land

MDPI

Article

What Drives Herbal Traditions? The Influence of Ecology and Cultural Exchanges on Wild Plant Teas in the Balkan Mountains

Mousaab Alrhmoun [1,2,*], Naji Sulaiman [1] and Andrea Pieroni [1,3]

[1] University of Gastronomic Sciences, Piazza Vittorio Emanuele II 9, 12042 Pollenzo, Italy; n.sulaiman@unisg.it (N.S.); a.pieroni@unisg.it (A.P.)
[2] Faculty of Agricultural, Environmental and Food Sciences, Free University of Bolzano, Piazza Università 5, 39100 Bolzano, Italy
[3] Department of Medical Analysis, Tishk International University, Erbil 4001, Iraq
* Correspondence: m.alrhmoun@unisg.it

Abstract: This study investigates the ethnobotanical diversity of wild plant teas across various populations in the Balkan mountain regions, focusing on cultural and ecological influences. Data were collected through ethnobotanical field surveys conducted in thirteen distinct areas, encompassing approximately 900 interviews with local populations, including Albanians, Bosniaks, North Macedonians, Goranis, and Serbs. The study identifies 143 genera used in traditional teas, with species frequency and distribution patterns analysed concerning elevation and cultural factors. Statistical analyses using Principal Component Analysis (PCA) and Cluster Analysis revealed clear grouping patterns between populations based on ecological zones. The results show a clear correlation between altitude and the herbal use of plant genera, with higher elevations (above 700 m) supporting a greater variety of local species. Cultural practices, such as tea consumption during communal gatherings, also significantly shaped the selection of plants across different populations. For instance, *Sideritis* species were most prevalent among Albanian and North Macedonian communities, while *Thymus* and *Mentha* species were widely used across all groups. Moreover, cultural exchanges can explain the similarity of wild teas reported by Bosniaks (in Bosnia) and North Albanians, located far away from each other but showing similar traits due to possible common origins or the effect of centuries of pastoralism, which may have generated a constant exchange of local plant practices. The study concludes that ecological conditions and cultural exchanges significantly influence the choice, use, and resilience of wild plant herbal traditions in the Balkans. However, modern pressures such as urbanisation and market-driven consumption are increasingly threatening these practices. This highlights the need for conservation strategies that integrate ecological preservation and cultural heritage safeguarding.

Keywords: Balkans; cultural exchanges; ecology; ethnobotany; herbal teas; wild plants

check for updates

Citation: Alrhmoun, M.; Sulaiman, N.; Pieroni, A. What Drives Herbal Traditions? The Influence of Ecology and Cultural Exchanges on Wild Plant Teas in the Balkan Mountains. *Land* **2024**, *13*, 2146. https://doi.org/10.3390/land13122146

Academic Editor: Eusebio Cano Carmona

Received: 14 November 2024
Revised: 2 December 2024
Accepted: 2 December 2024
Published: 10 December 2024

1. Introduction

The Western Balkan mountain regions, encompassing countries such as Albania, Montenegro, Kosovo, North Macedonia, Serbia, and Bosnia and Herzegovina, are celebrated for their exceptional ecological diversity and cultural richness, especially in traditional plant uses, having been so for at least two centuries [1,2]. These high-altitude ecosystems, characterised by elevations ranging from 700 to over 1700 m above sea level, support a unique assemblage of flora adapted to the region's varied climatic and edaphic conditions [2,3], which have played and still play a central role in local communities' cultural and traditional practices [1,2].

Among the diverse traditional practices observed in these mountainous areas, the preparation and consumption of herbal teas from wild plants stand out as a significant cultural and medicinal tradition [4,5]. These homemade herbal teas are derived from various wild plant species, each offering distinctive therapeutic and nutritional properties [2,4,5]. Understanding these ecological interactions is crucial for assessing the resilience and adaptability of these plant species, which are essential for sustaining both biodiversity and traditional practices [4,5]. The study of these plants offers insights into how they have evolved to thrive in their environments and how their uses reflect the ecological dynamics of the region.

From an ethnobotanical perspective, transmitting knowledge related to collecting, preparing, and utilising wild plants for tea is a crucial aspect of cultural heritage [6–8]. This traditional knowledge encompasses the practical aspects of plant use and the cultural values and beliefs associated with these practices. It provides a lens through which to explore how local communities interact with their environment, manage natural resources sustainably, and maintain cultural continuity [2,9].

Moreover, integrating traditional knowledge with contemporary ecological and conservation practices is essential to address modern environmental and socio-economic challenges [2,10,11]. As traditional practices face pressures from global change and modernisation, understanding and preserving these practices become crucial for maintaining biodiversity and cultural heritage [3,12]. The conservation of traditional knowledge and practices, alongside ecological conservation efforts, can contribute to more holistic and sustainable approaches to managing natural resources.

This study explores the intersection of ecology and ethnobotany by examining a large dataset of traditional uses of wild plant teas in Balkan mountain ecosystems and evaluating commonalities and differences.

2. Materials and Methodology

2.1. Study Area and Data Collection

The ethnobotanical data for this study were gathered through face-to-face interviews conducted between 2002 and 2017 across various regions in the Western Balkans. The focus was on high-altitude areas in Albania, Kosovo, Bosnia and Herzegovina, Serbia, and North Macedonia, with elevations ranging from approximately 500 to 1700 m above sea level (Figure 1). These regions were chosen for their ecological and cultural importance, particularly for communities that preserve traditional knowledge of wild plant use for herbal tea preparation.

Figure 1. *Cont.*

Figure 1. Locations of the thirteen Western Balkan areas where the ethnobotanical studies were conducted and considered for the comparative analysis (see Table 1).

Data were gathered via interviews conducted in ten distinct locations (Upper Kelmendi, Theth, Albanian Gora, Pešter, the Albanian Alps in Kosovo, the Reka Valley and diverse villages in NW North Macedonia where descendants of Reka Valley inhabitants live, diverse villages of NW North Macedonia, and the Dragash area and Štrpce /Shtërpcë in Kosovo), as well as from the literature review of other two studies (Prokoško Lake in Bosnia, Kopaonik in Serbia [13,14] and from an old survey of medicinal plants used in Sarajevo and surrounding villages in Bosnia by the Austrian dermatologist Leopold Leopold Glück, presumably conducted in the second half of the 19th century and published in 1894 [15].

The elevation range of the study sites varied significantly, from 500 m in North Macedonia to 1700 m at Prokoško Lake in Bosnia and Herzegovina. This diversity in elevation was essential for understanding the ecological factors influencing plant distribution and usage.

A total of 902 interviews were conducted across all regions, with the distribution as follows: 181 interviews in Bosnia and Herzegovina (B1), 207 interviews in Albania (107 in Gora, 50 in Upper Kelmendi, and 50 in Theth), 132 interviews in Kosovo (41 in Dragash and 91 in the Albanian Alps), approximately 100 interviews in Serbia (50 each in two locations, S1 and S2 in Pešter), and 272 interviews in North Macedonia (221 in mixed population areas and 51 in the Reka Valley).

Table 1. Ethnobotanical data on wild plant teas (botanical genera) in the considered Western Balkan sites.

Population	Country	Area	Elevation (m)	Frequency (n)	Percentage (%)	Genera of Wild Plant Teas	Data Collection Year	Reference
Albanians	Kosovo (KS)	Albanian Alps AA	500–700	28	7.22	*Abies, Achillea, Artemisia, Artostaphylus, Centaurium, Crataegus, Equisetum, Fraxinus, Gentiana, Hypericum, Lamium, Malva, Matricaria, Melissa, Mentha, Nepeta, Orchis, Origanum, Primula, Rosa, Rubus, Sempervivum, Taraxacum, Thymus, Tilia, Tussilago, Vaccinium, Verbascum*	2010	[16]
Goranis	Kosovo (KS)	Dragash DR	1000–1500	39	10.05	*Achillea, Alchemilla, Alnus, Althaea, Artostaphylus, Betula, Centaurium, Ceterach, Cornus, Corylus, Crataegus, Cydonia, Equisetum, Euphorbia, Fragaria, Fraxinus, Gentiana, Hypericum, Juglans, Juniperus, Malus, Matricaria, Melissa, Mentha, Origanum, Papaver, Pinus, Primula, Prunus, Rosa, Rubus, Rumex, Sambucus, Sempervivum, Tanacetum, Taraxacum, Teucrium, Vaccinium, Valeriana*	2015	[17]
Goranis and Albanians	Albania (AL)	Gora GO	1200–1400	21	5.41	*Achillea, Artostaphylus, Betula, Centaurium, Cornus, Cynodon, Gentiana, Hypericum, Juniperus, Matricaria, Melissa, Mentha, Nepeta, Orchis, Origanum, Plantago, Sambucus, Taraxacum, Thymus, Trifolium, Vaccinium*	2012	[2]

Table 1. *Cont.*

Population	Country	Area	Elevation (m)	Frequency (n)	Percentage (%)	Genera of Wild Plant Teas	Data Collection Year	Reference
Serbs	Serbia (SR)	Kopaonik KO	800–1000	58	14.95	*Achillea, Agrimonia, Althaea, Artostaphylus, Calendula, Capsella, Carlina, Castanea, Centaurium, Chelidonium, Cichorium, Corylus, Daphne, Echium, Epilobium, Equisetum, Eupatorium, Filipendula, Foeniculum, Fragaria, Glechoma, Hypericum, Inula, Juglans, Juniperus, Leonorus, Malva, Matricaria, Melissa, Melittis, Mentha, Ononis, Origanum, Pastinaca, Pimpinella, Pinus, Plantago, Polygonatum, Potentilla, Primula, Rhamnus, Rosa, Rumex, Ruscus, Solidago, Stachys, Symphytum, Tamus, Teucrium, Thymus, Tilia, Tussilago, Urtica, Vaccinium, Valeriana, Verbascum, Viola, Viscum*	2002–2005	[14]
Bosniaks	Bosnia and Herzegovina (BH)	Sarajevo and its surrounding villages SA	NA	34	8.76	*Achillea, Artemisia, Calendula, Chelidonium, Cornus, Dipsacus, Fraxinus, Hypericum, Inula, Melissa, Mentha, Parietaria, Phyllitis, Pimpinella, Pinus, Primula, Prunus, Quercus, Rosa, Rubus, Salix, Salvia, Sambucus, Satureja, Teucrium, Tussilago, Urtica, Valeriana, Verbascum, Verbena*	Between 1880 and 1890	[15]

Table 1. *Cont.*

Population	Country	Area	Elevation (m)	Frequency (n)	Percentage (%)	Genera of Wild Plant Teas	Data Collection Year	Reference
Albanians, Macedonias, and Goranis	Diverse villages in NW North Macedonia (MK)	NW Macedonia MK	Approximately 500–1300	20	5.15	*Artostaphylus, Centaurium, Crataegus, Dactylorhiza, Epilobium, Hypericum, Juniperus, Matricaria, Mentha, Orchis, Origanum, Plantago, Primula, Rosa, Rubus, Sideritis, Tanacetum, Thymus, Tilia, Vaccinium*	2009	[18]
Serbs and Bosniaks (Albanians)	Serbia (SR)	Pešter PE	1100–1200	32	8.25	*Achillea, Arctium, Betula, Calendula, Carum, Castanea, Chelidonium, Cirsium, Corylus, Crataegus, Fragaria, Gentiana, Hypericum, Inula, Juniperus, Leucanthemum, Matricaria, Melissa, Mentha, Nepeta, Ononis, Origanum, Plantago, Ribes, Rosa, Rubus, Sambucus, Taraxacum, Thymus, Tilia, Tussilago, Urtica*	2010	[19]
Bosniaks	Bosnia and Herzegovina (BH)	Prokoško Lake PL	1700	23	5.93	*Achillea, Aesculus, Agrimonia, Allium, Arnica, Artemisia, Centaurium, Cetraria, Euphrasia, Frangula, Geum, Hypericum, Matricaria, Melissa, Mentha, Plantago, Rubus, Salvia, Satureja, Silene, Symphytum, Teucrium, Urtica*	2007	[20]

Table 1. *Cont.*

Population	Country	Area	Elevation (m)	Frequency (n)	Percentage (%)	Genera of Wild Plant Teas	Data Collection Year	Reference
Albanians	North Macedonia (MK)	Upper Reka Valley and diverse Reka villages in NW Macedonia RE1/RE2	800–1300	52	13.40	*Achillea, Althaea, Bellis, Brassica, Calamintha, Capsella, Castanea, Centaurium, Cichorium, Convolvulus, Cornus, Daucus, Equisetum, Fragaria, Galega, Galium, Gentiana, Hypericum, Juglans, Juniperus, Ligustrum, Lythrum, Malva, Marrubium, Matricaria, Medicago, Melissa, Mentha, Morus, Ononis, Orchis, Origanum, Parietaria, Pinus, Plantago, Prunella, Rosa, Rubus, Sambucus, Saponaria, Sanguisorba, Sideritis, Sisymbrium, Tanacetum, Taraxacum, Thymus, Tilia, Trifolium, Tussilago, Urtica, Vaccinium, Verbascum*	2012 and 2022	[21,22]

Table 1. *Cont.*

Population	Country	Area	Elevation (m)	Frequency (n)	Percentage (%)	Genera of Wild Plant Teas	Data Collection Year	Reference
Serbs and Albanians	Kosovo (KS)	Shtërpcë/Štrpce SH	600–1200	54	13.92	*Achillea, Aconitum, Adiantum, Aesculus, Alnus, Althaea, Arctium, Betula, Capsella, Castanea, Centaurea, Centaurium, Cichorium, Cornus, Corylus, Crataegus, Cydonia, Cynodon, Daucus, Digitalis, Echinops, Elymus, Equisetum, Fragaria, Galium, Humulus, Hypericum, Juglans, Juniperus, Linaria, Malus, Matricaria, Melissa, Mentha, Morus, Origanum, Orlaya, Pinus, Plantago, Populus, Prunus, Pteridium, Robinia, Rosa, Rubus, Salvia, Sambucus, Teucrium, Thymus, Tilia, Trifolium, Urtica, Vaccinium, Veratrum*	2017	[23]
Albanians	Albania (AL)	Theth TH	700–900	9	2.32	*Centaurium, Crataegus, Hypericum, Origanum, Sisymbrium, Teucrium, Vaccinium*	2007	[24]
Albanians	Albania (AL)	Upper Kelmendi UK	1300–1700	18	4.64	*Acer, Achillea, Asplenium, Chelidonium, Hypericum, Juglans, Lilium, Matricaria, Origanum, Phyllitis, Primula, Prunus, Punica, Salvia, Teucrium, Thymus, Tilia, Verbascum*	2004	[25]

The semi-structured interviews followed a standardised scheme to collect information on wild plant species used for herbal teas, including collection methods, preparation, storage, and cultural significance. They were conducted in the respective local languages (Albanian, Serbian, Bosniak, North Macedonian, Gorani) with the help of interpreters when necessary. Participants aged 40 to over 80 years old were selected based on their attachment to farming and shepherding activities and following recommendations from local community leaders, such as village elders or individuals known for their extensive traditional knowledge of plants. These initial participants were chosen for their recognised expertise and were instrumental in connecting us with other knowledgeable individuals through snowball sampling. In addition to our field research conducted between 2004 and 2023, we have referenced data from two research studies conducted in Bosnia and Serbia, which included data from research conducted around Prokoško Lake in Bosnia and Herzegovina (2007), in the Kopaonik region in Serbia (2002–2005), and by Leopold Glück in the second half of the 19th Century; these were essential for enriching our understanding of ethnobotanical practices in those regions. This last source has been used only for conducting a historical comparison, but not for the actual analysis, since the methodology was not well described. Although our research groups did not conduct these studies, we have integrated their findings into our analysis to provide a more comprehensive picture of wild plant use in the Western Balkans. Additionally, we excluded all those ethnobotanical studies that employed unsound methodologies, i.e., that did not use solid semi-structured interviews (detectable by showing local vernacular names of plants) or that included herbalists and scholarly experts of medicinal plants in the sample. Moreover, studies conducted in non-mountainous areas were excluded since they were beyond the scope of this analysis. Additionally, a short field study in the high-mountain Lukomir village in Bosnia was conducted in October 2024 to further verify the data from the Bosniak ethnobotanical literature. These considerations ensured that our analysis consistently tried to understand herbal wild plant use in high-altitude Western Balkan regions.

2.2. Statistical Analysis

In the statistical analysis, we only considered wild plant genera (and not species) to purposely minimise the effect of over-differentiation of plant diversity across very different environments. Only 12 locations were considered in this analysis since the old Sarajevo survey was used only for a historical comparison, as it could not be considered given the unclear methodologies it adopted.

The ethnobotanical data were statistically analysed using SAS 9.4 software (SAS Institute Inc., Cary, NC, USA) and R to evaluate the data thoroughly. SAS 9.4 software was used for descriptive analysis to summarise plant genera usage, interview distribution, and ecological variables across study sites. Analysis of variance was applied to explore differences in plant genera distribution across varying altitudes. Correlation analysis was also conducted to examine the relationship between altitude and plant distribution.

R 4.4.1 software was employed for more specialised analyses and data visualisation. Correlation analysis assessed relationships between plant genera usage and ecological variables, such as altitude. Multivariate analysis, including Principal Component Analysis (PCA) and Cluster Analysis, identified patterns and groupings within the data, revealing associations between plant species, ecological conditions, and cultural contexts. Additionally, R facilitated the creation of plots and maps to represent the distribution of plant genera reports and their ecological contexts, aiding in interpreting environmental and spatial variations in plant use. This combined analytical approach enabled a comprehensive understanding of the relationships between traditional wild plant use, environmental factors, and cultural significance.

3. Results

3.1. Ethnobotanical Patterns and Cultural Significance of Wild Plant Teas in the Balkans

Notably, the Goranis of Kosovo (Dragash) report the highest variety of plant genera (39, or 10.05%), reflecting a well-preserved tradition of plant use and access to diverse flora in their mid-elevation region. Conversely, high-elevation areas such as Upper Kelmendi (inhabited by Albanians) and Prokoško Lake in Bosnia and Herzegovina (inhabited by Bosniaks) exhibit more selective plant use, with 18 and 23 genera (4.64% and 5.93%), respectively (Table 1). Moreover, specific genera like *Origanum*, *Thymus*, and *Teucrium* are commonly used across various populations, indicating that cultural preferences, particularly for medicinal and aromatic plants, often transcend ethnic and geographic boundaries. For example, Serbs and Bosniaks in Serbia's Pešter region and Serbs in the Kopaonik region demonstrate a remarkably diverse use of plants, possibly reflecting ecological diversity and the remarkable cultural significance and, therefore, broad diversity of herbal teas in Serbian traditions (Table 1).

The influence of cultural exchange is evident in mixed populations in NW North Macedonia, which reported using 52 genera (13.40%). This reflects a synthesis of ethnobotanical knowledge, blending diverse cultural customs within a single region. Historical continuity is also highlighted in areas like Dragash (Kosovo), where many plant species are documented in the older ethnobotanical study by [15] in Sarajevo, which is still used today (Table 1).

3.2. Impact of Elevation and Climate on Ethnobotanical Diversity Across the Balkans

Elevation and climate significantly impact the ethnobotanical diversity observed across the studied regions. As outlined in (Table 2), low-elevation areas, particularly in temperate-continental climates with Mediterranean influences, support a broader range of wild plant genera (117 genera, 48.15%). These areas, such as the Albanian Alps and parts of Macedonia, experience mild winters and warm summers, allowing for a longer growing season and higher biodiversity.

Mid-elevation areas (Dragash, Gora, Pešter, etc.) present a narrower but substantial diversity (89 genera, 36.63%). The cooler temperatures and shorter growing seasons associated with mountainous continental climates reduce the range of species available for tea-making. However, these regions still demonstrate robust ethnobotanical traditions, as evidenced by the vast array of genera documented in Goranis and Serbs' herbal practices.

High-elevation areas, such as Upper Kelmendi and Prokoško Lake, are marked by more specialised plant use, with only 37 genera (15.22%) reported. The harsher climate and reduced biodiversity at these altitudes may constrain the quantity and variety of plants available for ethnobotanical use.

The analysis of variance (ANOVA) reveals that the location has a significant effect on plant biodiversity, with a p-value < 0.0001, indicating that differences between locations contribute substantially to variations in the number and type of tea plant genera used. Elevation also significantly affects plant biodiversity, with a p-value of 0.0005. This result confirms that elevation changes have a notable impact on the diversity of plant genera used, aligning with the observed patterns in the dataset (Table 3).

The interaction between both location and elevation and their influence on plant biodiversity is significant (p-value of 0.043), suggesting that the effect of elevation on plant biodiversity varies across different locations. This interaction highlights the complexity of how environmental factors combine to influence plant use practices (Table 3).

Table 2. Distribution of wild plant teas used across different elevation categories and climate conditions in the Balkans.

Elevation Category	Population	Area	Climate Conditions	Frequency (n)	Percentage (%)	Genera
Low Elevation	Albanians, Serbs, North Macedonians, Goranis	Albanian Alps, Kopaonik, NW North Macedonia, Shtërpcë/Štrpce, Theth	Temperate Continental/Mediterranean Influence: Mild winters, warm summers, moderate precipitation (rain and occasional snowfall), and longer dry periods due to Mediterranean influences in coastal and near-coastal regions.	117	48.15	*Abies*, *Achillea*, *Aconitum*, *Adiantum*, *Aesculus*, *Agrimonia*, *Alnus*, *Althaea*, *Arctium*, *Artemisia*, *Artostaphylus*, *Betula*, *Calendula*, *Capsella*, *Carlina*, *Castanea*, *Centaurea*, *Centaurium*, *Chelidonium*, *Cichorium*, *Cornus*, *Corylus*, *Crataegus*, *Cydonia*, *Cynodon*, *Dactylorhiza*, *Daphne*, *Daucus*, *Digitalis*, *Echium*, *Echinops*, *Elymus*, *Epilobium*, *Equisetum*, *Eupatorium*, *Filipendula*, *Foeniculum*, *Fragaria*, *Frangula*, *Fraxinus*, *Galium*, *Gentiana*, *Glechoma*, *Humulus*, *Hypericum*, *Inula*, *Juglans*, *Juniperus*, *Lamium*, *Leonorus*, *Leucanthemum*, *Lilium*, *Linaria*, *Ligustrum*, *Malus*, *Malva*, *Marrubium*, *Matricaria*, *Medicago*, *Melissa*, *Melittis*, *Mentha*, *Morus*, *Nepeta*, *Ononis*, *Orchis*, *Origanum*, *Orlaya*, *Parietaria*, *Pastinaca*, *Phyllitis*, *Pinus*, *Plantago*, *Polygonatum*, *Populus*, *Potentilla*, *Primula*, *Prunella*, *Prunus*, *Punica*, *Pteridium*, *Quercus*, *Rhamnus*, *Ribes*, *Robinia*, *Rosa*, *Rubus*, *Rumex*, *Ruscus*, *Salix*, *Salvia*, *Sambucus*, *Sanguisorba*, *Satureja*, *Sempervivum*, *Sisymbrium*, *Sideritis*, *Silene*, *Solidago*, *Stachys*, *Symphytum*, *Tamus*, *Tanacetum*, *Taraxacum*, *Teucrium*, *Thymus*, *Tilia*, *Trifolium*, *Tussilago*, *Urtica*, *Vaccinium*, *Valeriana*, *Verbascum*, *Verbena*, *Veratrum*, *Viola*, and *Viscum*.

Table 2. *Cont.*

Elevation Category	Population	Area	Climate Conditions	Frequency (n)	Percentage (%)	Genera
Mid Elevation	Goranis, Serbs, Albanians	Dragash, Gora, Pešter, Reka and NW Macedonia	Mountainous Continental: Cooler temperatures, colder winters with substantial snowfall, and shorter summers. Precipitation is higher compared to lowland regions, with snow cover lasting longer.	89	36.63	*Achillea, Alchemilla, Alnus, Althaea, Artostaphylus, Arctium, Bellis, Betula, Brassica, Calendula, Calamintha, Capsella, Carum, Castanea, Centaurium, Ceterach, Chelidonium, Cichorium, Cirsium, Convolvulus, Cornus, Corylus, Crataegus, Cydonia, Cynodon, Daucus, Equisetum, Euphorbia, Fragaria, Fraxinus, Galega, Galium, Gentiana, Hypericum, Inula, Juglans, Juniperus, Leucanthemum, Ligustrum, Lythrum, Malus, Malva, Marrubium, Matricaria, Medicago, Melissa, Mentha, Morus, Nepeta, Ononis, Orchis, Origanum, Papaver, Parietaria, Pinus, Plantago, Primula, Prunella, Prunus, Ribes, Rosa, Rubus, Rumex, Saponaria, Sambucus, Sanguisorba, Sempervivum, Sideritis, Sisymbrium, Tanacetum, Taraxacum, Teucrium, Thymus, Tilia, Trifolium, Tussilago, Urtica, Vaccinium, Valeriana,* and *Verbascum*
High Elevation	Bosniaks, Albanians	Prokoško Lake, Upper Kelmendi	Alpine/Mountain Climate: Harsh, cold winters with heavy snowfall, cool summers, high humidity, and abundant rainfall. Snow cover can persist well into spring or early summer at the highest elevations.	37	15.23	*Acer, Achillea, Aesculus, Agrimonia, Allium, Arnica, Artemisia, Asplenium, Centaurium, Cetraria, Chelidonium, Euphrasia, Frangula, Geum, Hypericum, Juglans, Lilium, Matricaria, Melissa, Mentha, Origanum, Phyllitis, Plantago, Primula, Prunus, Punica, Rubus, Salvia, Satureja, Silene, Symphytum, Teucrium, Thymus, Tilia, Urtica,* and *Verbascum.*

Table 3. ANOVA results for the effects of location and elevation on plant biodiversity.

Variable	DF	Sum of Squares	Mean Square	F-Value	*p*-Value
Location	5	1200	240	8	<0.0001
Elevation	2	500	250	8.33	0.0005
Location × Elevation	10	600	60	2	0.043

3.3. Hierarchical Clustering of Plant Species Distribution Across Balkan Sites

A dendrogram analysis was conducted using hierarchical clustering to investigate the relationship between plant species distribution and environmental factors. The study was performed with the Euclidean distance measure to quantify the dissimilarity between sites based on plant genera presence and abundance. Ward's method minimises within-cluster variance, ensuring robust cluster formation.

The analysis grouped the sites as follows (Figure 2): Group 1: Prokoško Lake, Upper Kelmendi, and Theth, with correlation values ranging from 0.8 to 0.9. This group, characterised by high elevations, demonstrates a substantial similarity in plant species composition, reflecting their adaptation to harsh alpine climates and similar ecological conditions; Group 2: Gora, Pešter, Albanian Alps, and NW North Macedonia, with correlation values between 0.55 and 0.7. These mid-elevation sites exhibit moderate similarity in plant species, corresponding to their transitional climatic conditions and relatively higher plant diversity than the high-elevation sites; Group 3: Kopaonik, Reka, NW Macedonia, Dragash, Shtërpcë/Štrpce, with correlation values ranging from 0.62 to 0.78. This group encompasses sites with varying elevations but shows a lower level of correlation, indicating more diverse and less uniform plant species distribution, likely due to a broader range of climatic conditions and ecological zones.

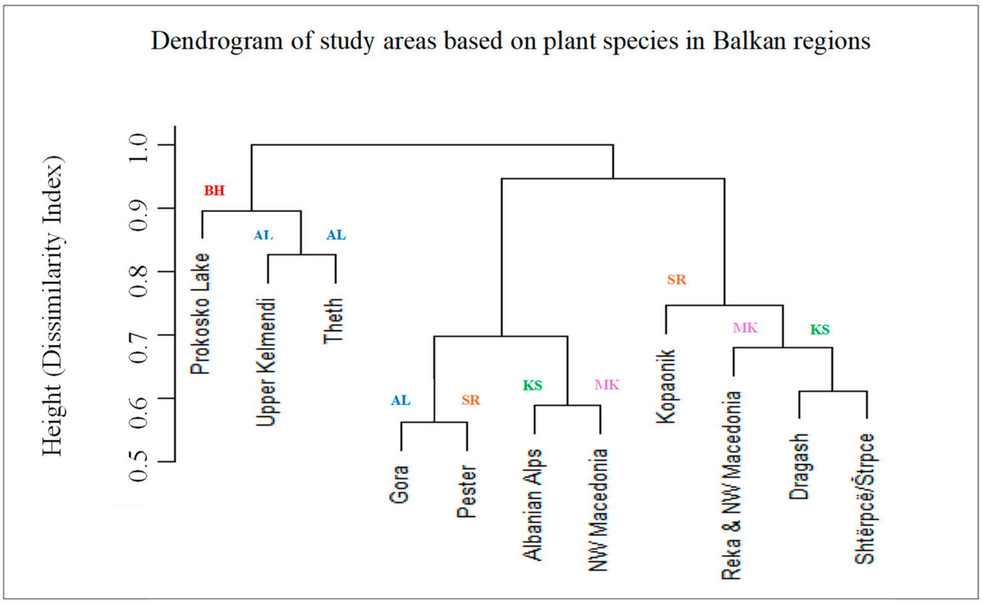

Figure 2. Hierarchical clustering dendrogram of Balkan sites based on plant species distribution. The dendrogram illustrates three distinct clusters of sites: Cluster 1 (Prokoško Lake, Upper Kelmendi, Theth), Cluster 2 (Gora, Pešter, Albanian Alps, North Macedonia), and Cluster 3 (Kopaonik, Reka NW Macedonia, Dragash, Shtërpcë/Štrpce). The height correlations for the clusters are 0.8–0.9, 0.55–0.7, and 0.62–0.78, respectively. These clusters demonstrate the influence of geographic and ecological factors on species diversity across different elevations and regions.

These groupings highlight how plant species distribution is influenced by elevation and climatic conditions, with distinct patterns emerging based on ecological and environmental similarities. The correlation values further emphasise the varying degrees of similarity in plant species across different sites, reflecting the study areas' environmental and geographical diversity.

Figure 3A presents the results of the Principal Component Analysis (PCA) on plant species composition across Balkan sites. The score plot illustrates the clustering of sites into three groups based on plant genera composition, indicating distinct ecological and geographical influences. The loading plot in Figure 3B highlights the contribution of various plant species to the differentiation of these sites along the first two principal components. Together, these figures underscore the variation in plant species distribution across different Balkan regions and elevations.

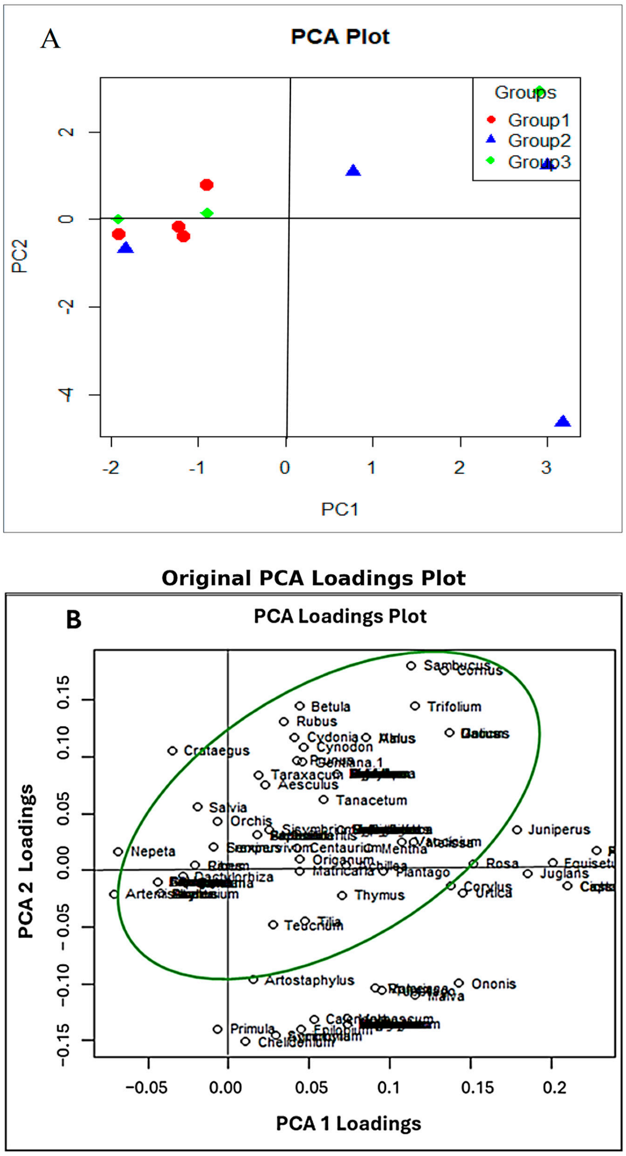

Figure 3. (**A**) PCA score plot of Balkan sites based on plant genera composition. The plot shows the grouping of sites (Group 1: Prokoško Lake, Upper Kelmendi, Theth; Group 2: Gora, Pešter, Albanian Alps, North Macedonia; Group 3: Kopaonik, Reka, NW Macedonia, Dragash, and Shtërpcë/Štrpce) according to the first two principal components. The clustering highlights the influence of ecological and geographical factors on the distribution of plant species across different elevations. (**B**): PCA loading plot of plant species distribution in Balkan sites. This plot visualises the contribution of various plant genera to the first two principal components, indicating which species are most influential in differentiating the regions.

To further validate the region groupings identified through the dendrogram, we constructed a correlation matrix (Figure 4) to visualise the relationship between plant species distribution across the study areas. The heatmap reveals distinct correlation patterns, with Group 1 (Prokoško Lake, Upper Kelmendi, Theth) showing the highest correlations (0.8–0.9), indicating similar ethnobotanical practices and ecological conditions. Group 2 (Gora, Pešter, Albanian Alps, North Macedonia) displayed moderate correlations (0.55–0.7), suggesting a transition in plant use and environmental influence. Group 3 (Kopaonik, Reka NW Macedonia, Dragash, Shtërpcë/Štrpce) exhibited correlations between 0.62–0.78, further supporting the classification of regions based on plant diversity and climatic factors

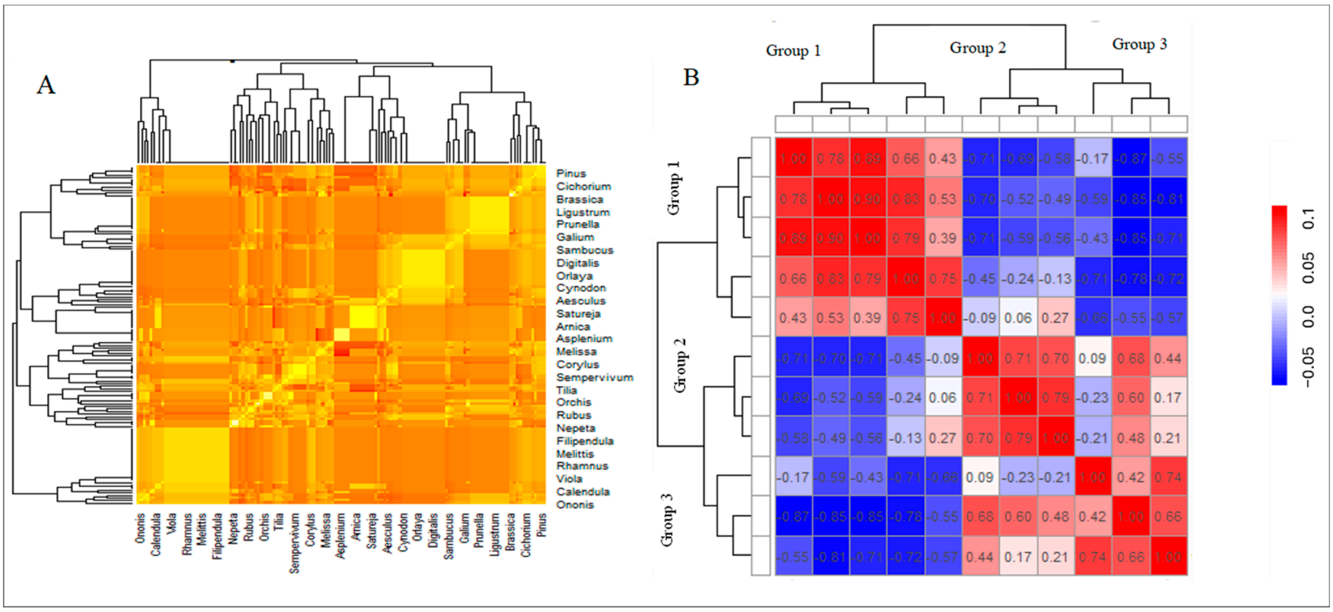

Figure 4. Heatmap of the correlation matrix of genera distribution across different regions, annotated by groupings identified in the dendrogram (Figure 3). Group 1: Prokoško Lake, Upper Kelmendi, Theth; Group 2: Gora, Pešter, Albanian Alps, North Macedonia; Group 3: Kopaonik, Reka NW Macedonia, Dragash, Shtërpcë/Štrpce. (**A**) The colour gradient indicates the degree of correlation between regions, with warmer colours representing higher correlations (e.g., Group 1) and cooler colours representing lower correlations. (**B**) Numerical values denote specific correlation coefficients.

4. Discussion

4.1. Ecological Constraints and Cultural Adaptation in Balkan Ethnobotany

The analysis of wild plant teas across Balkan populations revealed several key trends. Populations in higher elevations tend to use a narrower range of plant species adapted to their specific ecological conditions, while mid- and lower-elevation regions demonstrate greater plant use diversity. Specific plant genera, such as *Origanum*, *Thymus*, and *Mentha*, are widely used across different ethnic groups, reflecting a shared cultural tradition. However, a comparison with historical data suggests that modernisation has led to a decline in plant variety in some regions.

The harsh climatic conditions and challenging topography of high-altitude areas, such as the Albanian Alps and Prokoško Lake, create unique ecological niches where only certain resilient plant species can thrive [2,9,26]. These ecosystems are characterised by lower biodiversity compared to lower elevations, with a predominance of species that have evolved specific adaptations to cold, wind, and nutrient-poor soils [9,11,13,27]. For example, plants like *Juniperus* and *Vaccinium* not only withstand these harsh conditions but also provide essential medicinal and nutritional benefits, playing a vital role in the survival of local communities [21,23,28].

Over centuries, these communities have developed a profound knowledge of the plants' adaptive traits, recognising the specific bioactive compounds that allow these species to thrive in such environments [13,29]. This knowledge informs their selection and use of plants, with a strong focus on the medicinal properties that help address health issues exacerbated by the high-altitude climate, such as respiratory and circulatory ailments [15,23,30]. For instance, the anti-inflammatory and antioxidant properties of *Vaccinium* species are highly valued, as these traits are crucial for maintaining health in a physically demanding environment [31,32].

The ecological constraint in these regions, limiting the range of plant species, has led to developing specialised ethnobotanical practices [21,33]. These practices involve plant selection and detailed knowledge of the plants' optimal harvest times, preparation methods, and specific uses in traditional medicine [7,23]. The cultural transmission of this knowledge across generations reflects a long history of adaptation to environmental stressors, making it an essential element of local cultural identity [9,18].

Moreover, relying on fewer species highlights an adaptive strategy emphasising efficiency and sustainability [34]. By focusing on hardy, multi-functional plants that provide both medicinal and nutritional benefits, these communities ensure the resilience of their practices in the face of fluctuating environmental conditions [18,30,35]. This selective ethnobotanical knowledge, grounded in ecological realities, demonstrates how cultural traditions are shaped by the environment, with a reciprocal relationship where human practices influence plant biodiversity conservation and vice versa.

This expanded ethnobotanical knowledge can be attributed to more diverse environmental conditions in mid- and lower-elevation regions, such as those inhabited by Goranis and Bosniaks. The milder climate, increased soil fertility, and broader availability of water sources support a greater variety of flora, enabling these communities to explore a wider range of plant species [36,37]. As a result, the depth of ethnobotanical practice is not merely a response to ecological abundance but also reflects the cultural capacity to observe, experiment, and integrate plants into daily life in sophisticated ways [38,39]. The range of species, from medicinal to culinary, highlights the community's intricate ecological understanding and social resilience [18]. Ecologically, this greater plant diversity contributes to regional stability by supporting varied ecosystems that benefit from the plants' multifunctional roles [40]. Many species, such as *Tilia* and *Pinus*, act as keystone species within their habitats, fostering essential services like pollination, soil retention, and nutrient cycling [41]. Their sustainable use indicates a co-evolutionary relationship between the local populations and their surroundings, where knowledge passed down through generations ensures that plants are harvested in ways that promote regeneration and minimise environmental impact. This mutualistic interaction sustains biodiversity and reinforces the cultural identity of the people who depend on these species for survival [18,42].

Culturally, the broader availability of plant species facilitates a more nuanced relationship between communities and their environment [43]. Unlike in high-altitude areas, where people must rely on a limited number of resilient species, mid- and lower-elevation populations have developed a complex system of knowledge concerning using different plants throughout the year [21,35,40]. Plant genera like *Hypericum* and *Rosa* are valued for their medicinal benefits and are integral to herbal traditions and social customs, from seasonal gatherings to healing rituals. For instance, in some communities, *Hypericum perforatum* in the considered areas is often infused in oil to create a healing balm used in rituals for treating wounds or joint pain, a practice noted during interviews in the Kopaonik region [16]. Similarly, *Rosa canina* petals are used in traditional herbal baths to alleviate stress, as documented in Prokoško Lake communities [13]. This abundance allows for diversification in how plants are used, with different species contributing to a holistic approach to health and well-being.

This greater ecological and botanical diversity also encourages intergenerational knowledge transfer, where elders teach younger generations the subtleties of plant identification, usage, and conservation [20,44]. In these regions, ethnobotanical knowledge is deeply intertwined with cultural practices, ensuring that local traditions persist alongside environmental stewardship. For instance, plants like *Verbascum* and *Achillea*, frequently used in teas and remedies, are essential for their health benefits. They serve as cultural identity markers, grounding these populations in their history and connection to the land [9,18,40].

However, the decline in plant diversity usage in certain areas, particularly Albania and Serbia, is concerning [17,45]. This trend can be attributed to several factors, including modernisation, the adoption of modern technologies, changes in agricultural practices, increased reliance on processed or commercially available goods (such as packaged teas), and urbanisation—the process by which an increasing percentage of a population moves from rural areas to urban areas (cities and towns) and abroad, often leading to changes in lifestyle, economic activities, and social structures [9,46]—which is dramatic in many rural and marginalised regions of the world and of particular concern in the Balkans, where entire mountain areas and villages have become inhabited in recent years.

Traditional herbal practices, including the spread of tradition throughout the Southwestern Balkans, where elders prepare wild *Sideritis* spp. tea (mountain tea) during communal winter gatherings to foster social bonds and promote well-being is dramatically declining. This decline is due to the shift towards modern alternative commercial teas, threatening the continuity of these valuable cultural traditions involving wild plant teas. [47]. This cultural shift has significant implications, not only for the preservation of ethnobotanical knowledge but also for biodiversity. As traditional knowledge erodes, so does the sustainable harvesting of wild plants, which become increasingly a commodity to be over-utilised for trade, potentially threatening the ecosystems that depend on these practices [36,47].

To counteract these trends, it is essential to document and preserve the remains of ethnobotanical knowledge [17,18,20,35]. Efforts to promote the cultural value of wild plant teas, alongside initiatives to protect the ecological biodiversity of the region, are crucial [48]. Justifying these actions is essential: ethnobotanical traditions enrich cultural heritage and support environmental sustainability [33]. These practices have evolved over centuries, providing a blueprint for sustainable interaction with the environment. By integrating traditional knowledge with modern conservation efforts, both cultural preservation and ecological resilience can be achieved.

4.2. Shifting Ecological Boundaries and Plant Distribution Across Elevations

The presence of certain species across different elevations, observed in the dendrogram analysis, reveals an intriguing ecological and cultural phenomenon. Some plants, such as *Vaccinium* and *Juniperus*, are found in high-altitude regions and mid- and even lower elevations. This overlap suggests a historical and ongoing ecological adaptation where these species have migrated or been cultivated across various landscapes [49]. Over time, this process blurs the boundaries of distinct ecological zones, indicating that plant distribution is dynamic and influenced by natural and human-mediated changes [40,50].

This phenomenon highlights the importance of studying ecological shifts with cultural factors. As species become more widespread or migrate to different elevations due to climate change, land use practices, or other factors, the traditional knowledge of local populations may also adapt [29,35,51]. For instance, the similarities in ethnobotanical practices between distant regions like Gora and central Bosnia cannot be explained solely by elevation. Instead, the historical hypothesis of shared cultural origins (via the Medieval Bogomils) or cultural exchanges, mainly through transhumance shepherding routes, may help explain this pattern. These exchanges, transcending ethnic and linguistic boundaries, possibly helped spread ethnobotanical traditions. Thus, the similarities in plant use result from this cultural and ecological flow rather than from environmental factors alone. The dendrogram analysis showing distinct groups of wild tea species based on regional divisions suggests that, with time, these ecological borders could become more defined as the climate and ecosystems evolve. The more precise distinctions between plant groups across different elevations may also signal a reduction in plant distribution due to environmental pressures, including habitat loss and changing climatic conditions [43,51]. This trend emphasises the need for comprehensive studies integrating ecological changes with ethnobotanical knowledge to understand better how cultural practices adapt to shifting environmental realities [52,53].

Such shifts in plant distribution also raise important questions about biodiversity conservation. As plants historically confined to specific elevations expand or contract their range, the ecosystems they support might also change [38,54–57]. This could impact local biodiversity and ecosystem services, such as pollination and soil health, and alter traditional plant use patterns. Thus, understanding these ecological changes is critical not only for the preservation of biodiversity but also for maintaining the cultural heritage tied to these plants [18,24,35,53,58].

Climate change, along with human activities, is affecting the distribution of wild plant species used in teas and food across different elevations [59–61]. As temperatures rise and precipitation patterns shift, species like *Vaccinium* and *Juniperus* are moving to higher altitudes, altering their availability for local communities [62–65]. At the same time, modern agricultural practices, urbanization, and increased reliance on commercially produced teas diminish the diversity of wild plant species traditionally used for food and medicinal purposes [62,64,66–68]. This shift in plant availability challenges preserving local knowledge and practices [32,69,70]. To ensure the sustainability of these traditions, it is essential to integrate climate resilience strategies with efforts to protect the biodiversity of wild plants and preserve the ethnobotanical knowledge that sustains them [71–75].

4.3. Limitations and Challenges for Future Research

The sample size and geographic scope may not fully represent the cultural and ecological diversity of the Balkan region, potentially affecting the generalizability of the findings. Additionally, the research captures ethnobotanical knowledge at a specific time, which may overlook changes due to environmental shifts or cultural transformations. Reliance on local expertise for plant identification can also lead to inconsistencies. Due to the vast plant diversity involved, especially within specific genera, such as Lamiaceae, this study considered plants only at the genus level in this analysis. This approach is common in traditional folk knowledge systems, where species with similar morphology and uses are often grouped within one folk category (labelled by one folk name only). Furthermore, the study did not extensively consider ecological factors such as climate change or land use, which may impact plant availability. While the focus on wild plant teas provided valuable insights, it may have excluded other essential uses of these plants. Another point of consideration is the potential controversy or complementarity between local ethnobotanical knowledge and academic approaches, particularly in the context of cultural ecology, which examines how nature influences cultural practices. More accurate explorations of these intersections in future research could deepen our understanding and bridge the gaps between local and academic perspectives. These challenges underline the need for further statistical research with ethnobotanical data, possibly using big data analysis and AI, to explore the dynamic interplay between ecology, culture, and traditional practices linked to nature.

5. Conclusions

This study highlights the intricate relationship between ecology, culture, and the use of wild plant teas in the Balkan mountain regions. Through ethnobotanical analysis, it becomes clear that ecological factors, such as altitude and climate, and deep-rooted cultural traditions play a significant role. For example, in North Macedonia, elders prepare *Sideritis* tea (mountain tea) during winter gatherings, with the timing of tea preparation influenced by the cold, mountainous climate. This practice has been passed down through generations and is closely linked to the local environment's seasonal cycles. The rich botanical knowledge these communities preserve reflects centuries of adaptation to their natural environments and the importance of plants in their cultural and social practices.

However, modern influences, including urbanisation and the availability of commercial products, threaten the continuity of these practices. As traditional knowledge fades so too does the biodiversity that relies on sustainable plant harvesting. This study underscores the urgency of documenting and preserving this knowledge for cultural heritage and ecological sustainability.

By promoting awareness of the cultural and ecological significance of wild plant teas, we can support conservation efforts that protect both biodiversity and the intangible cultural heritage of the Balkan region. Integrating this ethnobotanical knowledge with modern environmental management strategies presents an opportunity to maintain the health of ecosystems while fostering a renewed appreciation for traditional practices. In doing so, we can ensure that these valuable traditions continue contributing to the region's cultural identity and environmental stewardship for future generations.

Author Contributions: M.A.: Conceptualization, Methodology, Conducted Software Analysis and Visualisation, Writing—Original Draft and Review; N.S.: Conceptualization, Methodology, Review and Editing the Manuscript. A.P.: Conceptualization, Supervision, Review and Editing, Funding. All authors have read and agreed to the published version of the manuscript.

Funding: The main portion of the considered field studies was funded by the University of Gastronomic Sciences, Pollenzo, Italy; the EU-funded ETHCSTWIN project (2024-2026) covered a short research mission in Bosnia during the fall 2024.

Institutional Review Board Statement: The study adhered to the International Society of Ethnobiology Code of Ethics: https://www.ethnobiology.net/wp-content/uploads/ISE-COE_Eng_rev_24Nov08.pdf (accessed on 24 November 2008). Before conducting interviews, verbal informed consent was obtained from all participants. Participants were fully informed about the research purpose, methods, and their rights, including those to withdraw from the study at any time.

Data Availability Statement: Data supporting the reported results are available from the corresponding author upon reasonable request.

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

References

1. Jovičić Vuković, A.; Terzić, A. Gastronomy and Regional Identity: Balkan versus National Cuisine. In *Gastronomy for Tourism Development*; Emerald Publishing Limited: Leeds, UK, 2020; pp. 1–25, ISBN 978-1-78973-756-1. [CrossRef]
2. Pieroni, A.; Quave, C. Ethnobotany and Biocultural Diversities in the Balkans. In *Perspectives on Sustainable Rural Development and Reconciliation*; Springer: New York, NY, USA, 2014; ISBN 978-1-4939-1491-3.
3. Valkó, O.; Tóth, K.; Kelemen, A.; Miglécz, T.; Radócz, S.; Sonkoly, J.; Tóthmérész, B.; Török, P.; Deák, B. Cultural heritage and biodiversity conservation—Plant introduction and practical restoration on ancient burial mounds. *Nat. Conserv.* **2018**, *24*, 65–80. [CrossRef]
4. Shrestha, S.; Medley, K.E. Integrating Ecological and Ethnobotanical Knowledge to Promote Collaborative Conservation Planning in the Nepal Himalaya. *Mt. Res. Dev.* **2017**, *37*, 97–107. [CrossRef]
5. Jarić, S.; Kostić, O.; Miletić, Z.; Marković, M.; Sekulić, D.; Mitrović, M.; Pavlović, P. Ethnobotanical and ethnomedicinal research into medicinal plants in the Mt Stara Planina region (south-eastern Serbia, Western Balkans). *J. Ethnobiol. Ethnomed.* **2024**, *20*, 7. [CrossRef] [PubMed]
6. Saraci, A.; Damo, R. A historical overview of ethnobotanical data in Albania (1800s–1940s). *Ethnobiol. Conserv.* **2021**, *10*. [CrossRef]
7. Liu, F.; Peng, J.; Feng, Y.; Ma, Y.; Ren, Y.; Sun, P.; Zhao, Y.; Liu, S.; Wu, F.; Xie, J. An ethnobotanical study on the medicinal herb practices of the gelao ethnic minority in North Guizhou, China: An exploration of traditional knowledge. *Front. Pharmacol.* **2023**, *14*, 1217599. [CrossRef]
8. Osterhoudt, S.; Eddens, K.S.; Abdulkhaliq, Z.S.; Armia, R.E.; Mahdi, H.S.; Mahmood, A.; Muhamed, H. The Role of Wild Plants in Cultural Restoration: Community Collaboration and Engaged Ethnobotany in the Nineveh Plains, Northern Iraq. *Econ. Bot.* **2024**, *78*, 109–125. [CrossRef]
9. Aziz, M.A. A rich fading biocultural diversity? A review of traditional herbal teas used by minorities in the Balkans. *Turk. J. Bot.* **2021**, *45*, 713–722. [CrossRef]
10. Giraud, N.J.; Kool, A.; Karlsen, P.; Annes, A.; Teixidor-Toneu, I. From trend to threat? Assessing the sustainability of wild edible plant foraging by linking local perception to ecological inference. *bioRxiv* **2021**. [CrossRef]
11. Nepal, T. The Role of Traditional Ecological Knowledge in Environmental Stewardship: Beyond Poverty and Necessity. *J. Resour. Energy Dev.* **2023**, *20*, 86–96. [CrossRef]
12. Tsioutsiou, E.E.; Amountzias, V.; Vontzalidou, A.; Dina, E.; Stevanović, Z.D.; Cheilari, A.; Aligiannis, N. Medicinal Plants Used Traditionally for Skin Related Problems in the South Balkan and East Mediterranean Region—A Review. *Front. Pharmacol.* **2022**, *13*, 936047. [CrossRef]

13. Šarić-Kundalić, B.; Fritz, E.; Dobeš, C.; Saukel, J. Traditional Medicine in the Pristine Village of Prokoško Lake on Vranica Mountain, Bosnia and Herzegovina. *Sci. Pharm.* **2010**, *78*, 275–290. [CrossRef] [PubMed]
14. Jarić, S.; Popović, Z.; Mačukanović-Jocić, M.; Djurdjević, L.; Mijatović, M.; Karadžić, B.; Pavlović, P. An ethnobotanical study on the usage of wild medicinal herbs from Kopaonik Mountain (Central Serbia). *J. Ethnopharmacol.* **2007**, *111*, 160–175. [CrossRef] [PubMed]
15. Glück, L. Skizzen aus der Volksmedicin und dem medicinischen Aberglauben in Bosnien und der Hercegovina. *Wissenschatliche Mitth. Aus Bosnien Und Der Herceg.* **1894**, *2*, 392–454.
16. Mustafa, B.; Hajdari, A.; Pajazita, Q.; Syla, B.; Quave, C.L.; Pieroni, A. An ethnobotanical survey of the Gollak region, Kosovo. *Genet. Resour. Crop Evol.* **2012**, *59*, 739–754. [CrossRef]
17. Pieroni, A. Traditional uses of wild food plants, medicinal plants, and domestic remedies in Albanian, Aromanian and Macedonian villages in South-Eastern Albania. *J. Herb. Med.* **2017**, *9*, 81–90. [CrossRef]
18. Rexhepi, B.; Mustafa, B.; Hajdari, A.; Rushidi-Rexhepi, J.; Quave, C.L.; Pieroni, A. Traditional medicinal plant knowledge among Albanians, Macedonians and Gorani in the Sharr Mountains (Republic of Macedonia). *Genet. Resour. Crop Evol.* **2013**, *60*, 2055–2080. [CrossRef]
19. Pieroni, A.; Giusti, M.E.; Quave, C.L. Cross-Cultural Ethnobiology in the Western Balkans: Medical Ethnobotany and Ethnozoology Among Albanians and Serbs in the Pešter Plateau, Sandžak, South-Western Serbia. *Hum. Ecol.* **2011**, *39*, 333–349. [CrossRef]
20. Sarić-Kundalić, B.; Dobes, C.; Klatte-Asselmeyer, V.; Saukel, J. Ethnobotanical Study on Medicinal Use of Wild and Cultivated Plants in Middle, South and West Bosnia and Herzegovina. *J. Ethnopharmacol.* **2010**, *131*, 33–55. [CrossRef]
21. Pieroni, A.; Rexhepi, B.; Nedelcheva, A.; Hajdari, A.; Mustafa, B.; Kolosova, V.; Cianfaglione, K.; Quave, C.L. One Century Later: The Folk Botanical Knowledge of the Last Remaining Albanians of the Upper Reka Valley, Mount Korab, Western Macedonia. *J. Ethnobiol. Ethnomed.* **2013**, *9*, 22. [CrossRef]
22. Berisha, R.; Sõukand, R.; Nedelcheva, A.; Pieroni, A. The Importance of Being Diverse: The Idiosyncratic Ethnobotany of the Reka Albanian Diaspora in North Macedonia. *Diversity* **2022**, *14*, 936. [CrossRef]
23. Mustafa, B.; Hajdari, A.; Pulaj, B.; Quave, C.L.; Pieroni, A. Medical and Food Ethnobotany among Albanians and Serbs Living in the Shtërpcë/Štrpce Area, South Kosovo. *J. Herb. Med.* **2020**, *22*, 100344. [CrossRef]
24. Pieroni, A. Local plant resources in the ethnobotany of Theth, a village in the Northern Albanian Alps. *Genet. Resour. Crop Evol.* **2008**, *55*, 1197–1214. [CrossRef]
25. Pieroni, A.; Dibra, B.; Grishaj, G.; Grishaj, I.; Gjon Maçai, S. Traditional Phytotherapy of the Albanians of Lepushe, Northern Albanian Alps. *Fitoterapia* **2005**, *76*, 379–399. [CrossRef] [PubMed]
26. Grasgruber, P.; Mašanović, B.; Prce, S.; Popović, S.; Arifi, F.; Bjelica, D.; Bokůvka, D.; Cacek, J.; Davidović, I.; Gardašević, J.; et al. Mapping the Mountains of Giants: Anthropometric Data from the Western Balkans Reveal a Nucleus of Extraordinary Physical Stature in Europe. *Biology* **2022**, *11*, 786. [CrossRef] [PubMed]
27. Ilić, T.; Kuzmanović, N.; Vukojičić, S.; Lakušić, D. Phytogeographic Characteristics of Montane Coniferous Forests of the Central Balkan Peninsula (SE Europe). *Plants* **2022**, *11*, 3194. [CrossRef]
28. Anwar, T.; Qureshi, H.; Shahzadi, S.; Siddiqi, E.H.; Ali, H.M.; Abdelhamid, M.M.A.; Nazim, M. Exploring the benefits of wild plants in dietary nutrition: Investigating perspectives, choices, health impacts and sustainable practices. *BMC Complement. Med. Ther.* **2024**, *24*, 100255. [CrossRef]
29. Nazari, M.; Ghasemi-Soloklui, A.A.; Kordrostami, M.; Latef, A.A.H.A. Deciphering the response of medicinal plants to abiotic stressors: A focus on drought and salinity. *Plant Stress* **2023**, *10*, 100255. [CrossRef]
30. Matejić, J.S.; Stefanović, N.Z.; Ivkovic, M.; Živanović, N.; Marin, P.D.; Džamić, A.M. Traditional uses of autochthonous medicinal and ritual plants and other remedies for health in Eastern and South-Eastern Serbia. *J. Ethnopharmacol.* **2020**, *261*, 113186. [CrossRef]
31. Cuevas-Cianca, S.I.; Romero-Castillo, C.; Gálvez-Romero, J.L.; Juárez, Z.N.; Hernández, L.R. Antioxidant and Anti-Inflammatory Compounds from Edible Plants with Anti-Cancer Activity and Their Potential Use as Drugs. *Molecules* **2023**, *28*, 1488. [CrossRef]
32. Ashique, S.; Mukherjee, T.; Mohanty, S.; Garg, A.; Mishra, N.; Kaushik, M.; Bhowmick, M.; Chattaraj, B.; Mohanto, S.; Srivastava, S.; et al. Blueberries in focus: Exploring the phytochemical potentials and therapeutic applications. *J. Agric. Food Res.* **2024**, *18*, 101300. [CrossRef]
33. Casas, A.; Blancas, J.; Lira, R. Mexican Ethnobotany: Interactions of People and Plants in Mesoamerica. In *Ethnobotany of Mexico. Ethnobiology*; Lira, R., Casas, A., Blancas, J., Eds.; Springer: New York, NY, USA, 2016; ISBN 978-1-4614-6669-7. [CrossRef]
34. Effiong, C.; Ngang, E.; Ekott, I. Land Use Planning and Climate Change Adaptation in River-Dependent Communities in Nigeria. *Environ. Dev.* **2024**, *49*, 100970. [CrossRef]
35. Anju, T.; Kumar, A. Traditional ecological knowledge and medicinal plant diversity usage among the Mullu Kuruman tribes of Wayanad district of Kerala, India and its implications for biodiversity conservation in the face of climate change. *Trees For. People* **2024**, *16*, 100595. [CrossRef]
36. Torres-García, M.T.; Oyonarte, C.; Cabello, J.; Guirado, E.; Rodríguez-Lozano, B.; Salinas-Bonillo, M.J. The potential of groundwater-dependent ecosystems to enhance soil biological activity and soil fertility in drylands. *Sci. Total Environ.* **2022**, *826*, 154111. [CrossRef] [PubMed]

37. Rosbakh, S.; Fernández-Pascual, E.; Mondoni, A.; Onipchenko, V. Alpine plant communities differ in their seed germination requirements along a snowmelt gradient in the Caucasus. *Alp. Bot.* **2022**, *132*, 223–232. [CrossRef]
38. Mekonnen, A.B.; Mohammed, A.S.; Tefera, A.K. Ethnobotanical Study of Traditional Medicinal Plants Used to Treat Human and Animal Diseases in Sedie Muja District, South Gondar, Ethiopia. *Evid.-Based Complement. Altern. Med.* **2022**, *2022*, 7328613. [CrossRef]
39. Domingo-Fernández, D.; Gadiya, Y.; Mubeen, S.; Bollerman, T.J.; Healy, M.D.; Chanana, S.; Sadovsky, R.G.; Healey, D.; Colluru, V. Modern drug discovery using ethnobotany: A large-scale cross-cultural analysis of traditional medicine reveals common therapeutic uses. *iScience* **2023**, *26*, 107729. [CrossRef]
40. Dietrich, P.; Ebeling, A.; Meyer, S.T.; Asato, A.E.B.; Bröcher, M.; Gleixner, G.; Huang, Y.; Roscher, C.; Schmid, B.; Vogel, A.; et al. Plant diversity and community age stabilize ecosystem multifunctionality. *Glob. Change Biol.* **2024**, *30*, e17225. [CrossRef]
41. Al-Maghrabi, D. The Role of Keystone Plant Species in Ecosystem Dynamics. *Res. Rev. J. Ecol. Environ. Sci.* **2024**, *12*, 56–57.
42. Chomicki, G.; Weber, M.; Antonelli, A.; Bascompte, J.; Kiers, E.T. The Impact of Mutualisms on Species Richness. *Trends Ecol. Evol.* **2019**, *34*, 698–711. [CrossRef]
43. Muchaku, S.; Magaiza, G.; Hamandawana, H. Translating Indigenous Knowledge into Actionable Climate-Change Adaption Strategies: A Case Study of Maluti-a-Phofung Local Municipality, Free State Province, South Africa. *Sustainability* **2023**, *15*, 1558. [CrossRef]
44. Kassam, K.-A. *Biocultural Diversity and Indigenous Ways of Knowing: Human Ecology in the Arctic*; University of Calgary Press: Calgary, AB, Canada, 2012; ISBN 978-1-55238-253-0.
45. Gixhari, B.; Hekuran, V. Geographic distribution of plant genetic resources diversity in tirana region. In Proceedings of the 6th International Conference of Ecosystems (ICE2016), Tirana, Albania, 3–6 June 2016.
46. de Bruin, S.; Holleman, C. Urbanization Is Transforming Agrifood Systems across the Rural–Urban Continuum Creating Challenges and Opportunities to Access Affordable Healthy Diets. In *Background Paper for The State of Food Security and Nutrition in the World 2023*; FAO: Rome, Italy, 2023.
47. Arjona-García, C.; Blancas, J.; Beltrán-Rodríguez, L.; Binnqüist, C.L.; Bahena, H.C.; Moreno-Calles, A.I.; Sierra-Huelsz, J.A.; López-Medellín, X. How does urbanization affect perceptions and traditional knowledge of medicinal plants? *J. Ethnobiol. Ethnomed.* **2021**, *17*, 48. [CrossRef] [PubMed]
48. Grasser, S.; Schunko, C.; Vogl, C.R. Gathering "tea"—From necessity to connectedness with nature. Local knowledge about wild plant gathering in the Biosphere Reserve Grosses Walsertal (Austria). *J. Ethnobiol. Ethnomed.* **2012**, *8*, 31. [CrossRef] [PubMed]
49. Prunier, R.; Holsinger, K.E.; Carlson, J.E. The effect of historical legacy on adaptation: Do closely related species respond to the environment in the same way? *J. Evol. Biol.* **2012**, *25*, 1636–1649. [CrossRef] [PubMed]
50. Inderjit; Catford, J.A.; Kalisz, S.; Simberloff, D.; Wardle, D.A. A framework for understanding human-driven vegetation change. *Oikos* **2017**, *126*, 1687–1698. [CrossRef]
51. Wang, Z.; Wang, T.; Zhang, X.; Wang, J.; Yang, Y.; Sun, Y.; Guo, X.; Wu, Q.; Nepovimova, E.; Watson, A.E.; et al. Biodiversity conservation in the context of climate change: Facing challenges and management strategies. *Sci. Total Environ.* **2024**, *937*, 173377. [CrossRef]
52. O'neill, A.R.; Badola, H.K.; Dhyani, P.P.; Rana, S.K. Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas. *J. Ethnobiol. Ethnomed.* **2017**, *13*, 21. [CrossRef]
53. Molnár, Z.; Aumeeruddy-Thomas, Y.; Babai, D.; Díaz, S.; Garnett, S.T.; Hill, R.; Bates, P.; Brondízio, E.S.; Cariño, J.; Demeter, L.; et al. Towards richer knowledge partnerships between ecology and ethnoecology. *Trends Ecol. Evol.* **2023**, *39*, 109–115. [CrossRef]
54. Ameztegui, A.; Coll, L.; Brotons, L.; Ninot, J.M. Land-use legacies rather than climate change are driving the recent upward shift of the mountain tree line in the Pyrenees. *Glob. Ecol. Biogeogr.* **2016**, *25*, 263–273. [CrossRef]
55. Liang, Q.; Xu, X.; Mao, K.; Wang, M.; Wang, K.; Xi, Z.; Liu, J. Shifts in plant distributions in response to climate warming in a biodiversity hotspot, the Hengduan Mountains. *J. Biogeogr.* **2018**, *45*, 1334–1344. [CrossRef]
56. Rew, L.J.; McDougall, K.L.; Alexander, J.M.; Daehler, C.C.; Essl, F.; Haider, S.; Rabitsch, W. Moving up and over: Redistribution of plants in alpine, Arctic, and Antarctic ecosystems under global change. *Arct. Antarct. Alp. Res.* **2020**, *52*, 651–665. [CrossRef]
57. Ladio, A.H. Ethnobiology and Research on Global Environmental Change: What Distinctive Contribution Can We Make? *Ethnobiol. Conserv.* **2017**, *6*, 1–8. [CrossRef]
58. Torre, L.D.; Cerón, C.; Balslev, H.; Borchsenius, F. A Biodiversity Informatics Approach to Ethnobotany: Meta-analysis of Plant Use Patterns in Ecuador. *Ecol. Soc.* **2012**, *17*, 15. [CrossRef]
59. Chen, I.-C.; Hill, J.K.; Ohlemüller, R.; Roy, D.B.; Thomas, C.D. Rapid Range Shifts of Species Associated with High Levels of Climate Warming. *Science* **2011**, *333*, 1024–1026. [CrossRef] [PubMed]
60. Mattalia, G.; Svanberg, I.; Ståhlberg, S.; Kuznetsova, N.; Prūse, B.; Kolosova, V.; Aziz, M.A.; Kalle, R.; Sõukand, R. Outdoor Activities Foster Local Plant Knowledge in Karelia, NE Europe. *Sci. Rep.* **2023**, *13*, 8627. [CrossRef] [PubMed]
61. Lenoir, J.; Gégout, J.C.; Marquet, P.A.; De Ruffray, P.; Brisse, H. A Significant Upward Shift in Plant Species Optimum Elevation During the 20th Century. *Science* **2008**, *320*, 1768–1771. [CrossRef] [PubMed]
62. Harsch, M.A.; HilleRisLambers, J. Climate Warming and Seasonal Precipitation Change Interact to Limit Species Distribution Shifts across Western North America. *PLoS ONE* **2016**, *11*, e0159184. [CrossRef]

63. Seastedt, T.; Oldfather, M. Climate Change, Ecosystem Processes and Biological Diversity Responses in High Elevation Communities. *Climate* **2021**, *9*, 87. [CrossRef]
64. Kellner, J.R.; Kendrick, J.; Sax, D.F. High-Velocity Upward Shifts in Vegetation Are Ubiquitous in Mountains of Western North America. *PLoS Clim.* **2023**, *2*, e0000071. [CrossRef]
65. Broadbent, A.; Newbold, L.; Pritchard, W.; Michas, A.; Goodall, T.; Cordero, I.; Giunta, A.; Snell, H.; Pepper, V.; Grant, H.; et al. Climate Change Disrupts the Seasonal Coupling of Plant and Soil Microbial Nutrient Cycling in an Alpine Ecosystem. *Glob. Change Biol.* **2024**, *30*, e17245. [CrossRef]
66. Avila, J.V.; Zank, S.; Valadares, K.M.; Maragno, J.M.; Hanazaki, N. The Traditional Knowledge of Quilombola About Plants: Does urbanization matter? *Ethnobot. Res. Appl.* **2015**, *14*, 453–462. Available online: https://ethnobotanyjournal.org/index.php/era/article/view/1103 (accessed on 12 November 2024). [CrossRef]
67. Akbulut, S.; Bayramoglu, M.M. Reflections of Socio-Economic and Demographic Structure of Urban and Rural on the Use of Medicinal and Aromatic Plants: The Sample of Trabzon Province. *Stud. Ethno-Med.* **2014**, *8*, 89–100. [CrossRef]
68. Karaköse, M.; Akbulut, S.; Özkan, Z.C. Ethnobotanical Study of Medicinal Plants in Torul District, Turkey. *Bangladesh J. Plant Taxon* **2019**, *26*, 29–37. [CrossRef]
69. Hanazaki, N. Local and Traditional Knowledge Systems, Resistance, and Socioenvironmental Justice. *J. Ethnobiol. Ethnomed.* **2024**, *20*, 5. [CrossRef] [PubMed]
70. Ludwinsky, R.H.; Hanazaki, N. Ethnobotany in a Coastal Environmental Protected Area: Shifts in Plant Use in Two Communities in Southern Brazil. *J. Ethnobiol. Ethnomed.* **2018**, *14*, 65. [CrossRef]
71. Yin, L.; Zachary, M.; Zheng, Y. The Traditional Knowledge Associated to Biodiversity in an Age of Climate Change. *Earth Sci.* **2018**, *7*, 209. [CrossRef]
72. Altieri, M.A.; Anderson, M.K.; Merrick, L.C. Peasant Agriculture and the Conservation of Crop and Wild Plant Resources. *Conserv. Biol.* **1987**, *1*, 49–58. [CrossRef]
73. LaRochelle, S.; Berkes, F. Traditional Ecological Knowledge and Practice for Edible Wild Plants: Biodiversity Use by the Rarámuri, in the Sirerra Tarahumara, Mexico. *Int. J. Sustain. Dev. World Ecol.* **2003**, *10*, 361–375. [CrossRef]
74. Pascual-Mendoza, S.; Saynes-Vásquez, A.; Pérez-Herrera, A. Traditional Knowledge of Edible Plants in an Indigenous Community in the Sierra Norte of Oaxaca, Mexico. *Plant Biosyst.—Int. J. Deal. All Asp. Plant Biol.* **2022**, *156*, 515–527. [CrossRef]
75. Gómez-Velázquez, J.; Vásquez-López, A.; Regino-Maldonado, J.; Jurado-Celis, S.N. A Review of Local-Scale Agricultural Sustainability in the Coffee Regions of Mexico. *IJANR* **2023**, *50*, 23–45. [CrossRef]