated plant both in pots and in gardens. The genus *Ocimum* comprises more than 70 species that are native to tropical and subtropical regions of Africa, Asia, and Central and South America, many of which have been used in various ways by humans since Antiquity [60,61]. Ancient authors in the Mediterranean region mentioned it as an early, fast-germinating leafy crop (seasoning herb) and medicinal plant, important both in veterinary practice (as purgative for cattle) [62,63] and as a human remedy for burred eyesight, respiratory problems, depression, swellings, scorpion stings, snake bites, etc. [63–65]. Currently, diverse biological activities of *Ocimum* extracts and essential oils have found application in a wide spectrum of medicines and food additives [66–68]. Christianity and Hinduism are two major religions that have held basils as plants with sacred symbolic and ritual value—in the former, it is *Ocimum basilicum* L. and in the latter, *Ocimum tenuiflorum* L. (syn. *Ocimum sanctum* L.). That was a significant factor in their secondary distribution around the world [60,69,70]. Along with its religious meanings, *O. basilicum* (sweet basil) was considered more as a medicinal (incl. aromatic) and decorative plant, largely cultivated in Bulgarian gardens, at least until World War II [71,72]. The all-curative perception of *O. basilicum* could be related to the homophony of its Bulgarian common name *bosilek* (босилек, in Greek *βασιλικός, royal*) with *lêk* (лѣк, from Proto-Slavic, *medicine*). Similarly, *bosilek* is also incorporated in the Bulgarian common names of some wild medicinal plants from the Lamiaceae family like shepherd's basil (*ovcharski bosilek*) for *Thymus* sp. and *Origanum vulgare* L., horse's basil (*konski bosilek*) for *Salvia pratensis* L. and *Mentha longifolia* (L.) L., and wild basil (*div bosilek*) for *Clinopodium suaveolens* (Sm.)

Kuntze and *Mentha longifolia* (L.) L., which could lead to the misnaming and mislabeling of these plants and related drugs [73]. Some Bulgarian ethnographic sources denote the *O. basilicum* varieties with "larger flowers" as гръцки босилек or "Greek" basil [74], and their broad-leaf counterparts (e.g., "Italiano Classico", "Genovese", etc., cultivars), informally called "Italian" basil, are ubiquitously available on the market for hobby gardeners since the import of foreign seeds was relieved after accession to the European Union in 2007. Although numerous nameless landraces of *O. basilicum* were found grown in Bulgarian rural gardens, only 39 accessions of local landraces of the species have been listed in Bulgarian National Inventory data in the EURISCO Database, most of which were collected after 2007 [75,76]. Sweet basil was reported recently for landrace hotspots in Italy and Greece; however, about half of the accessions in European gene banks (a total of 816) are stored in Germany, Croatia, and Ukraine [75,77].

The aim of the present study was to discern which plant characteristics, denomination(s), and/or use modalities are significant (focusing on laypeople) for affiliating and discerning *O. basilicum* as culturally important, currently and in the past. Cultivation for personal use is discussed as a factor in the preservation of local forms/landraces.

2. Results and Discussion

2.1. Cultural Context and Historical Relevance

The ritual use of *O. basilicum* in Europe was recorded both for Orthodox and Catholic Christian denominations, with strong connotations to marital and burial rites, the latter related to basil's denotations in the resurrection of Christ [60,78]. Hence, sweet basil was incorporated into folklore and could be found in ritual settings and decorations of people, icons, and buildings [71,79–82]. Being used in a variety of rituals and ceremonies, *O. basilicum* was popularly cultivated in home gardens and is quite frequently mentioned in Bulgarian folklore, and in that of other Balkan countries [71,83–86]. Vakarelski (1946) mentioned it as one of the important ritual plants used by the Orthodox Church in his instruction manual for field ethnographical studies in the "Plant world in Spiritual culture" section [87]. The symbolism related to sweet basil is popular in several Slavic countries, but it could be related rather to Orthodox Christianity than to some pre-Christian roots, as it is not so frequently reported for Central European countries where Catholicism is prevalent [79,80,88]. Its function in blessing bunches of Orthodox priests was considered part of the primitive/folk Christian ritual practices in Bulgaria that sought to connect earlier rituals with the Christian faith [89]. In the Kyustendil region (Southwestern Bulgaria), there is a preserved practice to celebrate the wheat harvest and the intergenerational transfer of knowledge related to breadmaking that is intertwined with the Orthodox Lifting of the Breads (Panagia) during the Dormition of the Mother of God commemorations on 15 August [90,91]. Flowering sweet basil together with other seasonal ornamentals like *Geranium macrorrhizum* L., *Chrysanthemum indicum* L., *Zinnia elegans* Jacq., *Tagetes erecta* L., etc., are used for the decoration of sacred bread and icons (Figure 1). Sweet basil oil is also used as a non-essential ingredient of the Great Chrism made by Bulgarian and Romanian Orthodox Churches [92,93].

Figure 1. Church decoration for the Dormition of the Mother of God commemoration (courtesy of and with permission of Plovdiv Holy Metropoly [94]).

Religious/ritual use of sweet basil was reduced during Communism (1944–1989), parallel to the oppression of the Orthodox Church along with all other denominations [95]. State antireligious policies prohibited public displays of faith and participation in rituals, which minimized and forced all rites and related ritual elements into private spaces [96]. Thus, festive and ritual decorations and ritual objects that would incorporate sweet basil and other symbolic plants became obsolete in public contexts. This was also reflected in floriculture at the time, when *Ocimum* was described as "a plant introduced before the Liberation (from Ottoman Empire) . . . of low decorative value, but still very fragrant" [97].

The medicinal properties of sweet basil are widely popular and related to its ritual functions in Bulgarian folk and modern medicine. Aside from the oral administration of infusions, extracts, and medicinal wines made of the herbage and seeds and fumigations for various ailments, in Bulgarian folk medicine, sweet basil branches are used to sprinkle other herbal infusions to improve their curative strength, as well as for cauterizations, and worn as an apotropaic bunch [74,98]. Sweet basil is also considered a fortune/health-bringing object, especially in marital and midwifery rituals (related also to the health of the mother and the newborn) [83,99,100]. The flowering herbage and seeds are mentioned in numerous preparations in all major professionally written phytotherapy textbooks and herbals, as well as in the multivolume compendium of folk prescriptions—Peter Dimkov's Bulgarian folk medicine (1926–1939) [101–105]. Most of the biological activities mentioned there (e.g., antibacterial, spasmolytic, carminative, orexigenic, anti-inflammatory, antitussive, anticonvulsant, relaxant, broncholytic, etc.) were found to be related to the constituents in the essential oil. It was valued in Indian, Chinese, and other Asian medical practices and further translated into modern medicine for the treatment of colds, coughs, urinary complications, earaches, menstrual irregularities, arthritis, and viral, fungal, and bacterial infections, to name a few [106,107]. Interestingly, the historical ethnopharmacological data from other Balkan countries showed limited use of *O. basilicum* [108–110]. Due to the broad profile of volatiles in the essential oil, like linalool, methyl chavicol, eugenol, bergamotene, and methyl cinnamate, *O. basilicum* varieties are often identified both by their morphological traits and as chemotypes [111,112]. Varieties considered most suitable for

culinary purposes were those with linalool content ranging between 19% and 38% [113]. The typical Bulgarian chemotype belongs to the European group but was reported to contain high linalool levels (50–70%). Some authors report also methyl cinnamate as a characteristic compound [114–118]. Indeed, with the growth of the essential oil industry in Bulgaria after the 1940s, sweet basil had become one of the largely explored cash crops. The production peak was in the late 1980s and early 1990s, with Bulgaria being the largest European producer of sweet basil oil, known also as Bulgarian basil oil [115]. Professionally selected Bulgarian cultivars of *O. basilicum* ("Trakia", "Jubileen", "Mesten", and others), developed in the 1960s–1980s, were also driven by the extraction of essential oils with linalool as the main prevailing component, and were sought for industrial cultivation, even outside Bulgaria [119–121]. Linalool is largely known for its use in perfumery, cosmetics, and household products and is much less popular in cooking, which could explain the reluctance of some seniors to consume it, together with the plant's connotations to funerals and death in some regions in Bulgaria [122,123]. Large quantities of linalool in Bulgarian sweet basils would easily explain the complete absence of sweet basil from earlier cookbooks and Communist catering recipe compendiums, not only in Bulgarian traditional dishes but also in Italian-style ones [124–131]. Some authors mentioned it, specifically *Ocimum basilicum* f. *minimum*, as a food plant used in sausages, pickles, and stews, but without any recipes provided [72,101,132]. On the other hand, currently, popular TV chefs are promoting the use of sweet basil not only as a part of foreign cuisines but also as an ingredient in some traditional dishes like beans stew in a clay pot and *patatnik*, a dish originating from Rhodopi Mts., made of grated potatoes with cheese or veal and/or mutton [133,134].

2.2. Online Questionnaire

Mixed closed- and open-ended responses of 220 adults were collected though an anonymous online questionnaire (Table 1). Most of the participants belonged to age groups of 21–40 (44.7%) and 41–60 years of age (43.3%), which correlated well with the age profile of Internet users in Bulgaria [135]. The prevalence of women (86%) could be associated with the higher involvement of women in sharing and general interest in factual plant-related information and also in gardening and cooking [136–139]. Similarly, the prevailing educational level was third level (university/college); however, there was little involvement from holders of biology and/or agriculture diplomas (under 15%). Participants who spent their formative years and started their compulsory education (6–8 years of age) before the end of Communism in Bulgaria were 51% of the sample (coded hereafter CDC, Childhood during Communism, as opposed to CDD, Childhood during Democracy).

Table 1. Characteristics of the participants.

Parameter	Frequencies		
	Total	**CDC** [1]	**CDD**
Age group (years)			
Under 20; N (%)	4 (1.9)	0 (0.0)	4 (4.0)
21–40; N (%)	96 (44.7)	0 (0.0)	96 (96.0)
41–60; N (%)	93 (43.3)	93 (80.9)	0 (0.0)
Over 60; N (%)	22 (10.2)	22 (19.1)	0 (0.0)
Total; N	215	115	100
Participant sex			
Female; N (%)	190 (86.0)	108 (90.8)	77 (80.2)
Male; N (%)	30 (14.0)	11 (9.2)	19 (19.8)
Total; N [2]	215	119	96

Table 1. *Cont.*

Parameter	Frequencies		
	Total	**CDC [1]**	**CDD**
Education level			
Primary; N (%)	1 (0.4)	0 (0.0)	1 (1.0)
Secondary; N (%)	39 (18.1)	25 (21.0)	14 (14.6)
College/University; N (%)	157 (73.0)	80 (67.2)	77 (80.2)
Non-disclosed; N (%)	18 (8.4)	14 (11.8)	4 (4.2)
Total; N	215	119	96
Biology/Agriculture proficiency and/or avid hobbyist; N (%)	38 (17.0)	19 (16.0)	18 (18.8)

[1] Participants are grouped according to the time of their childhood (before start of the compulsory education) during or after the Communist era, 1945–1989. [2] Sample sizes vary due to missing data in the different variables. N: Sample size.

All participants identified at least one image of *O. basilicum*, and the negative controls, *Mentha* sp. (presented by its owner as "Greek basil", bought from Greece) and *Salvia officinalis*, were mislabeled as sweet basil by less than 5% of the participants (both 3.7%, $p < 0.01$, Chi-Square test, Figure 2). *Ocimum basilicum* is known for its variable morphometric characteristics that depend on the genotype and the pedoclimatic conditions, as reflected in the numerous intraspecific taxa, many of which are currently transferred to synonymy [61,140]. This could explain why only two of six presented pictures of *O. basilicum* were clearly identified as sweet basil, namely a potted "Genovese" variety with large convex leaves (89.8%, $p < 0.01$) and a flowering individual of a local garden landrace from Ivaylovgrad (South Eastern Bulgaria) (58.6%, $p < 0.05$). Contrastingly, the other image presenting flowering *O. basilicum* (garden landrace from Samuilovo village, Southwestern Bulgaria) was positively identified only by 39.1% of the participants ($p < 0.01$), supposedly due to the lack of close-up details of flowers and leaves. The least identifiable O. *basilicum* was a dwarf "Globe" variety, internationally marketed as "Greek" basil (5.1%, $p < 0.01$) [141]. The specialized education and/or gardening hobby, age, or sex were found non-significant for plant identification when the study sample was taken as a whole ($p > 0.05$, Kruskal–Wallis and Mann–Whitney tests, data not shown).

The absolute number of CDC participants who identified the presented taxa was higher than that of CDD participants, and only for one variety and one landrace was the difference in favor of CDD, by only one participant (Table 2). When comparing the accuracy of CDC and CDD groups, there was a significant difference only for the "Genovese" variety ($p = 0.024$, Fisher's exact test). Identification skills and the time of the participant's childhood were significantly associated only for the "Genovese" variety and *Mentha* sp. ($\varphi_c > 1$, small association).

Identification accuracy was associated with the direct availability of *O. basilicum* in participants' homes (in pots) or in a home garden. The lack of interest and/or opportunities to cultivate was associated with a significantly lower ability to correctly identify most of the presented varieties/landraces, except for the least identifiable dwarf variety (Figure 3). Having potted sweet basil plants was found important for the most identifiable "Genovese" variety and the two landraces pictured in the flowering stage but not relevant for the rest of the cases ($p < 0.05$, Fisher's exact test).

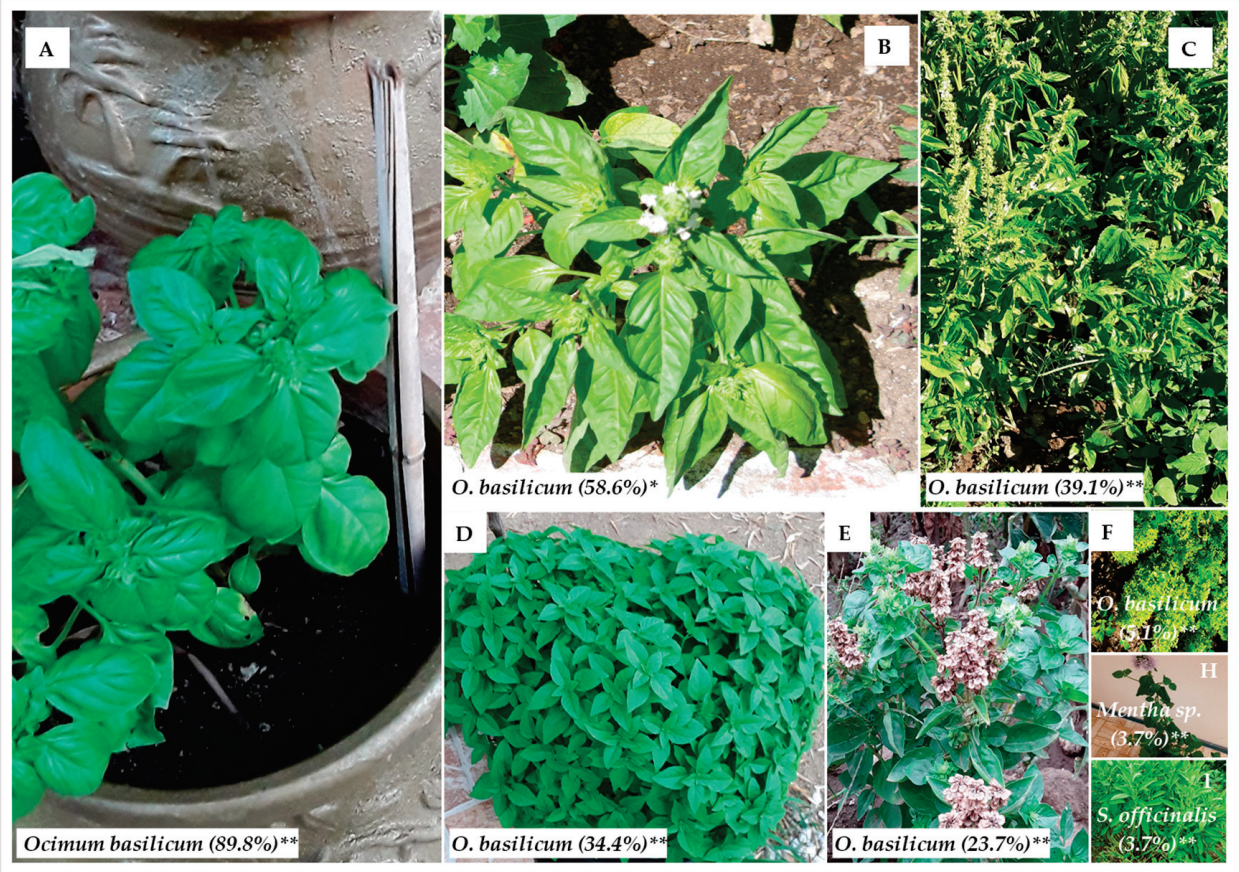

Figure 2. Treemap of participants (%, N = 215) recognizing "sweet basil" in the provided images: *Ocimum basilicum* "Genovese" variety (**A**); *O. basilicum* garden landrace from Ivaylovgrad (South Eastern Bulgaria, photo credit: Petar Petrov) (**B**); *O. basilicum* garden landrace from Samuilovo village (Southwestern Bulgaria) (**C**); *O. basilicum* "Bush" variety with small–medium ovate leaves (**D**); *O. basilicum* garden landrace, with fruits from Plevun village (Southeastern Bulgaria) (**E**); *O. basilicum* dwarf "Globe" variety (**F**); *Mentha* sp. (**H**); *Salvia officinalis* (**I**); * $p < 0.05$; ** $p < 0.01$ (Chi-Square test).

Table 2. Accuracy of CDC and CDD participants in identification of *Ocimum basilicum*.

Code [1]	Taxon	Setting, Number of Plants	Leaf Characteristics	Phenophase	CDC (%)	CDD (%)	Fisher's Exact Test (p, 2-Saided)	Phi and Cramer's V, φ_c
A	*Ocimum basilicum* "Genovese" variety	potted, single individual	large/medium elliptic	Vegetative	52.1	37.7	0.024	0.16 (small)
B	*Ocimum basilicum* landrace (Ivaylovgrad)	garden, single individual	medium–large/ medium ovate	Flowering	30.2	28.4	>0.05	0.09 (NS)
C	*Ocimum basilicum* landrace (Samuilovo)	garden, multiple individuals	medium–large/ medium ovate	Flowering	22.3	16.7	>0.05	0.029 (NS)
D	*Ocimum basilicum* "Bush" variety	potted, single individual	small–medium/ ovate	Vegetative	20.0	14.4	>0.05	0.04 (NS)
E	*Ocimum basilicum* landrace (Plevun)	garden, single individual	medium–large/ ovate-elliptic	Fruiting	11.6	12.1	>0.05	0.071 (NS)

Table 2. *Cont.*

Code [1]	Taxon	Setting, Number of Plants	Leaf Characteristics	Phenophase	CDC (%)	CDD (%)	Fisher's Exact Test (p, 2-Saided)	Phi and Cramer's V, φ_c
F	*Ocimum basilicum* dwarf "Globe" variety	garden, multiple individuals	very small/ narrow elliptic	Vegetative	2.3	2.8	>0.05	0.046 (NS)
H	*Salvia officinalis*	garden, multiple individuals	medium/ oblong–lanceolate	Vegetative	53.0	43.3	>0.05	0.028 (NS)
I	*Mentha* sp.	potted, single individual	small–medium/ elliptic	Flowering	52.1	44.2	>0.05	0.124 (small)

[1] Code letters follow those shown in Figure 2; N(CDC) = 115, N(CDD) = 100; CDC—Childhood during Communism, CDD—Childhood during Democracy; NS—non-significant.

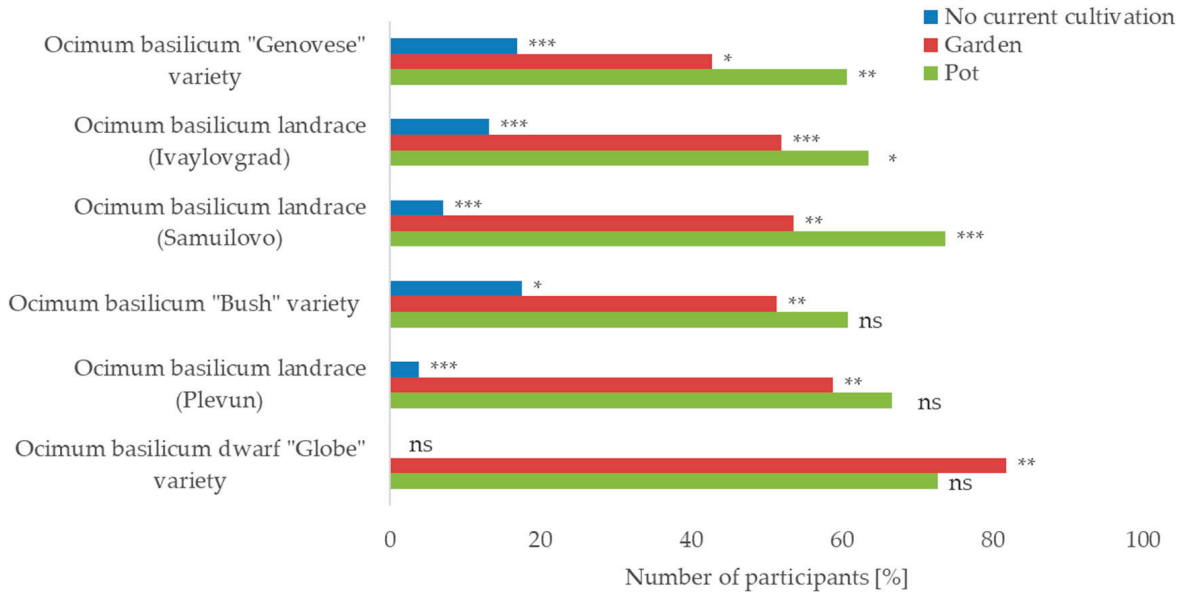

Figure 3. Effect of cultivation involvement on accuracy of *Ocimun basilicum* identification (N = 215); Fisher's exact test: * $p < 0.05$, ** $p < 0.01$, *** $p \leq 0.001$, ns—not significant.

Ready potted plants from the market were the preferred way to obtain plants at home (21.1%, N = 147), and only 6.7% of the participants had saved seeds for more than 10 years ($p = 0.001$, Chi-Square test, Figure 4a). Plants and seeds were procured most frequently through non-formal exchange and purchasing seeds from Bulgarian producers, an approach that could not guarantee the quality and origin of the seeds (Figure 4b). Vegetable plots and amateur greenhouses were found very popular among Bulgarians and home gardens are frequently used for semi-subsistence agriculture not only in the rural but also in urban and peri-urban areas, which motivates the procuring of seeds and other planting materials of various origins [123,142]. Still, non-formal exchange and seed saving could misleadingly reassure laypeople about the authenticity of the landraces and varieties due to cross-pollination between varieties and species in the genus *Ocimum* [143].

About half of the participants correctly identified no more than two pictures of *O. basilicum* varieties/landraces, with 35.4% correctly identifying only one (Figure 5a,b). Although the number of CDC and CDD participants who identified three or more sweet basil varieties/landraces was similar, 10% more CDC participants correctly identified at least two images.

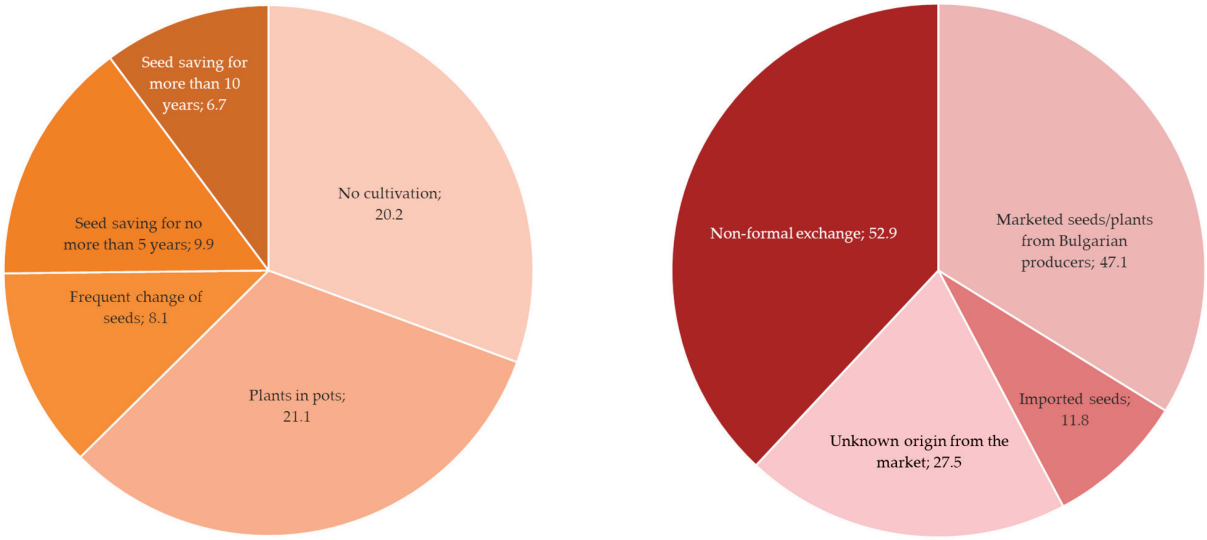

Figure 4. Procurement of *Ocimum basilicum* seeds and plants (%): (**a**) seed-saving practices (N = 147, $p < 0.001$, Chi-Square tests); (**b**) seed origin (N = 147).

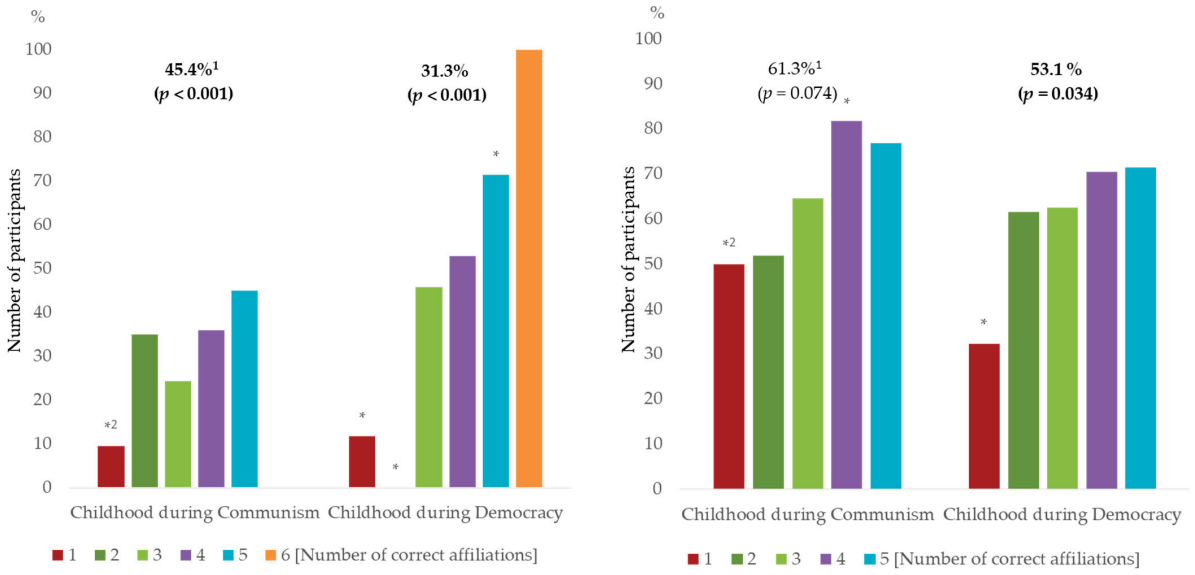

Figure 5. Number of correctly identified *Ocimum basilicum* varieties/landraces depending on interest in sweet basil cultivation in a garden (**a**) or in pots (**b**). [1] Percentage of participants involved in garden/pot cultivation (*p*-value, Chi-Square test). [2] Columns indicated with asterisk show significant difference between CDC and CDD groups involved or not in garden/pot cultivation ($p < 0.05$, Fisher's exact test); N(CDC) = 115, N(CDD) = 100.

Most of our participants (75.8%, $p < 0.001$, Fisher's exact test) were previously aware of different *O. basilicum* varieties, with 45.7% certain in their ability to discriminate among them, and 32.6% who were familiar, but not sure they could discriminate so easily. A significant number of CDC participants (83.2%) were more certain about their knowledge of different varieties than CDD participants (70.8%) ($p = 0.036$, Fisher's exact test).

For younger participants (CDD), cultivation, both in gardens and in pots, was equally important for the number of identified *O. basilicum* images, whereas for CDC, only experience in gardening was a significant factor ($p < 0.001$, Fisher's exact test). This could be related to the low percentage of CDD participants involved in growing sweet basil in home

gardens, which was considerably lower compared to CDC participants (31.1% to 45.4%, respectively). Age and more intensive contact with nature (like living in rural areas) were shown as important predictors of plant identification skills, as these experiences allow the accumulation of additional knowledge throughout the years [15,144]. Prior conditioning/education was also shown to improve species identification in general, but within our sample, such calculations would be misleading due to the prevailing participation of people without specialized higher education, and species identification is not emphasized enough in general primary and high school education in Bulgaria [15,145,146].

It was shown that various factors influence plant identification skills, i.e., local plant richness, demographic and socioeconomic factors, proficiency/professional involvement, source(s) of information, personal interests, etc. [16,147–151]. Previous studies argued that the presentation of real plants (cuttings, potted plants, etc.) results in better identification compared to images as they provide additional clues for the interviewees; however, this is not always possible and/or feasible [15,152]. In the majority of those cases, participants are bound to free-list taxa (majority of ethnobotanical studies) and/or to recognize sampled individuals/images of plants on a species level (together with mammals, insects, birds, etc., for species identification research), often combining species examples with drastically dissimilar features like different lifeforms, phenological stages, etc. Additionally, flowering plants were usually presented in the flowering stage as it is considered the most representative and attention-attracting [15,153]. In this study, over 96% of the participants discerned with great certainty the three species (mint, sweet basil, and common sage), among which *Mentha* sp. and *O. basilicum* were in the flowering stage. This supports the notion that Lamiaceae taxa are among the most popular medicinal and aromatic plants (wild and cultivated) to Bulgarians [76,154] and implied that identification relies on various aspects, e.g., in what phenological stage or form the specific taxa is most frequently seen and/or used.

Less than half of all participants agreed to answer the question of which of the presented images depicts "Bulgarian" or "*nash(enski)*" (ours) sweet basil. The landrace from Ivaylovgrad (picture B) gathered the most positive responses (28.57%, N = 98), followed by the "none of the presented" category and landrace from Samuilovo (image C) (27. 55% and 16. 33%, respectively, $p > 0.05$, Chi-Square test, Figure 6). The "Bush" variety was most frequently identified as the "Greek" variety (image D, 59. 06%, N = 149, $p < 0.001$) and the "Genovese" as "Italian" (image A, 73.29%, N = 161, $p < 0.001$). Remarkably, all participants were reluctant to assign specific use to any of the three country-bound identities, which was opposite to data on the Italian diaspora in Romania who discriminate between "their" (Romanian) and "our" (Italian) sweet basil solely according to its ritual and culinary use, respectively [78]. However, further exploration of the identification–usage nexus showed that high positive identification of the "Genovese" variety was reflected in the use frequencies.

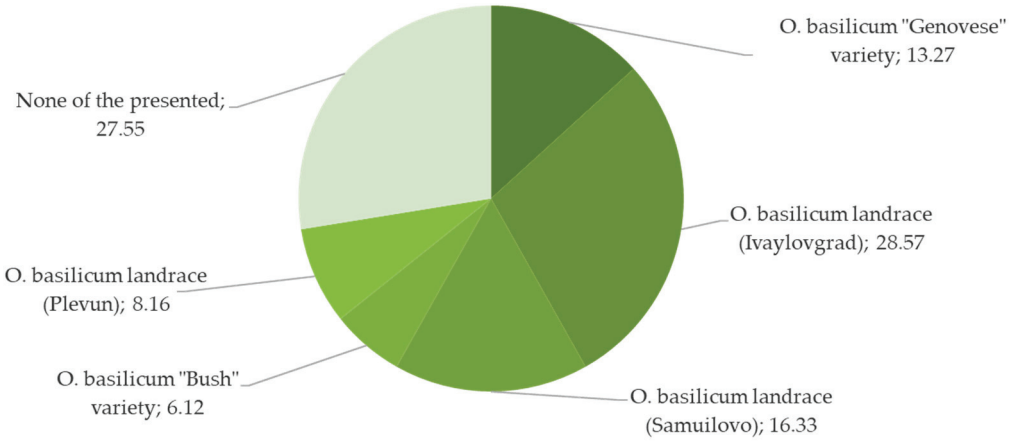

Figure 6. Affiliation of *Ocimun basilicum* images as "Bulgarian" basil (% of participants, N = 98).

The presence of flowers was expected to be helpful for the identification, due to the traditional symbolic value and popular use of *O. basilicum* as a medicinal and ornamental plant. However, identification accuracy was significantly associated with most of the current uses reported by participants but less with those they recall from their childhood memories (Figure 7). The food category was most frequent both for current and childhood years (83.3% and 44.7%, respectively, Table 3). However, this increase of about twofold in the number of participants using *O. basilicum* as a food plant was not associated with improved plant identification skills ($p = 0.130$, Fisher's exact test). The majority of the participants who used sweet basil as a culinary herb, both currently and in the past, tended to recognize one to three varieties/landraces, among which the "Genovese" variety prevailed. On the opposite side were ornamental ($p = 0.012$), medicinal ($p = 0.002$), and religious/ritual use ($p < 0.001$), for which the number of participants who correctly affiliated images peaked at four. Interestingly, for the latter, only past use was significantly associated with identification accuracy ($p = 0.007$).

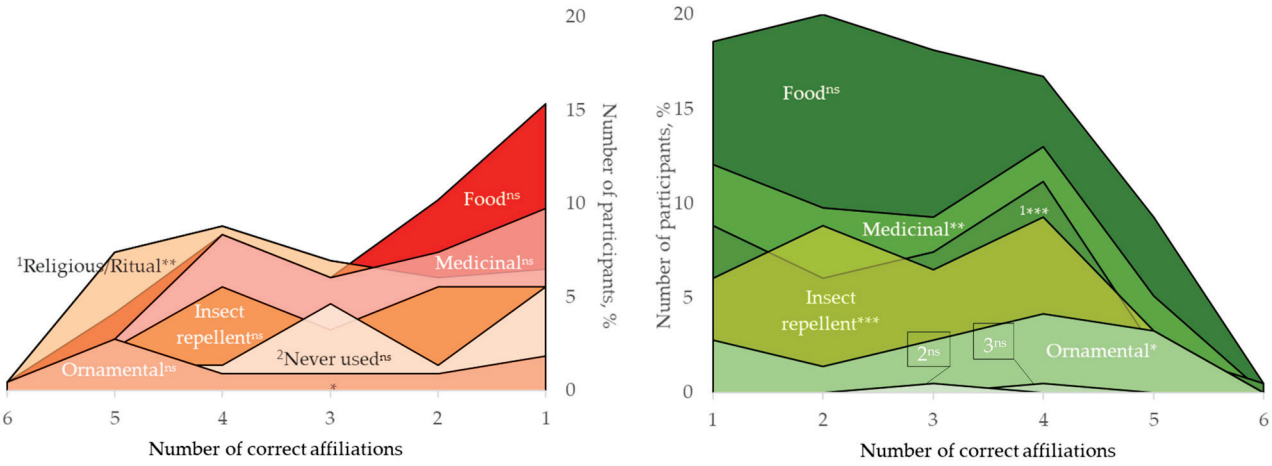

Figure 7. Frequencies of past (**a**) and current (**b**) uses of *Ocimum basilicum* by number of correctly affiliated images. [1] Religious/ritual use; [2] never used, [3] leavening agent; Fisher's exact test: * $p < 0.05$, ** $p < 0.01$, *** $p \leq 0.001$, ns—not significant; N = 215.

Table 3. Association between past and present uses of *Ocimum basilicum* in Bulgaria (*r*, Chi-Square Correlation).

Current \ Past	Food	Religious/ Ritual	Medicinal	Insect Repellent	Ornamental
Food	0.073	0.011	−0.053	−0.044	**−0.152** *
Religious/Ritual	**−0.175** **	**0.576** **	0.002	**0.165** *	0.028
Medicinal	−0.112	**0.208** **	**0.340** **	**0.157** *	−0.005
Insect Repellent	0.095	0.119	0.117	0.076	−0.073
Ornamental	−0.005	0.128	0.075	0.105	**0.151** *

Data in bold are significant at * $p < 0.05$, ** $p < 0.01$.

Data on the consumption of sweet basil showed that participants born during the Communist era use it more frequently in dishes both of Bulgarian and international cuisines compared to CDD participants (Fisher's exact test $p = 0.019$, $\varphi_c = 0.214$ (small association)). Very few of the CDD participants reported usage of *O. basilicum* only in Bulgarian dishes (12.6% to 28. 5% for CDC, Figure 8), which requires further research as there were no available data on the prevalence of consumption of home-cooked meals and cooking skills among this group in Bulgaria. Additionally, it was previously shown that even for some

recipes that are explicitly considered traditional, the way of preparation is more important for Bulgarians than the ingredients used [155].

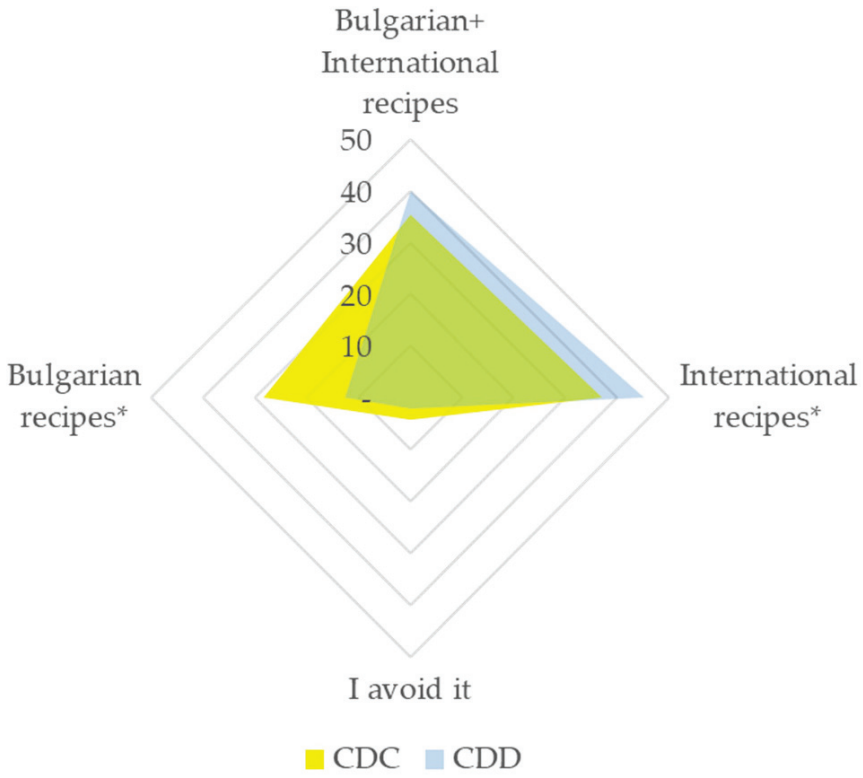

Figure 8. Preference of the participants (%) in consumption of *O. basilicum*. N(CDC) = 116; N (CDD) = 95; * significant difference between CDC and CDD groups (Fisher's exact test).

Religious/ritual use was the category in which minimal change was observed between use frequencies in the past and the present—about 36% of the participants, with about twice as many CDC continuously using *O. basilicum* in comparison to CDD ones ($p \leq 0.01$, Tables 3 and 4). Only 42 participants considered themselves as observing religious practices involving sweet basil, with CDC prevailing (70%, $p = 0.039$, Fisher's exact test, $\varphi_c = 0.251$). Nearly half of the participants who replied to the question on the rituals that involve sweet basil were not sure about its role (48.6%, N = 109), and the rest were divided between blessings (for health, inauguration, protection, etc.—27.5%) and funeral rites (23.9%). In all other categories, there was an increase in the reported use frequency, with medicinal and aromatic use growing from 34.4% to 49.3% and insect repellent use rising from 22.3% to 34%. For the latter, together with food, past and present use were not significantly related. The seniors (CDC) who started to consume sweet basil in their adult years constituted the major portion of participants who contributed to the significant increase in the food and medicinal categories ($p = 0.05$ and $p = 0.01$, respectively, Table 4). While the data for the food category could be related to the current availability of new imported varieties, the increase in medicinal use is more likely due to the persistence of traditional medicinal practices and lower prices of herbal medicines, shown to be important factors in late senior years, especially for women [156,157]. Intergenerational knowledge transfer was also shown to be important in the persistence of traditional medicinal practices [158].

Table 4. Present and recalled past uses of *Ocimum basilicum* in Bulgaria by CDC and CDD participants (number of participants who gave positive answers).

Time of Use	Past				Current			
Use Category	**CDC**	**CDD**	**Phi and Cramer's V**	**Fisher's Exact Test (*p*, 2-Sided)**	**CDC**	**CDD**	**Phi and Cramer's V**	**Fisher's Exact Test (*p*, 2-Sided)**
Food	44	49	**0.141**	0.05	112	91	0.015	1.00
Religious/Ritual	44	20	**0.175**	0.011	52	25	**0.183**	0.01
Medicinal	38	34	0.037	0.663	67	37	**0.177**	0.013
Insect Repellent	29	18	0.068	0.407	37	35	0.057	0.468
Ornamental	11	4	0.099	0.183	21	10	0.102	0.172

Data in bold are significant at $p < 0.05$; Phi and Cramer's V association coefficient: > 0.1 (small); 0.3 (medium); 0.5 (large).

Numerous books published in Bulgaria that cite folk medicine indicate that traditional knowledge was not neglected but favored by the state during Communism, in contrast to religion. Hence, the interest not only in traditional/"old" knowledge but also in the traditional medicine of other cultures was promoted on an official level, especially in the case of Chinese medicine [159]. Conversely, sweet basil, being part of folk beliefs, rarely finds a place in school textbooks on religion. In the current official editions of school textbooks, after 75 years of discontinuance, *O. basilicum* is mentioned only once (in the edition for 5th grade, 10–12 years of age) in relation to the Feast of the Exaltation of the Holy Cross (14 September), when blessed sprigs are brought home after the liturgy [160]. It is completely missing in pre-Communism religion textbooks that comprised mostly Biblical excerpts, focusing on canonically recognized *Boswellia* sp. and *Commiphora* sp. resins, *Olea europaea* L. (oil and branches), *Triticum aestivum* L. (bread), and *Vitis vinifera* L. (wine) [161]. During Communism, *O. basilicum* was part of botanical education, presented as an ornamental plant and source of essential oils, together with other taxa of the Lamiaceae family [162]. The inclusion of traditional knowledge in education curricula could be challenging, especially when the formal systems favor "modern" data and/or methods of interpretation dissimilar from the local culture [163–165]. In Europe, where industrial agriculture and subsequent urbanization are underlying the reduction in direct experiences with nature, the creation of opportunities for more local, personal, and sensory experiences is seen as a leverage point in reshaping environmental education [166]. Logically, the introduction of local knowledge for such educational purposes would serve its revitalization, but in an updated form that reflects contemporary developments in science [167].

Modern pharmacology stems from traditional uses of medicinal plants, and based on current biomedical research, many biologically active compounds are clearly related to specific uses known for centuries as well as new ones [168]. Fast implementation of these new data allows the development of new medicines and functional foods that reach the market, and through advertisement and targeted promotion, supplies patients and consumers with transformed and upgraded traditional knowledge that they can combine with their own [167]. Screening of medicinal use of *O. basilicum* in the Balkans recorded during ethnopharmacological studies revealed quite varied, relatively low popularity (use value 0.17–0.3) that corresponds to frequencies of medicinal use of sweet basil reported by our participants [76,169–171]. Cultivated plants were frequently found to have higher use values than wild ones; however, ethnobotanical indices could be misleading due to the differences in methodologies and aims of the research [172,173].

The availability of new and/or foreign traditional knowledge, currently easily available, through different sources (i.e., literature and media) would allow for expanding overall interest and engagement with an already known (plant) species and ultimately enhance identification skills. On the other hand, commodification, especially of food plants, has set a specific perception frame that is not diversity-inclusive and contributes to (agro) biodiversity loss [174–177]. Hence, ethnobotanical data and research that targets various dimensions of ecosystem services and elucidates a richer knowledge should be more eagerly included in formal and informal educational agenda to attract more attention to plants

and biodiversity as a whole [178–180]. Correspondingly, in this study, ten percent of the participants detailed their past use of *O. basilicum* bunches or individual sprigs also as a household repellent, placed in wardrobes and pantries, and one participant recalled it as being a pollinator attraction plant in vegetable gardens (Figure 9). Linalool, found in high concentrations in Bulgarian sweet basil varieties, is recognized as one of the important pollinator attractants as well as effective for plant protection against pests and fungal infections, hence suitable for organic farming and the adoption of agroecological practices [181–184]. Phenolic content was found to be related also to the microflora that different plant taxa harbor [185,186]. Sweet basil and other aromatic plants were reported in ethnographic sources as fermentation starters due to the beneficial lactic acid bacteria and yeast strains naturally occurring on them [187,188]. Currently, only one of our participants reported sweet basil as a leavening agent for the preparation of homemade bread, although they did not specify the usage of other ingredients.

Figure 9. Dry *Ocimum basilicum* herbage, traditionally used as a household insect repellent, hung under the roof in the village of Plevun, southeastern Bulgaria.

Association analyses of different uses of *O. basilicum* showed that cooking practices in the past were opposite to religious/ritual ones but correlated with its medicinal use (Table 5).

Table 5. Association between different uses of *Ocimum basilicum* in Bulgaria (*r*, Chi-Square correlation).

Past	Religious/ Ritual	Medicinal	Insect Repellent	Ornamental
Food	**−0.177 ****	**0.144 ***	0.078	0.058
Religious/Ritual		0.03	0.127	−0.061
Medicinal			**0.187 ****	0.001
Insect Repellent				−0.01
Current				
Food	0.035	0.024	0.023	0.051
Religious/Ritual		**0.337 ****	**0.290 ****	**0.222 ****
Medicinal			**0.274 ****	**0.292 ****
Insect Repellent				**0.300 ****

Data in bold are significant at * $p < 0.05$, ** $p < 0.01$.

Presently, the tendency is completely reversed, and all uses were found to be positively associated; however, food use had an insignificant association with the remaining uses. This implies that access to more varieties steered preference toward varieties suitable for the most frequent use—in the present study, food—with only 9.3% of CDC and 10.9% of CDD participants motivated to grow sweet basil for purposes entirely unrelated to food and/or other utilitarian purposes (Figure 10).

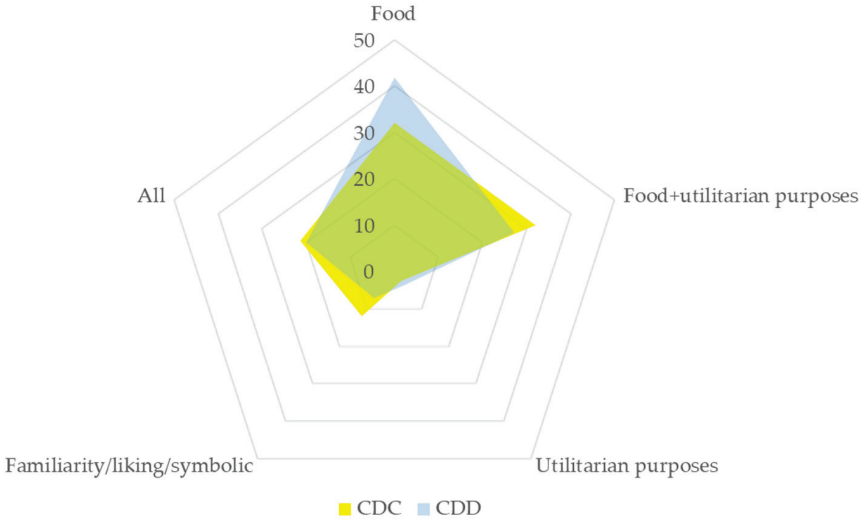

Figure 10. Motivation of participants (%) to grow *O. basilicum* at home and/or in a home garden. N(CDC) = 75; N (CDD) = 55; Fisher's exact test $p > 0.05$.

A moderate association was present only between religious/ritual and medicinal uses and between ornamental and insect-repellent uses, which is in agreement with the concurrent importance of multipurpose sweet basil essential oil [107]. The traditional role of sweet basil in home gardens as an ornamental plant was preserved, but by few (14.4% of the participants), and the availability of new varieties was reflected in about twice as many participants currently appreciating its decorative side, but presumably not as essential for the selection. Ornamental value was found to be an important factor in the introduction of more plant taxa in home gardens, especially in rural areas where more gardening space is available [189,190]. However, in Bulgarian home gardens, food plants were found to be a leading incentive, a feature more typical of tropical home gardens [191–193], as they were used for subsistence farming before and during Communism [123]. Broadening the inquiries regarding preference and selection of varieties/landraces to grow and/or consume/utilize among a larger sample would elucidate motivation drivers to cultivate certain varieties/landraces.

3. Materials and Methods

Recent and historical ethnographic botanical and agricultural data were obtained by inquiries of major scientific databases (Web of Knowledge, Scopus, AGRIS, CAB Direct, and ERIH PLUS), as well as print-only sources available in public libraries. Previous ethnobotanical information on the cultivation and utilization of *O. basilicum* in Bulgaria was obtained during field studies of home gardens in 2017–2021 [76,123]. Image data were collected with the permission of the garden owners. An anonymous online questionnaire was constructed in Bulgarian using Google Forms format in a manner to avoid the collection of personal data of the participants; it was disseminated using personal contacts, mail lists, and social media outlets from the autumn of 2018 until December 2022. All participants were duly informed of the purpose of the research and their consent to participate was obtained before further questioning, following the guidelines prescribed in the Code of Ethics of the International Society of Ethnobiology [194]. Sociodemographic data were limited to age, sex, education, and information about their permanent residence in Bulgaria. Only adults were considered eligible for the research. Compliance was confirmed by the Scientific Council of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, acting as an independent institutional Ethics Board (Decision No. 6/21/05/21).

Online participants were asked to recognize images of six *O. basilicum* varieties/landraces together with one picture of *Mentha* sp. and another of *Salvia officinalis* (see Supplementary File S1). Images were selected to represent the phenological stages (vegetative, flowering, and fruiting) and morphotypes of *O. basilicum* (3 foreign varieties and 3 landraces). *Mentha* sp. and *S. officinalis* were included as negative controls due to their common Bulgarian names, wild basil and horse basil, respectively. Further open and closed-end questions were related to:

Cultivation practices and motivation to cultivate sweet basil—in a garden and/or pots;

Current and past (childhood recollections) use in the following categories—food, religious/ritual, medicinal (including aromatic), insect repellent, ornamental, or other (open to additional uses);

Supposed "identity" of the presented sweet basil images related to the concept of "own" (Bulgarian) and foreign (Greek or Italian) and the means of participants to distinguish between them;

Seed saving and preference for planting material/seed origin.

Statistical Analysis

Frequencies (absolute and percentages) were used to describe ordinal or nominal variables (sex, age groups, and education; number of correctly identified varieties/landraces and use categories). Studied variables were found to deviate from a normal distribution; therefore, we report the results of comparative non-parametric tests. Chi-Square tests were used to assess if the frequency distributions of the categorical variables were significantly different. The statistical association between nominal and ordinal variables was evaluated through Fisher's exact test and Chi-Square correlation (r). The effect of sociodemographic parameters was initially assessed using the Mann–Whitney test (M-W) (between sexes), whereas the Kruskal–Wallis (K-W) test was applied for education levels and age ranges. Both tests produced insignificant results; therefore, we separated the participants into 2 groups according to the period they started their compulsory education (6–8 years of age): during Communism (1945–1989, CDC) and during Democracy (after 1989, CDD). The comparison between the two groups was sought due to the active role of schools in the indoctrination and prohibition of religious practices during Communism that would potentially affect traditional symbolic/religious use.

To examine the association between the identification skills, use categories, and participant preferences of the two groups (CDC and CDD), we estimated the Phi and Cramer's V association coefficients φ_c (following Cohen's guidelines [195], values were classified as 0.1 small, 0.3 medium, 0.5 large, in absolute value). All statistical tests were based on

two-sided exact significance and with a significance level at least of $\alpha = 0.05$. All analyses were performed using SPSS (ver. 20; IBM Corp., New York, NY, USA).

4. Conclusions

In modern (post-)industrial societies, "knowing your plant(s)" has increasingly become a "sudoskill" that laypeople often outsource to technology (devices and apps), together with the related issues and limitations [196]. A lack of immediate dependence on and/or attachment to certain (plant) species disengages a person's attention and reduces a plant's (positive) valence, especially when only a single use or function is known and/or prevalent. The preservation of cultural value, closer contact, and possession of some knowledge on the variety of services that a species and or an ecosystem provides is crucial for the recognition of its value and eventually its identity. Although the use frequencies and applications of crop plants are higher than those of wild ones, the reduced direct access to diverse characteristics limits identification skills. Further research on the effects of socioeconomic and cultural factors involving larger samples is needed, especially in countries where communities have undergone major political changes. The maintenance and promotion of a rich pool of varieties and landraces are vital both for the preservation of agrobiodiversity and the valuable cultural heritage that is under constant pressure from homogenization in the modern world. The halting of biodiversity loss and the restoration of ecosystems, aims of the United Nations in the current decade (until 2030), require a careful tailoring of measures that would enable more people to join proactively [197]. While conservation efforts are steered by international and national policies, the involvement and skills of the general public ensure the steady interest that would guarantee their implementation on the ground. Attaching diverse meanings and upholding local cultural values would prevent the commodification of resources and serve as a stepping stone to the development of more responsible attitudes toward nature awareness disparity [198]. As the effects of education and learning policies can be properly assessed only after several decades, it is important to urge policy makers and other stakeholders to adopt the most inclusive approaches to environmental knowledge. This will make it more accessible to the largest possible audience of any socioeconomic and cultural background.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/plants12152771/s1, Supplementary File S1: Online questionnaire (English translation).

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Different Ecological Niches of Poisonous *Aristolochia clematitis* in Central and Marginal Distribution Ranges—Another Contribution to a Better Understanding of Balkan Endemic Nephropathy

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Abstract: *Aristolochia clematitis* L. is a perennial herbaceous plant distributed throughout Europe, Asia Minor and Caucasus. It has been used as a medicinal plant since antiquity but not in recent times because it contains poisonous aristolochic acid, causing progressive kidney failure. The aim of this work was to study *Aristolochia clematitis* ecology on the basis of vegetation plots from the European Vegetation Archive, and to investigate the differentiation of its ecological niche using a co-occurrence-based measure of ecological specialization (ESI). The ecological niche was studied on three spatial scales: on the entire distribution area, its differentiation across 200 × 200 km grid cells and the differences between three central and three marginal regions. Our results suggest that *Aristolochia clematitis* has a very broad ecological niche occurring in a range of different habitats and climatic conditions, with a trend of a niche width decrease with the distance from the geographical center. The plant prefers more stable communities with less anthropogenic influence moving towards the margin of the distribution area. Specialization towards the marginal area is a result of evolutionary history, which refers to the recent anthropogenically induced spread from its original home range. A high incidence of *Aristolochia clematitis* in the vegetation of arable lands and market gardens as well as anthropogenic herbaceous vegetation in the distribution center corresponds to the geographical incidence of Balkan Endemic Nephropathy.

Keywords: poisonous plant; niche width; ethnoecology; environmental conditions; vegetation plots; ecological specialization index; traditional agroecology praxis

1. Introduction

The concept of a niche in ecology refers to the specific role and position that a species holds within its ecosystem and can be defined as the position and breadth of a species' distribution along various niche axes [1]. Niche theory assumes that a species has a fundamental niche [2] or physiological niche [3] in relation to some environmental gradient and in the absence of competitors. In the presence of competitors, the species niche is reduced to a realized or ecological niche. The impacts of competitors reduce the width of the realized niche and may shift its position [2,3].

The ecological response of organisms to different environmental factors varies across a species' geographical range. This variation may be the result of local adaptation to environmental conditions and may influence both fundamental and realized niche differentiation across the species' geographical range. The differentiation of the realized niche within the same global fundamental niche is the result of processes, such as variation in biotic interactions in different parts of the species' geographical range (e.g., facilitation, competitive displacement), habitat compensation processes (e.g., compensation of ecophysiological stress where species compensates the deterioration of physiological living conditions at the edge of their range by a change in the niche position) or species' dispersal limitation [4–8].

Usually, two parameters are used to describe the differentiation of the ecological niche within the geographical range of the species niche width (range of environmental conditions where it occurs) and niche position (ecological optimum or species' maximum probability of presence within its realized niche). There is a wide range of metrics for the estimation of species' niche width [9], all having their advantages and disadvantages. In the classic approach, the niche width is determined as the range of values along each of the particular environmental gradients that a species is able to utilize [10,11]. A species can have very narrow ecological niches on one particular measured gradient (specialists) but wider niches on some other (generalist) [12]. There is also an alternative approach, used in this study, which quantifies the species niche width using indirect estimations of the diversity of habitats in which the species occurs. Fridley et al. [13] introduced a method based on a principle that the niche width of a species corresponds to the pattern of its co-occurrence with other species. Habitat specialists occur in different localities with the same group of species, indicating that different localities are likely to be ecologically similar. Habitat generalists co-occur with a wide range of species across localities, indicating that these localities are ecologically heterogeneous. In this way, it is possible to measure species specialization without data about environmental factors at sites where the species are recorded, but it takes into consideration many environmental factors. Based on the original method of Fridley et al. [13], some methodological modifications were proposed [14–16], and many studies have applied this approach for a broad range of research questions [6,11,17,18]. Finally, inspired by the original method of Fridley et al. [13], Zelený and Chytrý [19] introduced the Ecological Specialization Index (ESI) as a measure of differences in species composition among samples containing the focal species using multiplicative beta diversity.

Aristolochia clematitis L. (*Aristolochiaceae*) is a perennial herbaceous plant that can grow up to 1 m. It often propagates vegetatively, through fragile rhizomes. The original area of distribution probably includes Southern Europe, Asia Minor and the Caucasus, and it secondarily spread to Central and Eastern Europe. It had probably already begun to spread significantly in the Middle Ages, both as a weed (especially in vineyards) and as a result of cultivation for medical purposes [20,21]. *A. clematitis* usually grows in warm, sunlit places, with nutrient-rich soils, in light floodplain forests, on the banks of watercourses, on embankments, wastelands, scrubby slopes, in vineyards and beside road and

railway embankments [20,21]. It is considered as a diagnostic species for riparian gallery forests (*Alno glutinosae-Populetea albae*) and tall-herb semi-natural perennial vegetation on disturbed forest edges, nutrient-rich riparian fringes and in forest clearings (*Epilobietea angustifolii*) [22].

Aristolochia clematitis has been used as a medicinal plant since antiquity, but today, it is forbidden for medical use due to its content of aristolochic acid, formally classified as a human carcinogen [23]. Balkan Endemic Nephropathy (BEN) is a chronic kidney disease associated with urothelial carcinomas that affects residents of rural farming villages located along tributaries of the Danube River in Bosnia and Herzegovina, Bulgaria, Croatia, Romania and Serbia [24–26]. Fifty years ago, Ivić proposed a role for chronic *Aristolochia* poisoning in the etiology of BEN [27]. He observed that seeds from these plants, which grew abundantly in local wheat fields, were mixed with wheat grain during the harvesting process. In a study, which included farmers who lived in 54 different villages in Bosnia, Croatia and Serbia, 86.4% of subjects with BEN reported that they had observed *Aristolochia clematitis* in wheat fields 20–30 years ago [28]. Research projects conducted in Croatia definitively confirmed that aristolochic acid is the most important risk factor and causative agent for BEN [26,29,30].

An important feature of BEN is focal, mosaic distribution. It has been reported in restricted areas in Balkan countries, and, even in these focal areas, not all villages were affected. It is questioned whether differences in the incidence of BEN could be explained with the species geographical range and with the ecological niche of *Aristolochia clematitis*.

Understanding the patterns of ecological niche differentiation and their underlying mechanisms is essential for understanding species' abundance and distribution patterns from the past, as well as for predicting their responses to environmental changes [31,32]. The differentiation of the realized niche is dominantly focused on restricted geographical extents, comparing central and peripheral populations [31,33], while there are not many studies of its differentiation along the geographical range of the species [5,6]. *Aristolochia clematitis* is a suitable target species for the study of ecological niche differentiation because it occurs over a large geographical area in very different habitats. Taking into account the insufficient knowledge of the species ecology, its past and present distribution, as well as its great importance as a cause of BEN, the aim of this work is to study the ecology of that species in more detail on the basis of vegetation plots from the European Vegetation Archive, and to investigate the width of the ecological niche and its differentiation on the entire area of the species distribution, using a co-occurrence-based measure of ecological specialization (ESI).

2. Materials and Methods

In order to investigate the ecological niche of *A. clematitis*, georeferenced vegetation plots from the European Vegetation Archive were used. Ecological conditions are described for each plot using several parameters: bioclimatic variables, habitat type, vegetation type, ecological indicator values and disturbance indicator values. The analysis was performed in three steps: (i) description of the ecological niche using the above indicators in the entire studied area, (ii) exploration of the ecological niche differentiation using the Ecological Specialization Index (ESI), and (iii) description of the differences in the ecological niche between the margin and center of the distribution area.

2.1. Vegetation Plots

The initial dataset consisted of 3239 vegetation plots (relevés) with the occurrence of *A. clematitis* from the European Vegetation Archive (EVA; [34], data exported on 9 November 2022). We removed records of non-vascular plants and merged the same species in different vegetation layers to ensure that each species occurred only once in each plot.

The database was geographically stratified to reduce oversampling of similar habitats within some regions [35]. Stratification was performed by assigning the plots to grid cells of approximately 200 km × 200 km that were subsequently used for the analysis. Grid cells

were based on Universal Transverse Mercator (UTM) grid system derivative, i.e., Military Grid Reference System (MGRS) with a square side length of 100 km. We performed merging of four adjacent 100 km squares to obtain 200 km × 200 km squares. Squares that were, prior to the merging, adjacent to a UTM Grid Zone Junction and, therefore, clipped were merged with the next full 100 km square with the same Grid Zone Designator. The same was carried out in the case when MGRS 100 km square crossed a latitude band boundary. Such spatial resolution, although coarse, accounts for poorly sampled areas in our dataset since a small number of plots cannot properly represent the habitat diversity of a particular area.

Within each MGRS grid square, we calculated Bray–Curtis dissimilarity among all pairs of plots (using log-transformed percentage covers in species composition data) and applied heterogeneity-constrained random (HCR) resampling procedure to resample the optimal subset of plots retaining maximum mean pairwise dissimilarity among selected plots [36]. Since each MGRS square may contain plots belonging to a wide range of habitats, we accepted recommendation of Wiser and De Cáceres [37], that more plots are selected from squares that have higher compositional heterogeneity. The minimum and maximum number of selected plots was 5 and 20, respectively. The resulting dataset, called the 'whole dataset' throughout this study, contains 851 vegetation plots and 2168 species (Figure 1, Table S1). This dataset is used for the description of the whole ecological niche, without considering niche differentiation.

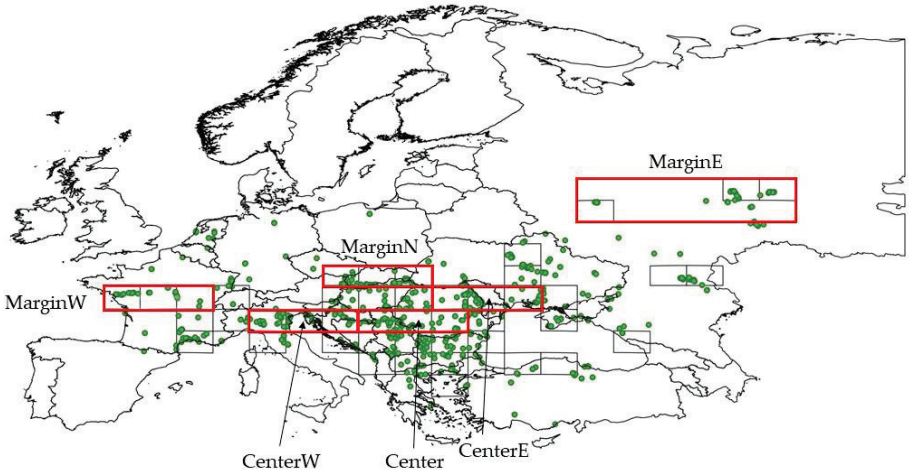

Figure 1. Localities of the plots after resampling (whole dataset, green dots), MGRS200 squares and regions used for calculating differences between central and marginal distribution range (bold rectangles).

2.2. Ecological Specialization Index and Niche Differentiation

Ecological Specialization Index (ESI) of *A. clematitis* was calculated for each of the MGRS grid cells following procedure of Zelený and Chytrý [19]. All calculations were performed in the R program (R Core Team 2017) using 'theta' library (https://github.com/zdealveindy/theta, accessed on 15 February 2023). As this procedure implies at least 10 occurrences of a given species per stratum. ESI was calculated only for 45 MGRS grid cells with at least 10 plots, which remained after HCR resampling (Figure 1). The final dataset for the analysis of niche differentiation contains 718 vegetation plots and 1918 species.

To study the difference between the central and marginal parts of species range in more detail, six regions were chosen (three in marginal and three in central area). In each region, three MGRS grid cells were merged in longitudinal direction (Figure 1).

2.3. Data for Niche Description

All plots were classified based on their species composition and species cover into EUNIS habitat types (European Nature Information System, 3rd hierarchical level) using the EUNIS-ESy expert system v. 2024-06-01 [38]. To avoid a large number of outliers as well as to obtain a clearer pattern, plots were merged into a smaller number of broader units (1st and 2nd level). Furthermore, plots were classified into vegetation classes using EuroVegChecklist expert system [22].

To describe macroclimatic gradients, each plot was characterized based on its geographical coordinates using 19 bioclimatic variables obtained from Chelsa v2.1 [39]. To quantify environmental factors on the micro scale, we used Ellenberg-type indicator values for light, temperature, moisture, reaction and nutrients [40]. Disturbance indicator values were used to estimate anthropogenic impact on studied vegetation types [41]. Four main continuous indicators were used: disturbance severity (mean magnitude of disturbance events—proportion of aboveground biomass killed by disturbance), soil disturbance (proportional increase in cover of bare ground by furrowing or soil turning), mowing frequency (mean frequency of cutting of plant biomass) and grazing pressure (severity of grazing—proportion of aboveground biomass killed by grazing). Unweighted mean Ellenberg-type and disturbance indicator values were calculated for each plot using JUICE v7.1 software [42].

Geographical center of all analyzed vegetation plots was calculated using 'Mean coordinate(s)' algorithm, while distance of the centroid of each MGRS grid square from the geographical center was calculated using 'Distance matrix' algorithm, both in QGIS v3.28 software.

2.4. Statistical Analysis

Descriptive statistical parameters and box-and-whiskers diagrams were used to describe the ecological niche and differences between regions. The significance of differences in ESI values as well in number of habitats and vegetation classes between central and marginal MGRS200 cells was tested using nonparametric Mann–Whitney U test ($p < 0.01$). The significance of differences in Ellenberg-type and disturbance indicator values between central and marginal MGRS200 cells was tested using nonparametric Kruskal–Wallis H test and multiple comparisons of mean ranks ($p < 0.05$).

Relationships between ESI and distances of MGRS200 centroids from the geographic center were explored using Pearson's r correlation coefficient ($p < 0.001$). Median values of all environmental variables in each MGRS200 square as well as percentage of EUNIS habitat types and vegetation classes were calculated. ESI was related to these medians as well as to niche width for each environmental gradient using Spearman correlations ($p < 0.01$). Niche width for each environmental gradient was estimated using quartile range of these variables in MGRS200 squares. All these calculations were performed in Statistica v14.0 software (TIBCO Software Inc., Palo Alto, CA, USA, 2020).

To explore the main patterns in the species composition of the vegetation plots in central and marginal regions as well as their relationship with environmental gradients, a detrended correspondence analysis (DCA) was used. DCA with passive projection of environmental variables and EUNIS habitat types was performed using the R package 'vegan' (https://cran.r-project.org/web/packages/vegan, accessed on 15 February 2023), operated through the JUICE v7.1 software [42].

3. Results

3.1. Characteristics of Ecological Niche in the Whole Studied Area

A. clematitis occurs in a wide range of climatic conditions, with a mean annual air temperature range between 0.8 and 18.1 °C and annual precipitation range between 276 and 2234 kg m^{-2} (Table S2). It prefers moderately warm habitats and appears in a wide range of soil moistures and nutrients (Figure S1). Such a wide ecological niche is confirmed by the large number of habitats (53 EUNIS habitat types, level 3) as well as the large

number of vegetation classes in which the species occurs (26 classes). Generally, it most often appears in riparian forests and on the edges and clearings next to these forests. It also very often occurs as a part of anthropogenic herbaceous vegetation. Although it is more often associated with moist or wet habitats, it can also be found in dry habitats, such as semi-dry and dry grasslands (Figure S2).

3.2. Differentiation of the Ecological Niche

A significant difference in ESI among the MGRS200 cells was determined, ranging from 1.88 to 6.59. The ESI pattern is quite heterogeneous across the distribution area, but a significant relationship is generally observed between the distance of the MGRS200 centroid from the geographic center and the ESI (Figure 2). In other words, there are considerable differences even between neighboring MGRS200 cells, but generally, *A. clematitis* is more specialized in squares that are further from the geographic center (Figure 3).

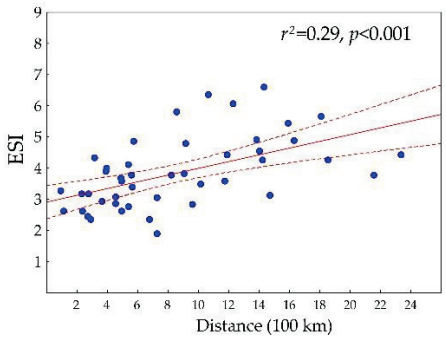

Figure 2. Relationships between distances of MGRS200 centroids from the geographic center and Ecological Specialization Indices (ESI).

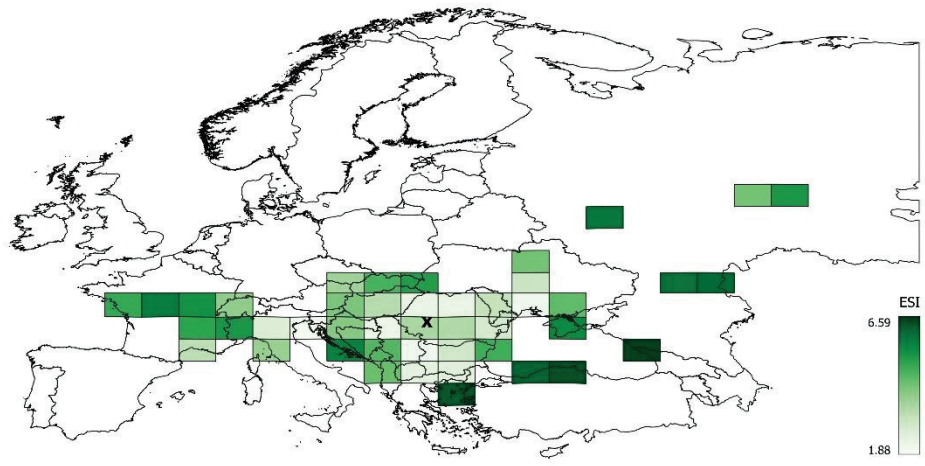

Figure 3. ESI values in studied MGRS200 cells. Letter x indicates geographical center of all analyzed vegetation plots.

MGRS200 cells where *A. clematitis* is more specialized (higher ESI) have lower ecological optimums for light and soil reaction. The relationships between ESI and the average disturbance regime on individual MGRS200 cells are even more significant; a higher ESI (narrower ecological niche) is related to a lower disturbance frequency and lower soil disturbance (Figure 3 and Figure S3). In MGRS200 cells where *A. clematitis* is more specialized (higher ESI), it occurs more often in forest habitats and less often in man-made habitats (Table 1, Figure 3 and Figure S3).

Table 1. Spearman correlations between ESI and medians and quartile ranges of variables describing ecological niche of *Aristolochia clematitis*. Only significant correlations are presented ($p < 0.05$).

Variable	Spearman R Between	
	ESI and Median	ESI and Quartile Range
Light	−0.35	-
Moisture	-	−0.48
Reaction	−0.33	-
Disturbance Severity	-	−0.49
Disturbance Frequency	−0.46	−0.50
Mowing Frequency	-	−0.45
Soil Disturbance	−0.38	−0.43
Perecentage of forest habitats	0.45	NA
Perecentage of man-made habitats	−0.41	NA

It is evident that ESI is significantly related to the width of the gradient for habitat moisture and all types of disturbance, indicating that the reduction in ESI is associated with a wider ecological niche for moisture and disturbance (Table 1).

3.3. Differences between Margin and Centre of the Distribution Area

In the studied marginal regions, *A. clematitis* is significantly more specialized ($p < 0.001$). The MGRS200 cells belonging to marginal regions had ESI values from 3.4 to 4.9 (mean 4.3), and those belonging to the central regions from 1.8 to 3.8 (mean 2.9). This is also clearly visible from the number of habitats and vegetation classes. In central regions, *A. clematitis* occurs in a greater number of EUNIS level 3 habitats ($p = 0.045$) and vegetation classes ($p = 0.029$) compared to marginal ones.

A. clematitis in peripheral regions occurs more often in forest habitats ($p = 0.003$, Figures 4 and 5), so the ecological optimum on the light gradient is shifted towards lower values (Figure 6). In the central regions, the overall ecological niche is wider, primarily because *A. clematitis* occurs more often in anthropogenic habitats there (Figures 4 and 5), so the ecological optimum is shifted towards a higher disturbance frequency and stronger soil disturbance (Figure 7). This mostly refers to the greater representation of arable lands and market gardens (such as communities of Papaveretea rhoeadis and Digitario sanguinalis-Eragrostietea minoris) as well as annual anthropogenic herbaceous vegetation (such as communities of Sisymbrietea).

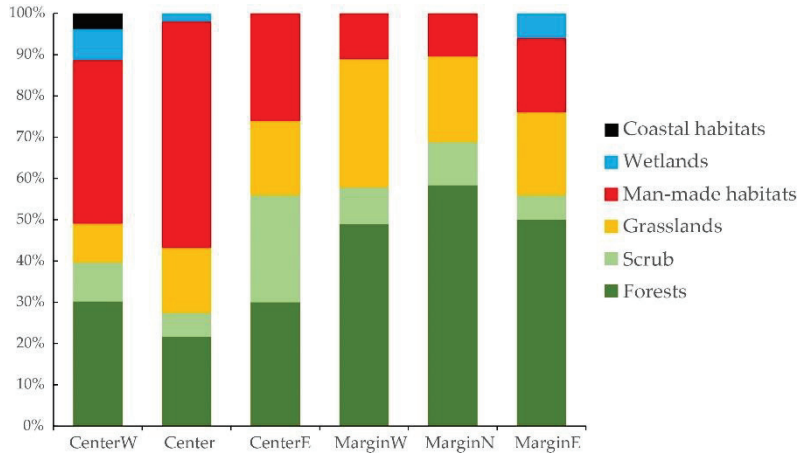

Figure 4. Percentage of particular habitat types (EUNIS level 1) in marginal and central regions.

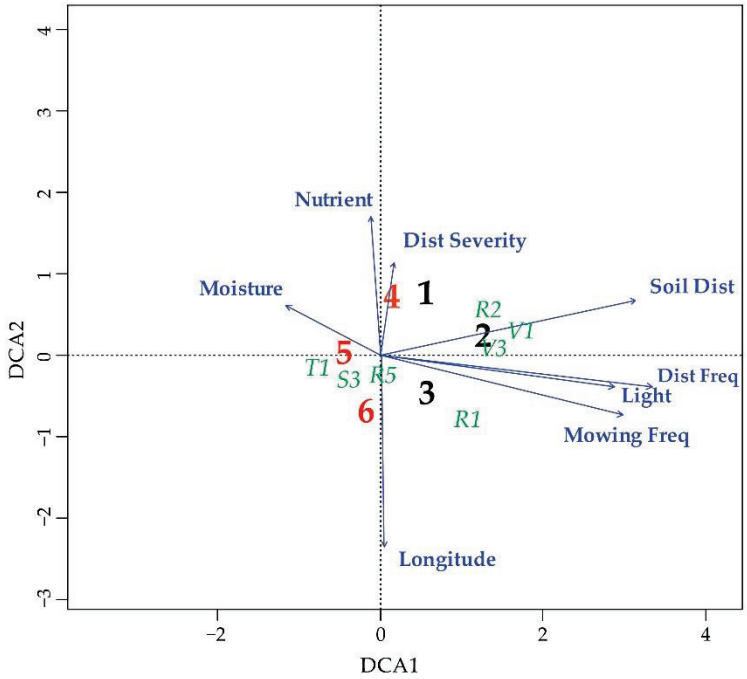

Figure 5. DCA ordination of the vegetation plots classified into three marginal and three central regions. Bolded red and black numbers correspond to centroids of all plots in particular region: 1—CenterW, 2—Center, 3—CenterE, 4—MarginW, 5—MarginN, 6—MarginE. Black numbers indicate central regions and red numbers indicate marginal regions. Mean Ellenberg indicator values and disturbance indicator values (bolded blue labels) as well EUNIS habitat types (green labels in italic) are passively projected. V1—arable land and market gardens, V3—artificial grasslands and herb-dominated habitats, T1—broadleaved deciduous forests, S3—temperate and Mediterranean-montane scrub, R1—dry grasslands, R2—seasonally wet and wet grasslands, R5—woodland fringes and clearings.

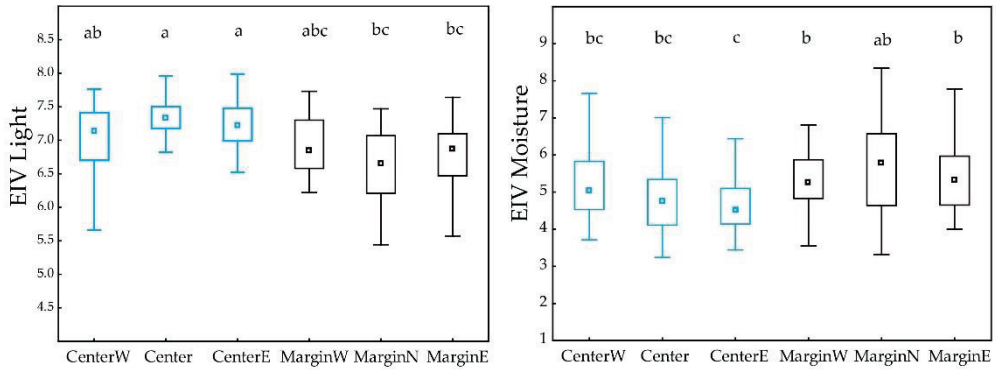

Figure 6. Differences in Ellenberg indicator values for light and moisture among marginal and central regions. Boxes show the 25–75% quartile range and the median value; whiskers indicate the range of values. Small letters indicate significant differences ($p < 0.05$).

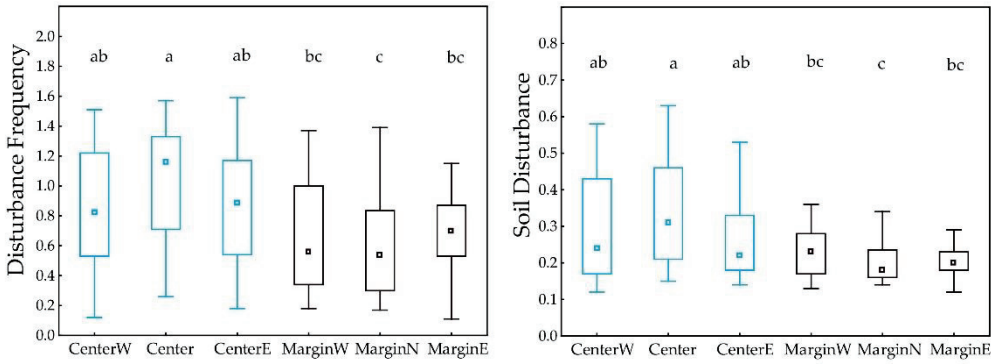

Figure 7. Differences in disturbance indicator values among marginal and central regions. Boxes show the 25–75% quartile range and the median value; whiskers indicate the range of values. Small letters indicate significant differences ($p < 0.05$).

4. Discussion

Our results suggest that *A. clematitis* generally has a very broad climatic niche, avoiding only the most xerothermal Mediterranean and northern hemiboreal and boreal climates (Table S2). This is somewhat unusual considering that the species originally spread in warmer areas south of the Alps and is an indication that it has successfully adapted to very different climates. In this climatically very different area, it occurs in a range of different habitats, from swamps and grasslands, riparian and mesic forests to arable lands, which is in accordance with the existing literature [20,21]. Regardless of its generally wide niche, there is a visible difference in the width of the ecological niche on different environmental gradients. Thus, for example, it occurs in a much wider range of soil moisture and nutrient values compared to the other studied gradients (Figure 6). It is very common that the niche width varies along different gradients, so on some, the species behaves as a specialist and on others as a generalist.

Our results also suggest that the realized niche space occupied by *A. clematitis* varies across distribution ranges, with a clear trend for niche width to decrease with distance from the geographic center (Figures 2 and 3). It has often been hypothesized that species on their distribution margin have narrower ecological niches than in the center [43], but the pattern is much more complex in different species, and there is probably no general rule [5,6], mostly because, in many species, geographic, environmental and historical centrality and marginality do not overlap [44,45]. Specialization towards the edge of the distribution area in *A. clematitis* is a result of its evolutionary history, which refers to recent anthropogenically induced spread from its home range. In the new regions, it is still not adapted to dramatically different climatic conditions. Šilc et al. [17] presented very similar findings comparing weed species' ecological niche on north–south gradients. The character and degree of differences between populations close to the species' range limits and those in the central part of their distribution are some of the fundamental questions in ecology [45]. The 'Centre-periphery' hypothesis is a common hypothesis explaining patterns of these differences. It states that genetic variability, individual fitness and population demography of a species decrease from the center to the edge of its geographic range [43], and this could lead to "ecological marginality" [45] and a reduced ecological amplitude or niche width [46].

Through this descriptive study, we cannot fully discriminate the reasons underlying the patterns of niche variation between central and peripheral populations because variation may be associated with a range of factors. According to Zelený and Chytrý [19], calculated ESI values are estimates of the realized niche width resulting from the interaction of three factors: (i) species fundamental niche, (ii) availability of suitable habitats for the focal species in the study area, and (iii) biotic interactions with other species.

4.1. Fundamental Niche

The species' fundamental niche is defined by its physiological constitution created during evolution and can be changed through local adaptation to new environmental conditions. However, in our case, the marginal populations of *A. clematitis* spread to a new area relatively recently, and, probably, no significant local adaptation occurred.

4.2. Availability of Suitable Habitats

Our analyses show that there is an ecological shift in marginal populations that occurs to a much lesser extent in dry, open anthropogenic habitats (Figures 6 and 7). In this way, they have both a narrower ecological niche on the gradients of light and moisture and a shift in the ecological optimum towards wetter and less open habitats (Table 1, Figure 6). They also have a narrower ecological niche for disturbance, as well as a shift in the ecological optimum towards a lower disturbance frequency and a lower soil disturbance (Table 1, Figure 7). Šilc et al. [17] also found that weed species that evolutionarily adapted to disturbed and warm sites in the south have narrower ecological niches in northern areas, although the level of agricultural disturbance along the gradient is similar. However, in their case, the species towards the range margin maintained a weed strategy and specialized in locally warmer and drier habitats, as a response to changed macroclimatic conditions. In our case, *A. clematitis* specialized to habitats with less anthropogenic pressure. Other environmental factors seem to have a smaller impact, although this specialization in itself led to an ecological shift towards wetter and darker habitats.

We consider that the availability of anthropogenic habitats in marginal areas did not significantly affect the ecological niche shift. Specifically, all types of anthropogenic habitats where *A. clematitis* occurs are available, both in the marginal and central parts of the distribution area [38], as well as most of the corresponding vegetation alliances [47]. However, although it probably spread to new areas anthropogenically [20,21], for some reason, it prefers more stable communities with less anthropogenic influence in these climatically different areas. In fact, this pattern is in accordance with the general rule that specialists occur in more stable environments [48], so towards range margins, it stays in more stable communities such as forests (Table 1, Figures S3 and S4). Such regional differences in the ecological niche may result from time-lagged range expansion from the Middle Ages and disequilibrium with the current climate in the new area [7].

It seems that, in the past, under favorable conditions, in the center of present distribution, the species became more competitive and expanded its ecological niche to various anthropogenic habitats. It is possible that these conditions during the Neolithic, when the climate became warmer and drier, combined with the spread of agriculture, stimulated many of today's weed species that were originally specialists in other habitats (e.g., forests, shrublands) to spread into anthropogenic habitats and become generalists [17]. Suitable climatic conditions combined with the rapid expansion and spread of human-modified habitats provided opportunities for plant species to expand their ecological niche [49]. Similarly, current global climate change could stimulate *A. clematitis* in marginal areas to expand its ecological niche towards different anthropogenic habitats.

4.3. Biotic Interactions

Biotic interactions, such as competition or facilitation, are important determinants of a species' realized niche, although they are difficult to measure directly. Biotic interactions depend on the composition of the regional species pool, namely the presence or absence of competitors that would narrow the realized niche or facilitators that would broaden it [50]. In the north, there is a smaller weed species pool but a larger number of weed species per plot [17,51], so it is possible that strong competition of weed species excludes *A. clematitis* from such habitats, reducing its ecological niche at the marginal part of the distribution area.

Furthermore, in areas with high regional (gamma) diversity (e.g., Southern France, Balkans), *A. clematitis* has a wider ecological niche compared to areas in the north (Figure 2)

where regional diversity is lower. It is not in accordance with the theory, which claims that the restriction of a species' realized-niche width through competition increases with regional diversity [52]. However, this is consistent with the findings of Manthey et al. [53] who showed that there was no such effect of the size of the species pool (species competition) on the restriction of the species' realized niche width and that plant species are more constrained by environmental conditions than by competition.

4.4. Methodology Strengths and Weaknesses

The method we used to quantify the ecological niche of *A. clematitis* critically depends on the quality and quantity of data in the source dataset and their geographical distribution. It means that ESI as well as other calculated parameters may be negatively affected by sampling bias. If samples from some habitats are underrepresented in the dataset, then some species with a broad niche may appear as more specialized [19]. Also, the results can be scale-specific because they depend on the size of the window in which the niche parameters are calculated. The applied ESI calculation methodology was designed to minimize sampling bias, and the same trend in the obtained results in both niche width and optimum shift on two spatial scales shows that the results are reliable (cf. Table 1, Figures 3–5). In addition, the areas of Europe that are best covered by vegetation plots have higher ESI than others that are less covered (cf. Figure 2) [34]. Moreover, co-occurrence-based metrics are used to estimate potential shifts in species' realized niche, taking into account many environmental gradients and incorporating not only the abiotic but also the biotic dimensions (species competition) [13,34].

In considering the differences between the margin and center of the range, the focus is on the western, northern and eastern edges but not the southern. The southern margin of the species' range differs from the others for several reasons. The southern margin is sharper because it is geographically bound by the Mediterranean region. The Mediterranean climate is an obstacle to the spread of this species in the south. In addition, *A. clematitis* was present on the southern margin before it spread northward, probably as early as the Middle Ages [20,21]. Moreover, a limiting factor for the analysis of the southern margin is the low number and density of available plots from Central and Southern Italy, the south of the Balkan Peninsula and Turkey, which could also be due to the sporadic occurrence of the species. Considering these facts, it is very difficult to determine the southern margin of the species' range. For this reason, it is necessary to study the ecology of *A. clematitis* at the southern edge with more field data.

4.5. Balkan Endemic Nephropathy

It is interesting that the geographical incidence of BEN largely corresponds to the geographical center of the distribution of *A. clematitis* [24–26]. Although our results show that the plot abundance of this species is not higher in the Balkans, an important finding is that, here, it occurs more often in man-made habitats, especially in the vegetation of arable lands and market gardens as well as anthropogenic herbaceous vegetation on the edge of agricultural fields (Figure 6 and Figure S3). Obviously, this ecological behavior allowed *A. clematitis* to come into contact with various crops, and, thus, the disease manifested itself more significantly here. Our results indicate that similar conditions appear in the north of Italy [54] and south of Ukraine (Figure 3 and Figure S3). However, contrary to Balkan countries, a higher incidence of chronic kidney disease and/or urothelial cancers was never reported from those regions. It would be interesting to investigate whether, in these regions, different harvesting and milling procedures disabled the commingling of *A. clematitis* seeds with wheat seeds. It is also possible that both in Italy and Ukraine, no one connected either chronic kidney disease or urothelial cancers with exposure to aristolochic acid. In such research, it should be taken into account that improved harvesting and milling technologies in Balkan countries have eliminated the contamination of wheat grain with *A. clematitis* seeds, thus decreasing exposure to aristolochic acid in home-baked bread and the subsequent development of BEN. In addition, nowadays, farmers purchase, for home

consumption, flour and bread that is not contaminated with *A. clematitis* seeds. All these changes consequently resulted in a reduction in the prevalence of BEN. Even more, BEN completely disappeared in some former endemic villages [55].

5. Conclusions

Our results suggest that *A. clematitis* has a very broad ecological niche occurring in a range of different habitats and climatic conditions, with a trend of niche width decrease with the distance from the geographical center of the present distribution. The plant prefers more stable communities with less anthropogenic influence moving towards the margin of the distribution area. Specialization towards the marginal area is a result of the evolutionary history, which refers to recent anthropogenically induced spread from its original home range.

The high incidence of the species in the vegetation of arable lands and market gardens as well as anthropogenic herbaceous vegetation in the distribution center corresponds to the geographical incidence of BEN. The results of this research offer a significant contribution for understanding how the spatial distribution and ecological niche of *A. clematitis* were related to such a devastating disease as BEN. It also demonstrates how a multidisciplinary approach is needed for a complete understanding of environmental diseases.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/plants12173022/s1, Figure S1: Ellenberg-type indicator values for the whole ecological niche of *Aristolochia clematitis* calculated on a whole dataset; Figure S2. Percentage of EUNIS habitat types and vegetation classes in the whole dataset; Figure S3: Medians of environmental variables across MGRS cells; Figure S4: Ellenberg-type and disturbance indicator values of the vegetation plots classified into three marginal and three central regions. Table S1: Contributing vegetation plot databases with Global Index Vegetation plot Databases codes, names and number of their plots included in the final stratified and resampled dataset; Table S2. Descriptive statistics for the bioclimatic variables calculated on a whole dataset.

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