

SOMMARIO

Questa tesi esplora il ruolo dell'etnobotanica in Calabria, con particolare attenzione all'Area Grecanica, evidenziandone l'importanza per la conservazione della biodiversità e la valorizzazione delle tradizioni locali. L'indagine etnobotanica ha documentato l'uso di 157 taxa, selezionandone cinque (*Asparagus acutifolius*, *A. albus*, *Crepis aspromontana*, *Hypochaeris radicata* e *Pimpinella anisoides*) per studi di domesticazione e conservazione *ex-situ*. Analisi morfo-metriche hanno mostrato miglioramenti nelle caratteristiche di alcune specie coltivate, suggerendo il potenziale della domesticazione. Studi fitochimici su *C. aspromontana* hanno rivelato composti antiossidanti, evidenziando il valore nutrizionale delle piante spontanee calabresi. La ricerca sottolinea come l'integrazione delle conoscenze etnobotaniche nelle pratiche agricole moderne possa preservare la biodiversità, rafforzare l'identità culturale e promuovere lo sviluppo economico locale, garantendo un futuro sostenibile per il patrimonio etnobotanico della regione.

ABSTRACT

This thesis explores the role of ethnobotany in Calabria, with a particular focus on the Graecanic Area, highlighting its importance for biodiversity conservation and the valorization of local traditions. The ethnobotanical survey documented the use of 157 taxa, selecting five (*Asparagus acutifolius*, *A. albus*, *Crepis aspromontana*, *Hypochaeris radicata*, and *Pimpinella anisoides*) for domestication studies and *ex-situ* conservation. Morphometric analyses showed improvements in the characteristics of some cultivated species, suggesting the potential of domestication. Phytochemical studies on *C. aspromontana* revealed antioxidant compounds, emphasizing the nutritional value of Calabria's wild plants. The research underscores how integrating ethnobotanical knowledge into modern agricultural practices can preserve biodiversity, strengthen cultural identity, and promote local economic development, ensuring a sustainable future for the region's ethnobotanical heritage.

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Biodiversity conservation and sustainable use of ethnobotanical cultural heritage

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**BIODIVERSITY
 CONSERVATION AND
 SUSTAINABLE USE OF
 ETHNOBOTANICAL
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Da sinistra verso destra: pianta di *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) in natura; vista dall'alto della fiumara Amendolea, Bova, Città Metropolitana di Reggio Calabria, durante un'intervista; pianta di *Scolymus hispanicus* L. (Asteraceae); ghianda di *Quercus pubescens* Willd. subsp. *pubescens* (Fagaceae) utilizzata come pipa giocattolo; collari per capre realizzati con legno di *Morus nigra* L. (Moraceae); pianta di *Hypochaeris radicata* L. (Asteraceae) raccolta durante un'intervista; vasetti con piante di *Asparagus albus* L. (Asparagaceae) raccolte in natura e coltivate in vaso; pianta di *Pimpinella anisoides* L. (Apiaceae) in natura.

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Biodiversity conservation and sustainable use of ethnobotanical cultural heritage

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*Alla mia famiglia:
i miei genitori, Natale e Rebecca.
A voi, con tutto il mio cuore.*

“Success is the sum of small efforts, repeated day-in and day-out”.

Robert Collier

Table of contents

Abstract	1
Riassunto	3
CHAPTER 1. State of the Art	6
1.1. Exploring Ethnobotany: Its Significance and Purpose	6
1.2. The history of ethnobotany in the world.....	7
1.3. Ethnobotany in Europe.....	9
1.4. Ethnobotany in Italy	10
1.5. Ethnobotany in Calabria	12
1.5.1. <i>Graecanic Area</i>	13
1.6. Ethnobotany and Biodiversity Conservation: a Heritage to be Valued	14
1.7. Ethnobotany and Sustainable Development through the Exploitation of Wild Plants: Economic Opportunities and Challenges	16
1.8. The future of ethnobotany	17
2. Aims of the Doctoral Thesis	18
3. References	20
CHAPTER 2. Ethnobotanical Knowledge in Calabria (Southern Italy): a summary review	44
CHAPTER 3. An overview of ethnobotanical knowledge for the enhancement of typical plant food and the development of a local economy: the case of Calabria region (Southern Italy)	65
CHAPTER 4. Ethnobotanical survey in the Graecanic Area of Reggio Calabria (Southern Italy): a treasure chest of biodiversity and traditions at risk of extinction	78

CHAPTER 5. Target Species Selection and Morphometric Analyses: A Study on <i>Asparagus albus</i>, <i>A. acutifolius</i>, <i>Crepis aspromontana</i>, <i>Hypochaeris radicata</i>, and <i>Pimpinella anisoides</i>	108
1. Introduction	108
2. Materials and Methods.....	109
2.1. Selection of target species.....	109
2.1.1. <i>Asparagus acutifolius</i> L. and <i>Asparagus albus</i> L.....	110
2.1.2. <i>Hypochaeris radicata</i> L.	111
2.1.3. <i>Crepis aspromontana</i> Brullo, Scelsi & Spamp.....	112
2.1.4. <i>Pimpinella anisoides</i> V.Brig.....	113
3. Results and discussion	119
4. Conclusions	120
5. References	121
CHAPTER 6. Conservation and Valorization of two endemic Calabrian species used as food within the Graecanic area (Southern-Italy) through domestication trials.	127
CHAPTER 7. A Comparative Morphometric and Phytochemical Analysis of the Calabrian Endemic Treasure <i>Crepis aspromontana</i> with Alimentary Potential..	138
General Conclusions and Future Perspectives	171
List of figures.....	174
List of tables	181
ADDITIONAL ARTICLES	183
APPENDIX 1. The Use of Plants for Building Purposes in the Popular Tradition.....	183
APPENDIX 2. Contribution to the Ethnobotanical Knowledge of Serre Calabre (Southern Italy)	190

APPENDIX 3. Ethnobotanical studies on the Tyrrhenian side of the Aspromonte Massif (Calabria, Southern Italy)	211
APPENDIX 4. A review of <i>Opuntia ficus-indica</i> ethnobotany in Italy and North Africa	230
APPENDIX 5. Floristic update on the SAC "Pentidattilo" (Calabria, Southern Italy).....	253
Acknowledgements	264

Abstract

This doctoral thesis focuses on the importance of ethnobotany in Calabria, particularly in the Graecanic Area, highlighting its crucial role in biodiversity conservation and the promotion of local cultural traditions. The main objective of this work was to investigate the local ethnobotanical knowledge still present in the Graecanic Area and the potential of wild plants, with a specific focus on those used in food, to promote sustainable economic development in the region.

Through a historical and cultural analysis, it has been highlighted how ethnobotany represents a fundamental discipline for understanding the relationships between local communities and surrounding plant resources. The food traditions of Calabria, which include the use of wild plants, were emphasized as an integral part of the Mediterranean diet, known for its health benefits. However, these traditions are at risk due to socioeconomic changes and modernization, making their promotion and conservation necessary.

An important ethnobotanical survey was conducted in the Graecanic Area, revealing a rich heritage of biodiversity and traditions. Interviews with local informants documented the use of 157 species, highlighting the variety of species and their value. Among the most important plants emerging from the survey, five target species were selected for potential domestication and *ex-situ* conservation testing: *Asparagus acutifolius* L., *A. albus*, *Crepis aspromontana* Brullo, Scelsi & Spamp., *Hypochaeris radicata* L., and *Pimpinella anisoides* V.Brigh. These were identified as significant food resources with potential culinary and medicinal applications.

To ensure the conservation of these species, a morphometric analysis was carried out with the aim of developing domestication protocols. The results showed that cultivating some species, such as *A. albus* and *Crepis aspromontana*, improves their morphological characteristics, suggesting that domestication practices can increase the value of these plants.

The research also emphasized the importance of *ex-situ* conservation, through the collection of germplasm from *C. aspromontana* and *P. anisoides*, and germination trials. Vitality tests were conducted to assess the cultivation potential of the selected species, demonstrating how ethnobotany can serve as a tool for the recovery and enhancement of local biodiversity.

Furthermore, phytochemical analyses were conducted on *C. aspromontana*, revealing the presence of phenolic and flavonoid compounds known for their antioxidant properties, suggesting that Calabria's wild plants could contribute to a healthy and nutritious diet.

In conclusion, this thesis highlights the importance of ethnobotany as a tool for biodiversity conservation and the promotion of local traditions. Integrating ethnobotanical knowledge into modern agricultural practices not only ensures the preservation of endemic species but also strengthens the cultural identity of Calabria while promoting economic opportunities for local communities. Through the promotion of wild plants and the dissemination of local food traditions, it is hoped to ensure a sustainable future for Calabria's ethnobotanical heritage, supporting the resilience of communities and their ability to adapt to environmental changes.

Riassunto

La presente tesi di dottorato si focalizza sull'importanza dell'etnobotanica in Calabria, in particolare nell'Area Grecanica, evidenziando il suo ruolo cruciale nella conservazione della biodiversità e nella valorizzazione delle tradizioni culturali locali. L'obiettivo principale di questo lavoro è stato quello di indagare le conoscenze etnobotaniche locali ancora presenti nell'Area Grecanica e il potenziale delle piante spontanee, con un focus specifico su quelle utilizzate nell'alimentazione, per promuovere uno sviluppo economico sostenibile nella regione.

Attraverso un'analisi storica e culturale, è stato messo in evidenza come l'etnobotanica rappresenti una disciplina fondamentale per comprendere le relazioni tra le comunità locali e le risorse vegetali circostanti. Le tradizioni alimentari della Calabria, che includono l'uso di piante selvatiche, sono state messe in luce come parte integrante della dieta mediterranea, riconosciuta per i suoi benefici per la salute. Tuttavia, queste tradizioni sono a rischio a causa di cambiamenti socioeconomici e modernizzazione, rendendo necessaria la loro valorizzazione e conservazione.

Un'importante indagine etnobotanica è stata condotta nell'Area Grecanica, rivelando un ricco patrimonio di biodiversità e tradizioni. Interviste a informatori locali hanno documentato l'uso di 157 specie, evidenziando la varietà delle specie e il loro valore d'uso. Tra le piante più importanti emerse dall'indagine, sono state selezionate cinque specie target con la quale testare una possibile domesticazione e conservazione *ex situ*: *Asparagus acutifolius* L., *A. albus*, *Crepis aspromontana* Brullo, Scelsi & Spamp., *Hypochaeris radicata* L. e *Pimpinella anisoides* V. Brig. Esse sono state identificate come risorse alimentari significative, con potenziali applicazioni sia culinarie che medicinali.

Per garantire la conservazione di queste specie, è stata svolta un'analisi morfometrica, con l'intento di sviluppare protocolli di domesticazione. I risultati ottenuti hanno mostrato che la coltivazione di alcune delle specie, come *A. albus* e *Crepis aspromontana* migliora le caratteristiche morfologiche, suggerendo che le pratiche di domesticazione possono aumentare il valore delle piante.

La ricerca ha anche messo in evidenza l'importanza della conservazione *ex situ*, attraverso la raccolta di germoplasma di *C. aspromontana* e *P. anisoides*, e la realizzazione di prove di germinazione. Sono stati condotti test di vitalità per valutare il potenziale di vitalità e di coltivazione delle specie selezionate, evidenziando come l'etnobotanica possa fungere da strumento per il recupero e la valorizzazione della biodiversità locale.

Su *C. aspromontana*, inoltre, sono state svolte analisi fitochimiche, rivelando la presenza di composti fenolici e flavonoidi, noti per le loro proprietà antiossidanti, suggerendo che le piante selvatiche della Calabria possano contribuire a una dieta sana e nutriente.

In conclusione, questa tesi sottolinea l'importanza dell'etnobotanica come strumento per la conservazione della biodiversità e la valorizzazione delle tradizioni locali. L'integrazione delle conoscenze etnobotaniche nelle pratiche agricole moderne non solo garantisce la preservazione delle specie endemiche, ma contribuisce anche a rafforzare l'identità culturale della Calabria, promuovendo al contempo opportunità economiche per le comunità locali. Attraverso la valorizzazione delle piante spontanee e la diffusione delle tradizioni alimentari locali, si auspica di garantire un futuro sostenibile per il patrimonio etnobotanico calabrese, sostenendo la resilienza delle comunità e la loro capacità di adattarsi ai cambiamenti ambientali.

Keywords

Traditional Knowledge, Wild Plants, Food Plants, Endemic Species, Wild Resources, Phytochemical Analysis.

CHAPTER 1. State of the Art

1.1. Exploring Ethnobotany: Its Significance and Purpose

The term *ethnobotany* was coined by John Harshberger [1] during a lecture at the Academy of Natural Sciences of Philadelphia in the United States, marking the formal establishment of the discipline. Harshberger described ethnobotany as a branch of botany focused on studying the uses of plants by indigenous peoples. Rooted at the intersection of anthropology and botany, ethnobotany also engages fields such as pharmacology, agriculture, and environmental sciences [2,3]. From its inception, the term *ethnobotany* has been multifaceted, with a range of interpretations and nuances associated with the discipline.

In 1916, Robbins et al. [4] argued that ethnobotany was not merely a record of plant uses but also a reflection of traditional impressions of the surrounding environment, expressed through practices and rituals. Later, in 1932, Gilmore [5] expanded this concept, emphasizing that ethnobotany encompassed not only tribal botanical economics but also the entire body of traditional knowledge about plants and plant life.

The ethnobotanical studies conducted by Richard Evans Schultes were so groundbreaking and systematic that he earned recognition as the “father” of modern ethnobotany. Schultes dedicated his career to exploring the relationships between plants and indigenous cultures, particularly focusing on the traditions of Amazonian peoples. In the 1940s, Schultes [6] defined the discipline as the study of the relationships between humans and the surrounding vegetation. Around the same time, Jones [7] highlighted the interrelations between “primitive humans” and plants. Later, Ford [8] refined the focus to the direct interactions between humans and plants.

In the 1990s, Wickens [9] proposed a perspective that concentrated on studying useful plants before their commercialization and eventual domestication, while Martin [10] described ethnobotany as a collection of studies documenting the interactions between local populations and their natural environment.

Over time, ethnobotany has evolved beyond examining the practical uses of plants to include how societies perceive and manage them. The relationships between humans and the plants they depend on are both complex and diverse, leading to numerous redefinitions of the discipline without a definitive consensus on its scope [11].

The human-plant relationship can generally be categorized into two types: abstract and concrete. The abstract dimension pertains to the perception of plants in magical or ceremonial contexts, such as in folkloric rituals, while the concrete dimension refers to the practical use of plants, such as for food preparation or domestic life [12].

It is evident that human existence is intricately linked to the plant kingdom and humanity's ability to harness plant resources [13].

Ethnobotanical research is not confined to the present; it extends back to antiquity. For instance, the presence of fragmented or carbonized plant remains at archaeological sites can provide insights into the alternative uses of specific plants and the agricultural practices of past populations [14]. A second major area of ethnobotany focuses on contemporary human societies. Direct observation among modern indigenous populations, combined with bibliographic data, contributes to the gradual accumulation of a rich repository of knowledge [6].

It is important to note that while ethnobotany primarily examines the traditional and symbolic knowledge of plants within specific cultural contexts, the selection and cultivation of species by indigenous communities is more aptly categorized as an agronomic practice, with its own distinct origins and historical development.

1.2. The history of ethnobotany in the world

Globally, ethnobotany has documented a wealth of knowledge held by indigenous and rural communities regarding the use of plants for food, medicine, and material purposes [15].

The history of ethnobotany is deeply rooted in the European explorations of the New World, during which European travellers began documenting the

plant use practices of indigenous peoples. These early accounts were often incidental and based on empirical observations. A notable example is Christopher Columbus's voyage, during which he first encountered tobacco (*Nicotiana* sp.pl.) being used by the inhabitants of Cuba. In addition to tobacco, Columbus introduced other highly significant plants to Europe, such as maize (*Zea mays* L.), allspice (*Pimenta dioica* (L.) Merr.), and cotton (*Gossypium* sp.pl.), all of which were collected based on local practices [16,17].

In subsequent centuries, explorers and settlers continued to observe and document indigenous plant use, particularly for food and medicinal purposes. Spanish missionaries and conquistadors, for example, recorded the use of plants by civilizations such as the Aztecs and Incas, referencing species like cacao (*Theobroma cacao* L.) and potatoes (*Solanum tuberosum* L.) [18]. These early studies were largely descriptive and often anecdotal, relying on firsthand experiences.

The 18th century marked a shift toward more systematic scientific exploration of natural history. Figures such as Richard Spruce, during his travels in the Amazon, described the ritual use of psychoactive plants like *Banisteriopsis caapi* (Spruce ex Griseb.) Morton [19]. However, ethnobotany remained a fragmented discipline until the late 19th century, with knowledge scattered among the accounts of missionaries and European naturalists.

In the years that followed, ethnobotany advanced further thanks to systematic studies by American botanists such as Stephen Powers and Edward Palmer, who introduced greater scientific rigor to the study of plants used by indigenous populations [8]. This phase marked a transition from casual observation to in-depth scientific investigation, paving the way for modern ethnobotany.

The economic importance of these ethnobotanical discoveries is also evident. Many plants introduced to the Old World through these observations, such as tobacco, maize, and cacao, have become cornerstones of the global agricultural economy, with an estimated annual commercial value in the billions of dollars [15,20].

Studies conducted in various regions, from the Amazon [21] to sub-Saharan Africa, highlight the critical role of ethnobotanical practices in biodiversity conservation and the sustainable management of natural resources [22].

In Asia, the work of Pei Sheng-Ji has documented traditional plant use in the mountainous regions of Tibet and Southeast Asia, providing valuable insights into how communities adapt to harsh climatic conditions and utilize plants for medicinal, nutritional, and ritual purposes [23]. These studies underscore how traditional plant knowledge is deeply intertwined with local culture and demonstrate its contributions to sustainability and biodiversity conservation [3].

In Africa, the significance of ethnobotany is evident in numerous studies that have leveraged traditional plant knowledge to address symptoms associated with COVID-19 and explore potential prevention strategies. These investigations underscore the vital role of medicinal plants in managing health emergencies, highlighting how traditional medicine remains an essential resource for many African communities, even in modern contexts [24-27].

1.3. Ethnobotany in Europe

Ethnobotany has received significant contributions from European scholars, enriching the understanding of traditional practices and biodiversity. This discipline is deeply rooted in a long history of research and documentation of plant knowledge by physicians and naturalists dating back to antiquity [28].

Two particularly impactful areas where European ethnobotany has made a mark are ethnopharmacology and palynology. Ethnopharmacology, for instance, has greatly benefited from researchers such as William Withering, who in the 18th century investigated the use of *Digitalis purpurea* L. for treating dropsy, initiating a systematic analysis of medicinal plants and validating the importance of traditional medicine [29,30]. Another pivotal contribution came from James Mackenzie, who recognized the efficacy of *D. purpurea* in treating cardiac arrhythmias, demonstrating how traditional knowledge can integrate with modern medicine [29]. Today, studies confirm that the leaves of this plant contain

glycosides such as digitoxin and digoxin, which are used in treating cardiac disorders [31].

Similarly, palynology has provided invaluable tools for studying historical interactions between humans and plants. As early as the 19th century, scientists like Christian Ehrenberg and Lennart von Post explored the potential of fossil pollen to reconstruct vegetation changes over time, opening new avenues for understanding ancient agricultural practices and environmental shifts [32-34]. Nonetheless, while palynology provides valuable insights into past vegetation and environmental changes, its role in ethnobotanical research remains secondary to the direct study of cultural practices and human-plant interactions.

In recent decades, the consumption of wild plants has emerged as a significant component of nutrition in the Mediterranean Basin [35,36]. Research has highlighted their nutritional composition, antioxidant and antimicrobial properties, as well as safety considerations associated with their consumption [28,37-39]. Recently, Motti et al. [40] published a review on the contribution of 32 edible flowers to the Mediterranean diet, documenting 251 plant species from 45 families and 141 genera, with a particular focus on Asteraceae.

Numerous ethnobotanical studies have been conducted in Spain, contributing to the preservation of traditions related to plant use not only as food but also as medicine, in crafts, games, and religious rituals [41-48].

Other significant works include studies from Albania [49], Greece [50-53], Italy [40,54-56], and Portugal [57].

1.4. Ethnobotany in Italy

Ethnobotany in Europe has developed particularly in the Mediterranean context, where the climatic and geographical diversity has fostered the proliferation of a vast range of endemic plant species [58].

In Italy, the first ethnobotanical studies date back to the second half of the 20th century, marking the beginning of academic interest in the interaction between local communities and surrounding plant resources. Since the mid-

1970s, research has focused on various Italian regions, exploring the use of wild plants for medicinal, alimentary, magical, and unconventional practices [59,60].

In many rural Italian communities, the use of wild plants remains a living practice [61], with numerous studies documenting the most common uses, local traditions, and *phytonyms*, the dialectal names of plants [62-64].

Northern Italy has been particularly well-documented from an ethnobotanical perspective, with in-depth studies conducted in Lombardy [65-69], Piedmont [69-72], and Tuscany [61,73-80]. Central Italy has also been the focus of numerous ethnobotanical investigations, contributing to the preservation of knowledge related to plant uses [81-84].

In Southern Italy, the conservation of ethnobotanical knowledge is particularly significant due to the strong ties with rural traditions and the continued use of wild plants for alimentary, medicinal, and ritual purposes. Specifically, regions such as Calabria (detailed in section 1.5), Sicily [85-97], Basilicata [98-104] and Campania [63,84,105-112], preserve a rich heritage of local knowledge that survives in rural communities, contributing to the preservation of practices related to the gathering and use of spontaneous plants.

Numerous publications analyse ethnobotanical knowledge on a national scale. A notable example is the work by Ghirardini et al. [55], which highlights the variability and richness of wild food plant use across different Italian communities. This study underscores how local traditions tied to the consumption of these plants are deeply rooted in each community's food culture, emphasizing the central role of taste in their selection and preservation.

Research such as that by Barbera et al. [113] has further emphasized the importance of traditional knowledge in the sustainable management of plants, as demonstrated by Sicilian agricultural practices related to *Opuntia ficus-indica* (L.) Mill. Particularly in southern regions like Calabria, a unique reservoir of biodiversity exists, with numerous wild species still used for alimentary and medicinal purposes thanks to the transmission of traditional knowledge [99-104,113,114]. This knowledge is often linked to sustainable land management practices that have developed over millennia.

1.5. Ethnobotany in Calabria

Calabria has sparked significant ethnobotanical interest. Numerous studies have been conducted on this subject, highlighting the region's cultural stratification, shaped by various peoples, including Greeks, Romans, Byzantines, Arabs, Normans, and Albanians. This has resulted in both linguistic and biological diversity [115]. Furthermore, Calabria remains home to rural communities where subsistence agriculture persists, and some ancient customs are still preserved. It is therefore essential to focus research on this region, rich in living knowledge [116].

Several significant studies have been carried out in Calabria. Barone [117] conducted research in the areas of Falconara and San Lucido (Cosenza), providing valuable insights into local ethnobotany. Leporatti and Pavesi [118] documented numerous traditional uses in the provinces of Catanzaro, Cosenza, and Reggio Calabria, highlighting practices of great interest. Passalacqua et al. [116,119] made a substantial contribution with an extensive collection of medicinal uses in the provinces of Catanzaro, Crotona, Cosenza, and Reggio Calabria. Nebel et al. [120] focused on alimentary uses in the Graecanic Area, exploring the region's culinary traditions. Leporatti and Impieri [121] conducted a study on medicinal uses in the Alto Tirreno Cosentino. Tagarelli et al. [122] collected data on plants used to treat malaria in Calabria, particularly between the 19th and 20th centuries. Siviglia [123] published an important work on traditional uses of edible plants in the Serre Calabre (Vibo Valentia). Bellusci [124] conducted research in the Pollino National Park (Cosenza), while Lupia et al. [125] documented a variety of ethnobotanical uses in Calabria. Maruca et al. [126] focused on the traditional uses of plants in the Reventino Massif (Catanzaro). Musarella et al. [127] carried out an ethnobotanical survey in the areas of Poro and the Calabrian Preserre (Vibo Valentia). Mattalia et al. [115,128] gathered information on ethnobotanical practices among the Arbëreshë, Occitan, and Calabrian populations in the province of Cosenza.

1.5.1. Graecanic Area

The Graecanic Area of Calabria (Fig. 1), located on the southern Ionian side of the Metropolitan City of Reggio Calabria, is characterized by a strong cultural and linguistic identity rooted in Ancient Magna Graecia. This territory preserves a remarkable heritage of ethnobotanical knowledge [120, 129-131] but is also increasingly threatened by pressures arising from modernization and cultural homogenization [132].

The Graecanic communities have developed a symbiotic relationship with the local flora, utilizing a variety of spontaneous plants for alimentary, medicinal, and ritual purposes.

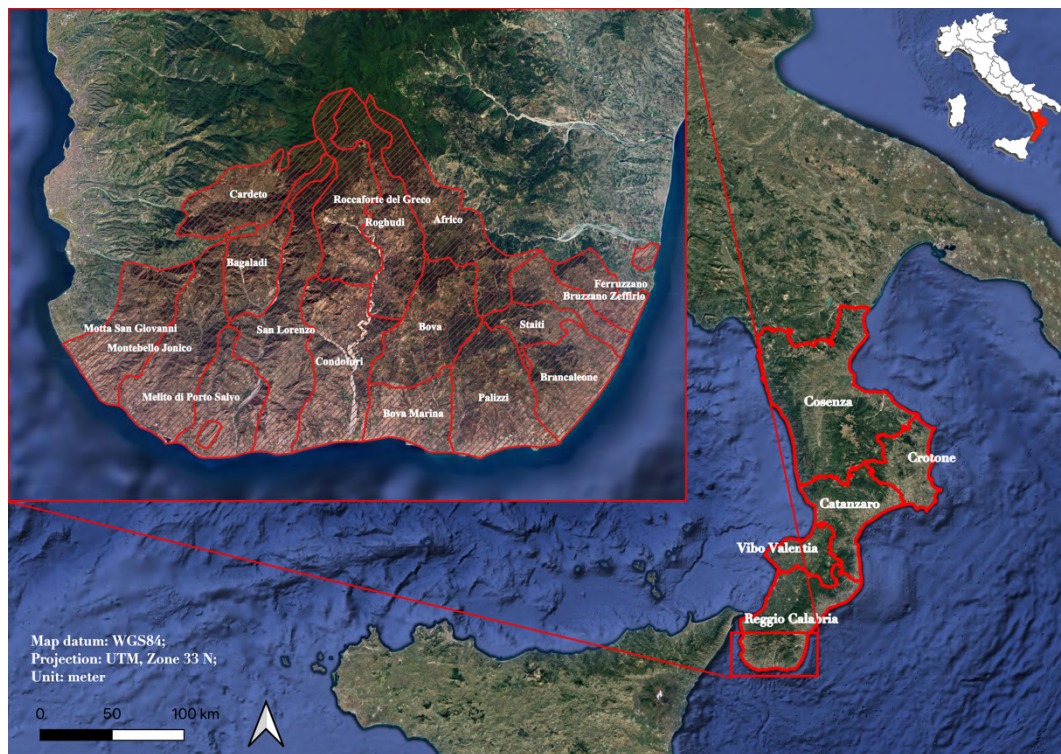


Figure 1. The Graecanic area of the Metropolitan City of Reggio Calabria (Calabria, Southern Italy), with municipal borders highlighted in red. The included municipalities are Africo, Bagaladi, Bova, Bova Marina, Brancaleone, Bruzzano Zeffirio, Cardeto, Condofuri, Ferruzzano, Melito di Porto Salvo, Montebello Jonico, Motta San Giovanni, Palizzi, Roccaforte del Greco, Roghudi, San Lorenzo, and Staiti (adapted from Google© 2024).

This area is distinguished by a strong cultural and anthropological identity that has withstood various global changes for centuries [120]. The Graecanic Area is part of the cultural and linguistic heritage of Magna Graecia (8th century BC) and the history of the subsequent Byzantine Empire in southern Italy. During the Magna Graecia period, the entire eastern Mediterranean was dominated by Greek culture. Today, the Graecanic Area is concentrated in the Aspromonte mountains at the southernmost tip of the Italian Peninsula (Calabria region) and in Salento, in the Apulia region [133].

The inhabitants of the Graecanic Area, compared to the surrounding Italian population, are characterized by an ancestral language (*Graecanico*), a unique culture, and history, as an ethnic and linguistic minority [134]. The geographical isolation of the villages has ensured the preservation of many aspects of their historical-cultural heritage [135].

However, in recent decades, this heritage has faced decline, primarily due to emigration and urbanization. Migration waves and the abandonment of mountain areas have led to significant depopulation, making the intergenerational transmission of Graecanic linguistic and cultural knowledge increasingly difficult [136,137]. Economic transformations, emigration, and natural disasters, such as the floods and earthquakes of 1951 and 1971, have also caused demographic decline and the abandonment of traditional activities, favouring migration to new coastal settlements, the so-called *marine* [138].

1.6. Ethnobotany and Biodiversity Conservation: a Heritage to be Valued

The conservation of biodiversity through ethnobotany has recently been recognized as a fundamental approach to preserving ecosystems, as biodiversity represents both an ecological and cultural resource [139]. In Calabria, rural landscapes rich in native species and medicinal plants are a treasure trove of traditions at risk of being lost due to modernization and the abandonment of traditional agricultural practices [140]. Indigenous knowledge reflects a profound understanding of the local environment accumulated over millennia, offering

sustainable solutions for managing plant resources while maintaining ecosystem balance [141].

Recent studies have highlighted how ethnobotanical knowledge can contribute to the resilience of local communities in the face of climate change, as many traditionally used species are adapted to extreme environmental conditions [142]. The use of wild plants in the Mediterranean diet, such as *Cichorium intybus* L. and *Borago officinalis* L., can open new opportunities for sustainable development, rediscovering and promoting local traditional products [143].

Despite the value of this knowledge, the shift toward modern lifestyles and urbanization has led to the progressive loss of traditional practices involving the collection and use of wild plants, threatening the transmission of this knowledge to future generations [60,144]. Participatory conservation, which involves local populations, has become a globally recognized practice. It not only helps protect plant species at risk of extinction but also preserves traditional knowledge threatened by globalization [139].

Recent studies demonstrate that traditional agricultural practices based on ethnobotanical knowledge are crucial for addressing global challenges such as climate change, genetic erosion, and deforestation. For example, indigenous communities in Latin America and Africa use agroforestry systems that not only conserve biodiversity but also enhance the resilience of local ecosystems [145,146].

Moreover, *ex situ* conservation practices, such as maintaining seed lots in germplasm banks and propagating priority species, are essential for protecting plant biodiversity [147-150]. These measures aim to preserve endangered species, including Crop Wild Relatives (CWRs), and strengthen populations of target plants in their natural habitats.

1.7. Ethnobotany and Sustainable Development through the Exploitation of Wild Plants: Economic Opportunities and Challenges

Beyond its role in biodiversity conservation, ethnobotany has gained increasing importance in sustainable development. Local knowledge of medicinal, food, and agricultural plants offers innovative solutions to contemporary challenges such as food security and global health. Traditional medicinal plants, in particular, have inspired the discovery of numerous active compounds used in modern pharmaceuticals, such as those derived from the Madagascar periwinkle (*Catharanthus roseus* (L.) G.Don), which has yielded effective cancer treatments [151-155].

Beyond medicine, ethnobotany significantly impacts agriculture, where traditional techniques based on the sustainable use of plants reduce dependency on chemical pesticides and fertilizers. Practices such as intercropping and the use of soil-enriching crops are gaining the attention of farmers and researchers seeking more sustainable approaches [156].

Ethnobotany can also stimulate local economic development through sustainable tourism, attracting visitors interested in biodiversity and local traditions [157,158]. This renewed interest in traditional knowledge could encourage further research on plant biodiversity, promoting natural resource conservation and raising awareness within local communities [159].

Investing in the education and awareness of communities regarding ethnobotanical practices can enhance their resilience and adaptability in the face of environmental challenges. Policies supporting the documentation and promotion of these practices can foster synergies between institutions, academics, and local communities, contributing to a more conscious use of natural resources [21].

One of the most relevant aspects of contemporary ethnobotany is the sustainable exploitation of wild species, many of which are underutilized. These species can represent new economic opportunities for farmers and rural communities [28]. However, to mitigate the risk of species extinction due to habitat loss and human pressure, the exploitation of these resources must be

accompanied by conservation and domestication projects. Such efforts can promote both their preservation and the creation of new market opportunities for high-quality local products [160,161].

1.8. The future of ethnobotany

In recent decades, ethnobotany has undergone significant evolution, increasingly integrating multidisciplinary approaches ranging from ecology and conservation biology to cultural anthropology. Today, the discipline no longer focuses solely on studying plant use by indigenous or local communities but also investigates the deep interconnections between humans and the environment, exploring how plants have shaped human societies and *vice versa* [162,163]. This evolution has highlighted the value of traditional knowledge, particularly for biodiversity conservation and sustainable resource management.

Ethnobotany thus emerges as a dynamic discipline, capable of adapting to global needs and addressing contemporary environmental and social challenges. However, its future depends on collaboration with indigenous and local communities, not only to preserve their knowledge but also to ensure they benefit from the shared wisdom. Policies must be developed to protect the rights of indigenous populations, promoting their active involvement in decision-making processes related to natural resource management.

Furthermore, continuing to document and preserve traditional knowledge is crucial for finding a balance between modernization and cultural conservation. This balance could be the key to addressing future challenges related to biodiversity, food security, and global health. In summary, ethnobotany, which began as a study of traditional plant uses, has evolved into a multidimensional discipline, essential for tackling urgent issues of our time. Its ability to bridge traditional knowledge and modern science offers concrete tools for promoting sustainability, protecting biodiversity, and ensuring the well-being of local communities.

2. Aims of the Doctoral Thesis

The following hypotheses formed the starting point of this study:

1. Is ethnobotanical knowledge still alive within the Graecanic Area, a region deeply influenced by Greek culture and characterized by unique cultural and linguistic traditions that have been preserved over time?
2. Among the plants used by the local population, is it possible to identify species of particular interest that can be enhanced through domestication and commercialization processes?

Based on these hypotheses, the following research objectives were outlined:

- **Enhancement of ethnobotanical knowledge in Calabria and the Graecanic Area:** This research aims to document and analyze existing ethnobotanical knowledge, contributing to a database useful for future studies and conservation interventions. Accurate documentation of local knowledge is essential for developing effective conservation strategies. This study aligns with previous research on traditional uses in Southern Italy [99,120]. The findings on the ethnobotanical uses in Calabria are detailed in Chapters 2 and 3, while those regarding the Graecanic Area are presented in Chapter 4.
- **Selection and subsequent valorization of local and endemic species for local exploitation:** Identifying plant species with commercial potential is crucial to promoting biodiversity and ensuring the sustainability of local agricultural practices. As highlighted by Piergiovanni [164] the socioeconomic context is fundamental for the valorization and commercialization of local species and the preservation of native germplasm. The development of this objective is discussed in Chapter 5.
- **Domestication trials of target species:** Domestication trials are essential for developing sustainable agricultural practices that ensure the conservation of native species and their continued use. Five food species

traditionally used by the inhabitants of the Graecanic Area were selected as target species for domestication trials: *Asparagus albus* L., *A. acutifolius*, *Crepis aspromontana* Brullo, Scelsi & Spamp., *Hypochaeris radicata* L., and *Pimpinella anisoides* V.Brig. Research on domestication practices will contribute to better exploitation of local resources, reducing pressure on wild plants [147]. Additionally, the domestication and potential commercialization of these resources could serve as effective strategies to mitigate the exploitation of at-risk resources. These sustainable approaches align with the principles of a circular economy, while simultaneously protecting the planet's biodiversity against challenges posed by climate change [165]. The results of domestication trials for *A. acutifolius*, *A. albus*, and *H. radicata* are presented in Chapter 5, while those for *C. aspromontana* and *P. anisoides* are discussed in Chapter 6.

- **Morphometric and phytochemical analyses of target species:** A detailed analysis of the selected species will provide a clear overview of their morphological and phytochemical characteristics, contributing to a deeper understanding of their potential and highlighting how these traits can be positively or negatively influenced by domestication. Previous studies have shown that domestication can impact the morphological and phytochemical traits of species [166,167]. The methods employed and the results obtained are discussed in Chapter 7.

3. References

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CHAPTER 2. Ethnobotanical Knowledge in Calabria (Southern Italy): a summary review

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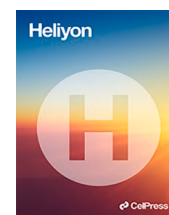
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Ethnobotanical knowledge in Calabria (southern Italy): A summary review

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ABSTRACT

This paper presents a comprehensive overview of ethnobotanical knowledge in Calabria, southern Italy. The diverse plant uses and knowledge in the region stem from the cultural contributions of various populations that have inhabited the area since ancient times. To achieve the stated objective, an in-depth review of 16 bibliographic sources published between 1950 and 2024 was conducted, and data on ethnobotanical uses was extracted. The data were then analyzed using various indices, including CI, CV, FC, PPV, RFC, RI, and UV, to determine the most relevant species, families, and plant parts. A total of 4873 records were collected. The analysis shows that the Asteraceae family is the most used, while *Urtica dioica* L. and *Sambucus nigra* L. are the most frequently used species according to the CV index. Medicinal and alimentary purposes are the most common types of use. This study could serve as a foundation for further detailed research, contributing to the valorisation of the ethnobotanical heritage of this region.

1. Ethnobotanical knowledge: A wealth to be enhanced

As defined by Prance [1], ethnobotany is the study of the relationships between plants and people, including their uses, beliefs, management systems, classification, and language. It also encompasses the aquatic and terrestrial ecosystems associated with them. Prance posits that human existence be unfeasible without plants. In their study, Gilani & Rahman [2] put forth the proposition that herbs and plants have been integral to the human experience since the earliest periods of recorded history.

The studies conducted by Harshberger [3] and Balée [4] demonstrated the strong correlation between cultural practices and the utilization of plants. The studies indicate that plants were not merely material resources, but also held significant symbolic and spiritual meaning for indigenous societies. Subsequently, ethnobotanical studies have developed to integrate cultural understanding with scientific methodology.

The practice of ethnobotanical knowledge among indigenous communities can be traced back to the earliest periods of human civilization and has remained largely unchanged over time [5–7]. The field of ethnobotany is highly regarded for its vast repository of knowledge, as evidenced by numerous scientific contributions [8–11]. In the past, it was common practice for people to utilize wild plants in the preparation of medical remedies, including treatments for animal diseases. This was likely due to the isolation or inaccessibility of certain areas [12,13]. It is noteworthy that even in the present day, certain populations continue to consume seasonal foods derived from wild (or uncultivated) plants that are capable of self-sustainability without direct human intervention [14–16]. Furthermore, these plants are recognized for their high fiber content and bioactive compounds [17–19]. In the field of medicine, plants

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continue to play a crucial role in the development of new drugs [1,20,21], as they tend to produce minimal side effects and are naturally assimilated by the body [22–24].

The significance of plants in Europe, particularly in the Mediterranean region, is well documented. They constitute a fundamental element of the Mediterranean diet, as evidenced by numerous studies [25,26]. Italy, the country of origin of this dietary pattern, has been the subject of numerous studies investigating the beneficial effects of these dietary habits on human health [27,28].

The Italian region of Calabria has attracted considerable interest from ethnobotanists. A substantial body of research has been conducted on this subject [29–44], with studies highlighting the region's cultural stratification, shaped by various peoples including Greeks, Romans, Byzantines, Arabs, Normans, and Albanians. This has resulted in both linguistic and biological diversity [42]. Furthermore, Calabria is still home to rural communities where subsistence farming is practiced, and some archaic customs are still observed. It is therefore imperative that research be concentrated on this region, which is rich in living knowledge [31].

The objective of this study is to synthesize and examine all documented traditional plant uses in Calabria, with the aim of creating a digital database of the region's ethnobotanical heritage. Furthermore, it is essential to ensure the preservation and, more crucially, the promotion of this endangered cultural asset.

2. Materials and methods

2.1. Study area

The area under consideration is the Calabria region (Fig. 1), which spans approximately 15,222 km². Calabria is bordered to the east and south by the Ionian Sea, to the west by the Tyrrhenian Sea, and to the north by the region of Basilicata. The Strait of Messina forms a natural boundary between Calabria from the island of Sicily.

The region is predominantly mountainous, with approximately 90 % of its surface area occupied by two sections of the Apennine chain. These include the southern Apennines, which encompass the Pollino Massif, and the predominantly siliceous Calabrian Apennines, which consist of the Coastal Range, Sila Massif, Serre Calabre and Aspromonte Massif [45]. As stated by Pesaresi et al. [46], the Calabria region exhibits a Mediterranean bioclimate, displaying considerable mesoclimate fluctuations influenced by factors such

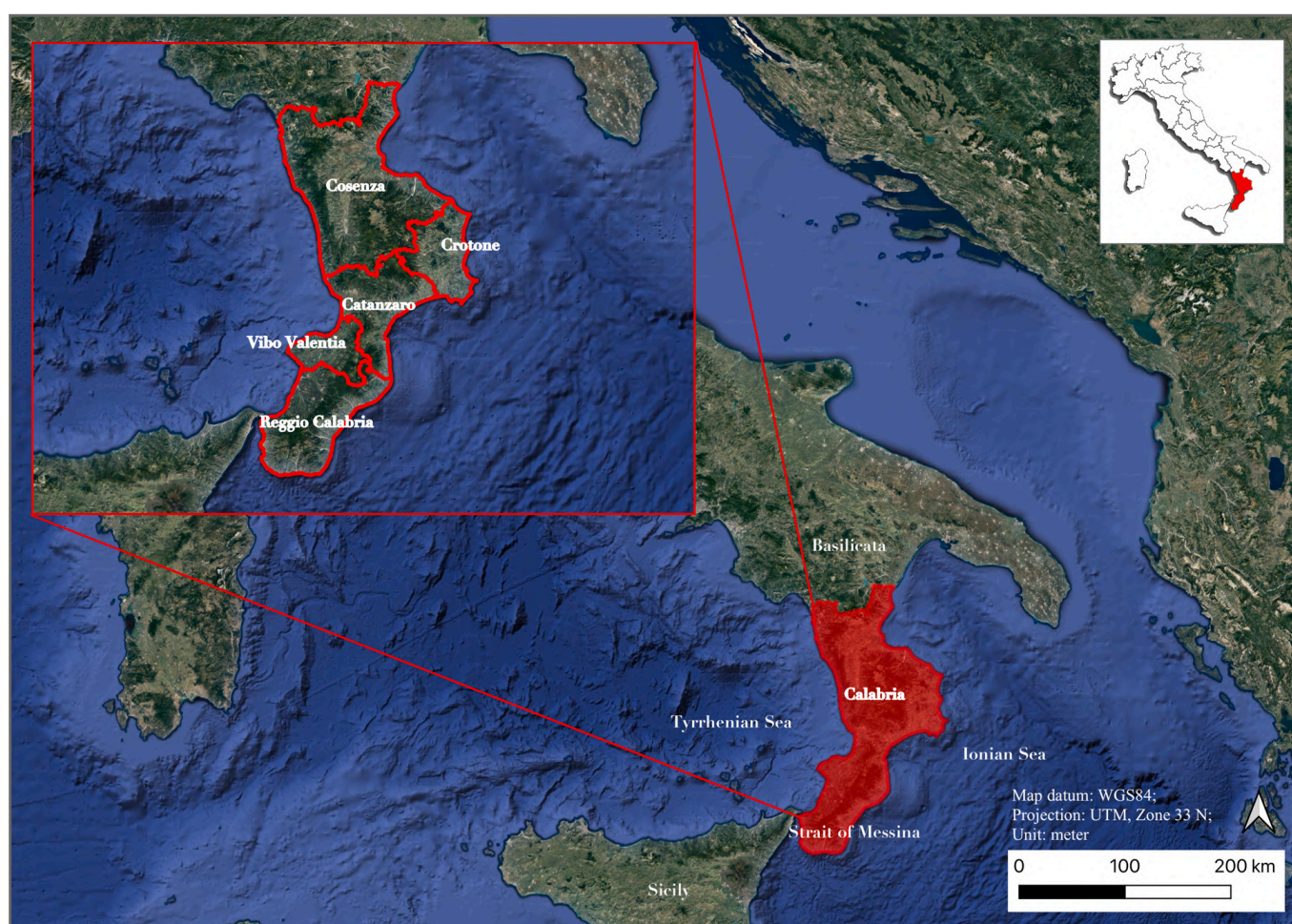


Fig. 1. Calabria region (Southern Italy). In red are the boundaries of the five provinces of the region: Catanzaro, Cosenza, Crotona, Reggio Calabria and Vibo Valentia (adapted from Google© 2024).

as altitude, topography, and proximity to the sea.

2.2. Data collection

To gather information, a variety of online and printed bibliographic sources were consulted. The keywords “Ethnobotany” AND “Calabria” were employed in online searches on the Scopus (last accessed February 20, 2024) and Google Scholar (last accessed February 20, 2024) platforms, with the objective of locating scientific articles pertinent to ethnobotanical studies. The search yielded a total of 13 results on Scopus and 409 results on Google Scholar. All available sources were subjected to a rigorous evaluation process to ascertain their potential inclusion in the database. Furthermore, an exhaustive examination of printed books from a range of libraries was conducted. Following a robust selection process, 13 scientific articles, two books and one master’s thesis were selected for inclusion, as they addressed the specific topic of ethnobotanical uses in Calabria. All other sources that did not directly relate to ethnobotanical uses or focus solely on one species or the region were excluded from further consideration.

The data on the species’ uses were extracted from the bibliographic sources and compiled into a digital database using Microsoft Office Access® software.

The database is structured as follows:

- bibliographic source consulted;
- province;
- municipality;
- locality;
- family;
- taxon (scientific name);
- common name;
- synonyms;
- dialectal name;
- life form and growth mode;
- chorological type;
- origin (native, alien - or allochthonous - and cryptogenic);
- type of use (food, medicinal, craft, recreational, domestic, etc.);
- purpose;
- disease group (for medicinal uses);
- part of the plant used;
- mode of preparation;
- mode of use.

For updated scientific nomenclature (including both scientific binomials and family names), Bartolucci et al. [47] was used for native species, while Galasso et al. [48] was referenced for alien species. The origin of alien taxa was also based on Galasso et al. [48]. The life form of the taxa is classified in accordance with Raunkiaer’s [49] system, while the chorological classification is based on Pignatti [50] approach. The data on medicinal uses were organized in accordance with Cook’s classification system [51].

2.3. Data analysis

In order to quantify the significance of the species within the study area, a series of indices were employed:

- *Cultural Importance Index (CI)* (1) [52,53] which is the sum of the percentage of informants who mention the use of each species and is calculated as follows:

$$CI = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}/N \quad (1)$$

where:

- UR_{ui} is the number of types of use for each species;
- N is the total number of informants.
- *Cultural Value (CV)* (2) [54] which calculates the cultural value of the species as follows:

$$CV = \frac{U_s}{U_{tot}} * \frac{FC}{N} * \left[\sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}/N \right] \quad (2)$$

where:

- U_s is the number of uses for species 's';
- U_{tot} is the total number of potential uses of a species considered in the study;
- FC is the number of respondents mentioning the species;
- N is the total number of informants;
- UR_{ui} is the sum of all Use Reports (UR) of the species, i.e. the sum of the number of respondents who mentioned each use of the species, divided by N.
- *Frequency of Citation (FC)* [55], which refers to how frequently a taxon is cited by informants.
- *Family Importance Value (FIV)* (3) [21], which represents the number of times a botanical family is mentioned by informants. The FIV index is calculated as follows:

$$FIV = \frac{FC_{(family)}}{N} \quad (3)$$

where:

- FC (family) is the number of informants citing family;
- N is the total number of informants.
- *Plant Part Value (PPV)* (4) [56], used to identify the most commonly utilized part of the plant during the interviews, calculated using the following this formula:

$$PPV = \frac{RU_{plant\ part}}{RU} \quad (4)$$

where:

- $RU_{plant\ part}$ is the sum of records with that plant part;
- RU is the total of records with all plant parts.
- *Relative Frequency of Citation (RFC)* (5) [52], which has the same function as the FC index but is relative to the total number of informants, with a value ranging between 0 and 1:

$$RFC = \frac{FC}{N} = \frac{\sum_{i=1}^{i_N} UR_i}{N} \quad (5)$$

where:

- FC is the number of informants mentioning the species;
- N is the total number of informants.
- *Relative Importance Index (RI)* (6) [52] was used to calculate the relative importance of each species and is determined using the following formula:

$$RI = \frac{RFC_{(max)} + RNU_{(max)}}{2} \quad (6)$$

Table 1

List of all the bibliographic sources with the year of publication, the Calabrian provinces (according to Fig. 1) and the types of use documented.

N°	Bibliographic sources	Years of publication	Calabrian provinces	Types of documented use
1	Barone [29]	1963	CS	ME
2	Leporatti and Pavesi [30]	1989	CS, CZ, RC	CO, DO, ME, VE
3	Passalacqua et al. [31,32]	2006; 2007	CS, CZ, KR, RC	AG, AL, CO, DO, FO, HA, LU, MA, ME, RE, VE
4	Nebel et al. [33]	2006	RC	AL
5	Leporatti and Impieri [34]	2007	CS	ME
6	Tagarelli et al. [35]	2010	CS, CZ, KR, RC, VV	ME
7	Siviglia [36]	2011	VV	AL
8	Bellusci [37]	2017	CS	CO, ME, VE
9	Lupia et al. [38]	2017	CS, CZ, KR, RC, VV	AG, AL, CO, DO, FO, HA, LU, MA, ME, OR, RE, VE
10	Maruca et al. [39]	2018	CZ	AG, AL, CO, DO, FO, HA, LU, MA, ME, RE
11	Musarella et al. [40]	2019	VV	AG, AL, CO, DO, HA, MA, ME, OR, RE, VE
12	Mattalia et al. [41,42]	2020a,b	CS	AL, CO, DO, ME
13	Gentile et al. [43]	2022	VV	AG, AL, CO, DO, FO, HA, LU, MA, ME, OR, RE
14	Patti et al. [44]	2024	RC	AG, AL, CO, DO, FO, HA, LU, MA, ME, OR, RE

Calabrian provinces: CS: Cosenza; CZ: Catanzaro; KR: Crotona; RC: Reggio Calabria; VV: Vibo Valentia. Ethnobotanical uses: AG: Agropastoral; AL: Alimentary; CO: Cosmetic; DO: Domestic; FO: Forage; HA: Handicraft; LU: Ludic; MA: Magic; ME: Medicinal; OR: Ornamental; RE: Religious; VE: Veterinary.

where:

- $RFC_{(max)}$ is the Relative Frequency of Citation over the maximum, obtained by dividing FC by the maximum value in all species [$RFC_{(max)} = FC/\max(FC)$]
- $RNU_{(max)}$ is the Relative Number of Use Categories over the maximum, obtained by dividing the number of uses of the species by the maximum value in all species in the survey [$RNU_{(max)} = NU/\max(NU)$].

The CI and RI indices were calculated using RStudio software, version 2023.9.1.494 [57], with the EthnobotanyR package (version 0.1.9), developed by Whitney [58], in accordance with the guidelines set forth by Tardío & Pardo-de-Santayana [52]. In contrast, the CV, FC, FIV, PPV, RFC and UV indices were calculated using the Microsoft Excel® software.

3. Traditional uses found in Calabria

A total of 16 bibliographic sources were consulted, comprising 13 scientific articles, two books and one master's thesis. These sources contain information on all the Calabrian provinces (Table 1).

For each Calabrian province, the specific study areas referenced in the published literature were identified, along with the relevant species records and their documented uses (Fig. 2). Fig. 2 illustrates the distribution of publications and known records across the five Calabrian provinces. It is noteworthy that the table in the bottom right corner indicates that the province of Cosenza has the highest number of publications (8) and records (2241). This is likely due to the presence of rural populations in the region who possess extensive ethnobotanical knowledge across a broader territory. The province of Reggio Calabria has been the subject of study in both the Ionian strip (Graecanic area) and in the Tyrrhenian strip, with a total of five publications and 822 records. The provinces of Vibo Valentia and Catanzaro each have four publications. The province of Crotona has been the subject of fewer studies than other provinces, with only two publications and 88 records.

The existence of numerous studies in a single region indicates a particular interest in the preservation of traditional knowledge pertaining to the utilization of plants.

A total of 4873 records were obtained from the bibliographic sources consulted, providing detailed information on the uses of 517 taxa belonging to 97 families and 318 genera. The full list of families, along with the number of taxa in each, the number of records, the FC index (family) and the FIV index (%) (3), is provided in Table 2.

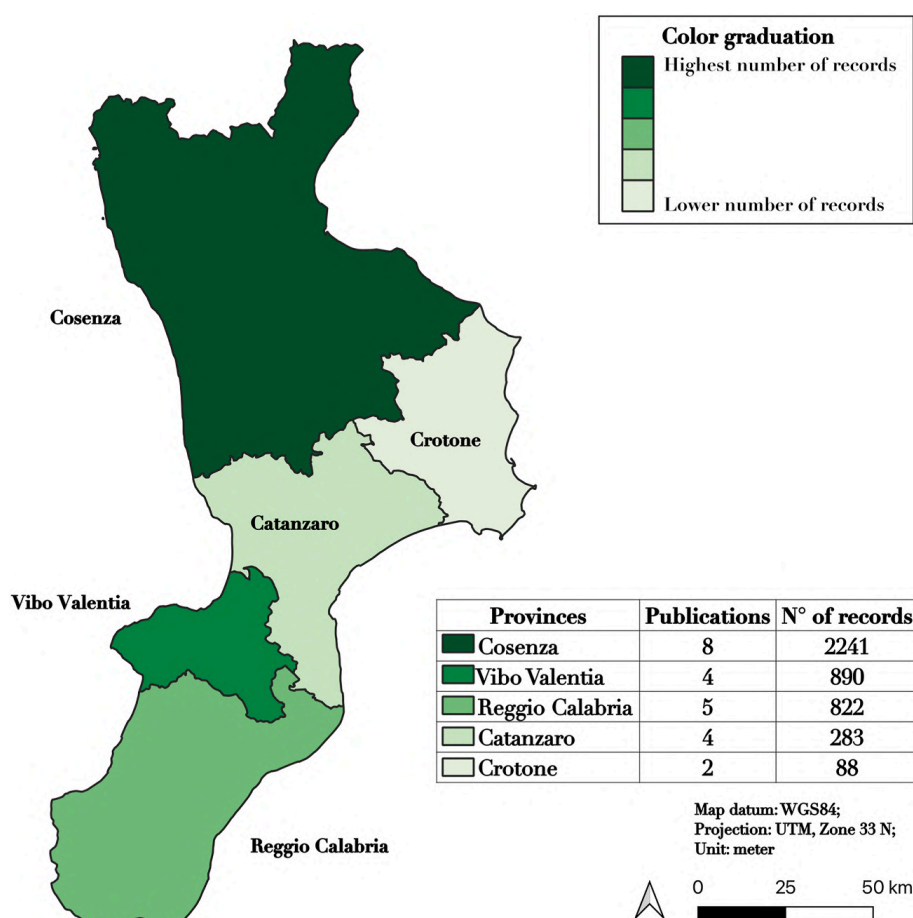


Fig. 2. Distribution of ethnobotanical knowledge documented in the literature across the five Calabrian provinces (adapted from Google© 2024).

According to Table 2, the families with the highest number of records are Asteraceae (679), Lamiaceae (408), Rosaceae (394), and Apiaceae (261). The Family Importance Value (FIV) 3 confirms the importance of these families in the region: Asteraceae, Lamiaceae and Rosaceae each have an FIV value of 100 %, meaning that they are mentioned in all 16 bibliographic sources consulted. Apiaceae, mentioned in 14 bibliographic sources, has an FIV of 87.50 %.

A total of 517 taxa were recorded, including 51 subspecies and 12 genera. The three most common life forms were Hemicryptophytes (33 %), Phanerophytes (22 %), and Therophytes (21 %). These life forms reflect the typical characteristics of many species in the Calabrian territory and are adaptations to different ecological conditions [59–62]. It is important to note that other life forms, although present in smaller percentages, contribute to the significant ecological diversity among the species considered (Fig. 3).

In terms of chorological types (Fig. 4), the most representative group comprises 38.2 % of the species observed in Calabria. This group belongs to the Mediterranean chorotype *sensu lato*. Within this category, the Mediterranean chorotype is further subdivided into three types: Stenomediterranean (19 %), Eurimediterranean (19 %), and Mediterranean-Mountain (0.2 %). This division highlights the significant presence of species typical of Mediterranean and Mediterranean-Mountain environments in the region. This distribution is consistent with the regional bioclimate [46]. The Eurasian chorotype follows, with 25 % of the taxa. Notably, there is also a significant presence of cultivated taxa (12 %) and a smaller percentage of alien taxa (5 %). These results highlight the remarkable heterogeneity and complexity of the Calabrian flora, with dynamic interactions between native, alien and cultivated taxa [63].

In terms of origin, taxa were classified as native (N), alien (A) and cryptogenic (C), where each category is split into cultivated and wild (Fig. 5). As shown in Fig. 5, native taxa dominate (80.6 %) with 79.3 % of wild native and 1.4 % cultivated native taxa: this highlights the significant ethnobotanical importance of native species in the region. Alien taxa represent 17.8 %, with 10.3 % of this group consisting of cultivated and 7.6 % of wild taxa. Cryptogenic taxa represent only 1.5 % of the entire regional ethnobotanical flora.

Among other data, the plant parts used for ethnobotanical purposes, as reported in publications, were also recorded (Fig. 6). The most used parts are the leaves (1452 records), followed by the fruits (819) and aerial parts (664).

The Plant Part Value (PPV) index highlights the most frequently used plant parts by comparing the records for each part ($RU_{\text{plant part}}$) with the total number of records (4873): Table 3 shows the most frequently used plant parts according to the PPV index.

As shown in Fig. 6 and Table 3, the most frequently used plant parts are the leaves (1452 records and PPV 0.298), followed by the fruits (819 records and PPV 0.168) and the aerial parts (664 records and PPV 0.136). Almost all parts of the plant are used, depending on the intended use. For example, the leaves of *Malva sylvestris* L. are consumed as food (in salads and in main dishes) [36], while the flowers of the same plant are used in infusions and medicinal decoctions [43].

3.1. Types of use

Plants are used for a variety of purposes, and those recorded for the Calabria region are summarized in Fig. 7. The figure shows different types of plant use, organized by the number of records and the number of taxa used for each specific purpose.

The most common uses are medicinal (2588 records and 277 taxa) and food (1764 records and 299 taxa), which are often more common than other uses because they form the basis of human survival [64,65]. Since ancient times, people have relied on local plants for food and natural remedies for ailments. Less common are uses related to daily life, such as domestic uses (135 records and 62 taxa), which include purposes such as cleaning dishes and preparing perfumes and soaps. Equally important is the category “handicraft” (119 records and 53 taxa), which includes the professional manufacture of items such as chairs, baskets and spoons.

The data collected from the bibliographic sources were classified by types of use, and Fig. 8 illustrates the composition of these sources according to the number of records for each type of use.

Fig. 8 shows that some publications focused exclusively on medicinal uses [29], while others focused on food uses [33]. In any case, these two types of uses are present in almost all the studies and represent the most significant uses in terms of the number of records.

Domestic use (highlighted in yellow) is also well represented in several publications, confirming the importance of plants in everyday life. Although ludic, magical, ornamental, and religious uses are less frequently mentioned, but still provide valuable insights that will be discussed in more detail later.

In order to highlight the most important, versatile and widely known taxa, several indices were calculated on the basis of the collected data. Table 4 lists some of the species from the publications, ranked by decreasing Cultural Value (CV) index. The full list of taxa, including information on common names, dialect names, life forms, chorological types, origins, uses, purposes, and associated indices, can be found in Supplementary Material 1.

According to the CV index (2), the most relevant species is *Urtica dioica* L. (CV 2.920). A total of 115 records (UR) were collected for this taxon, and it also has a high value for the CI (7.188), RFC (0.813), RI (0.717) and UV (0.500) indices. This species is used for six different types of uses (U_s), including agropastoral, handicrafts, food (e.g. omelettes and pasta dishes), cosmetics, household and medicinal uses, especially for its diuretic and hypotensive properties. *Urtica dioica* is widely used in different regions of Italy [66–71] and is a common species, as evidenced by numerous publications worldwide [72–75].

Another important species is *Sambucus nigra* L. (CV 1.969), which is well known and widely used in Calabria. It appears in almost all the publications consulted (14 out of 16) and has the highest RFC index (0.875) among the species recorded. Other indices also confirm its importance in the region (CI 6.750; RI 0.582; UV 0.333). *Sambucus nigra* is mainly used in four categories, but the most common uses are in the food and medicinal fields. Elderflower, locally known as “*fiuri i maju*”, is often used to flavour omelettes, side dishes, and to stuff “*pitta chijna*” (Vibo Valentia) [36,43], and in the medicinal field to prepare decoctions for anti-inflammatory purposes, such as the treatment of skin inflammations, reddened eyes, or wounds [29,40,43].

Opuntia ficus-indica (L.) Mill., an invasive neophyte plant species, has “colonized” the regional territory over time [76,77], adapting to drier environments where it competes with native plants typical of the Mediterranean belt. In Calabria, this species has found a place

Table 2

Comprehensive list of recorded families in alphabetical order, including the number of taxa in each family, the number of records, the FC index (family) and the FIV index (%) (3).

N°	Family	Number of records	Number of taxa	FC (family)	FIV %
1	Acanthaceae	1	1	1	6.25
2	Aizoaceae	2	2	1	6.25
3	Amaranthaceae	40	6	9	56.25
4	Amaryllidaceae	111	9	11	68.75
5	Anacardiaceae	14	2	6	37.50
6	Apiaceae	261	17	14	87.50
7	Apocynaceae	10	2	5	31.25
8	Aquifoliaceae	3	1	2	12.50
9	Araceae	4	2	2	12.50
10	Araliaceae	10	1	6	37.50
11	Arecaceae	4	3	2	12.50
12	Aristolochiaceae	1	1	1	6.25
13	Asparagaceae	107	8	13	81.25
14	Asphodelaceae	17	4	5	31.25
15	Aspleniaceae	7	1	4	25.00
16	Asteraceae	679	77	16	100.00
17	Berberidaceae	3	1	1	6.25
18	Betulaceae	25	5	5	31.25
19	Boraginaceae	95	6	14	87.50
20	Brassicaceae	138	27	13	81.25
21	Cactaceae	62	1	12	75.00
22	Campanulaceae	2	1	1	6.25
23	Cannabaceae	12	3	6	37.50
24	Capparaceae	38	1	6	37.50
25	Caprifoliaceae	10	1	2	12.50
26	Caryophyllaceae	20	7	8	50.00
27	Cistaceae	2	2	1	6.25
28	Convolvulaceae	22	6	6	37.50
29	Coralliaceae	2	1	1	6.25
30	Cornaceae	1	1	1	6.25
31	Crassulaceae	16	6	6	37.50
32	Cucurbitaceae	27	6	5	31.25
33	Cupressaceae	13	2	4	25.00
34	Dennstaedtiaceae	6	1	4	25.00
35	Dioscoreaceae	4	1	2	12.50
36	Dipsacaceae	11	4	4	25.00
37	Dryopteridaceae	3	2	2	12.50
38	Ebenaceae	1	1	1	6.25
39	Equisetaceae	28	2	10	62.50
40	Ericaceae	47	2	9	56.25
41	Euphorbiaceae	22	7	9	56.25
42	Fabaceae	190	31	16	100.00
43	Fagaceae	88	10	15	93.75
44	Gentianaceae	9	2	5	31.25
45	Heliotropiaceae	4	1	4	25.00
46	Hypericaceae	22	2	7	43.75
47	Iridaceae	8	5	3	18.75
48	Juglandaceae	74	1	14	87.50
49	Juncaceae	5	2	3	18.75
50	Lamiaceae	408	40	16	100.00
51	Lauraceae	120	1	12	75.00
52	Linaceae	1	1	1	6.25
53	Loranthaceae	3	1	2	12.50
54	Lythraceae	29	2	8	50.00
55	Malvaceae	167	4	11	68.75
56	Moraceae	123	3	12	75.00
57	Myrtaceae	71	4	14	87.50
58	Oleaceae	53	4	12	75.00
59	Onagraceae	7	2	3	18.75
60	Orchidaceae	1	1	1	6.25
61	Orobanchaceae	2	1	1	6.25
62	Oxalidaceae	8	3	3	18.75
63	Papaveraceae	55	5	12	75.00
64	Passifloraceae	3	1	1	6.25
65	Phytolaccaceae	2	1	2	12.50
66	Pinaceae	30	5	6	37.50
67	Piperaceae	2	1	1	6.25

(continued on next page)

Table 2 (continued)

N°	Family	Number of records	Number of taxa	FC (family)	FIV %
68	Plantaginaceae	41	8	12	75.00
69	Plumbaginaceae	2	1	2	12.50
70	Poaceae	169	18	13	81.25
71	Polygonaceae	34	11	7	43.75
72	Polypodiaceae	3	3	3	18.75
73	Portulacaceae	37	1	12	75.00
74	Primulaceae	5	3	3	18.75
75	Pteridaceae	23	1	4	25.00
76	Ranunculaceae	63	6	12	75.00
77	Resedaceae	4	1	2	12.50
78	Rhamnaceae	20	2	5	31.25
79	Rosaceae	394	31	16	100.00
80	Rubiaceae	10	5	3	18.75
81	Rutaceae	88	7	10	62.50
82	Salicaceae	22	6	7	43.75
83	Santalaceae	14	2	4	25.00
84	Sapindaceae	3	2	2	12.50
85	Scrophulariaceae	65	7	9	56.25
86	Smilacaceae	16	1	3	18.75
87	Solanaceae	76	10	12	75.00
88	Tamaricaceae	3	2	2	12.50
89	Thymelaeaceae	8	1	3	18.75
90	Typhaceae	5	2	3	18.75
91	Ulmaceae	6	1	4	25.00
92	Urticaceae	221	5	15	93.75
93	Valerianaceae	18	4	6	37.50
94	Verbenaceae	16	2	5	31.25
95	Viburnaceae	115	2	14	87.50
96	Violaceae	7	3	5	31.25
97	Vitaceae	19	1	6	37.50
TOT	97	4873	517	-	-

*Corallinaceae are a family of red algae.

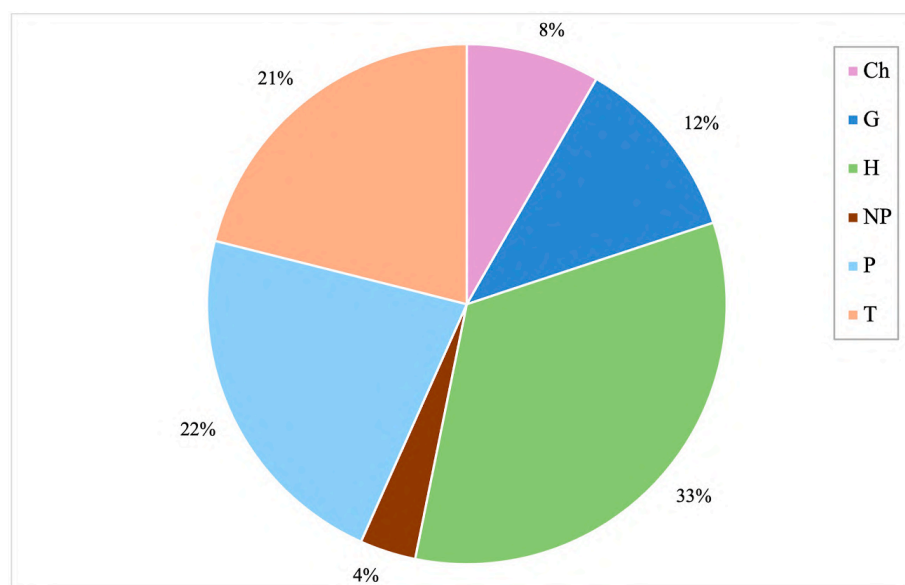


Fig. 3. Life spectrum of ethnobotanical taxa detected in Calabria (Southern Italy). Ch- Chamaephytes; G- Geophytes; H- Hemicryptophytes; NP- Nanophanerophytes; P- Phanerophytes; T- Therophytes [49].

in local ethnobotany [29,30,32,33,35,38–44]. It has 62 records and is used for five different types of use. Its indices are quite high (CI: 3.875; CV: 1.211; RFC: 0.750; RI: 0.484; UV: 0.417), indicating how people have adapted to environmental changes and integrated this plant into their practices.

3.1.1. Medicinal uses

The most common use category is medicinal, with 2588 records and 277 different taxa (Fig. 7). Within this category, numerous

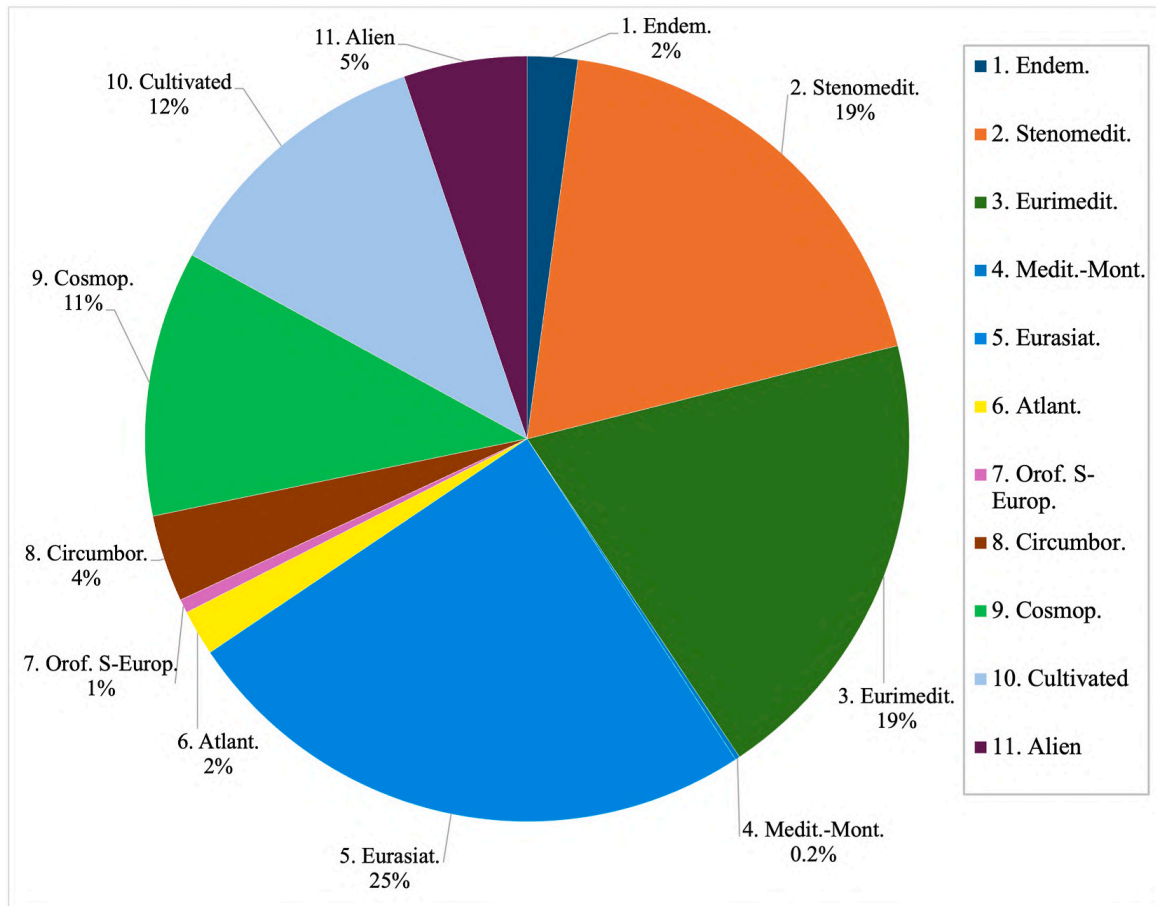


Fig. 4. Chorological spectrum of ethnobotanical taxa use detected in Calabria (Southern Italy) according to Ref. [50].

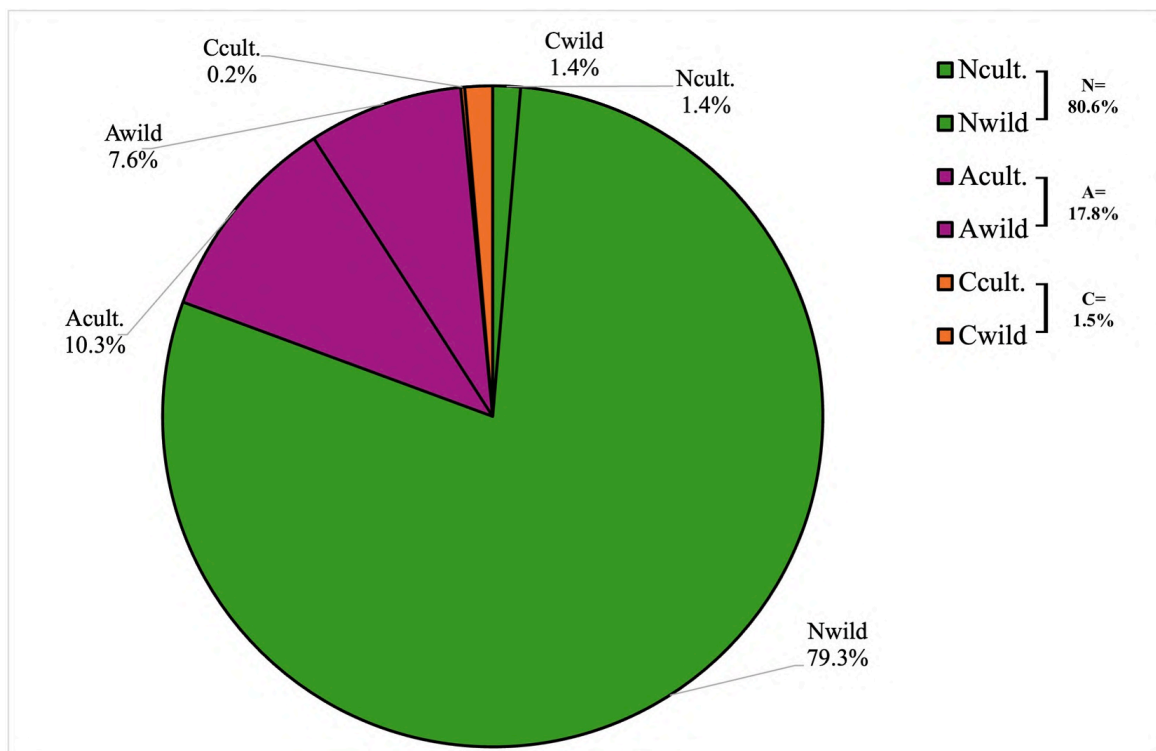


Fig. 5. Origin of ethnobotanical taxa detected in Calabria (Southern Italy) in accordance with [48]. Acult. – Alien cultivated; Awild – Alien wild; Ccult. – Cryptogenic cultivated; Cwild – Cryptogenic wild; Ncult. – Native cultivated; Nwild – Native wild.

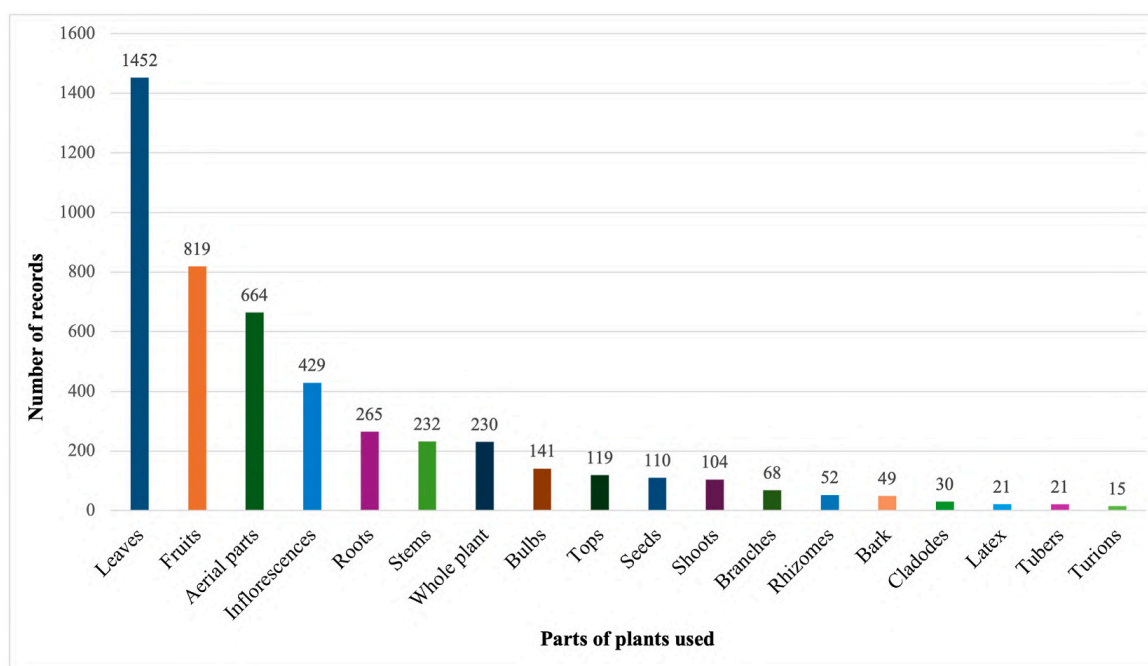


Fig. 6. Plant parts most used for ethnobotanical purposes in Calabria (Southern Italy).

Table 3

Most frequently used plant parts for ethnobotanical purposes in Calabria (Southern Italy) ranked by Plant Part Value (PPV) index (4).

Parts of plants used	RU _{plant part}	PPV
Leaves	1452	0.298
Fruits	819	0.168
Aerial parts	664	0.136
Inflorescences	429	0.088
Roots	265	0.054
Whole plant	232	0.048
Stems	230	0.047
Tops	141	0.029
Bulbs	119	0.024
Seeds	110	0.023
Shoots	104	0.021
Branches	68	0.014
Rhizomes	52	0.011
Barks	49	0.010
Cladodes	30	0.006
Tubers	21	0.004
Latex	21	0.004
Turions	15	0.003

subcategories cover different health problems. For example, the subcategory “1-Digestive system disorders” includes treatments for digestive tract disorders, tracheitis and dental problems (Fig. 9). This subcategory stands out with the highest number of records (659) and the largest number of taxa (167) used to treat these ailments.

The second most common medicinal category is “2-Skin, ear, hair, and wounds”, with 657 records and 154 different taxa. This is followed by the third category, “3-Systemic diseases”, which includes diseases that affect the whole organism, such as fever, with 318 records and 89 different taxa.

Table 5 shows the most frequently used taxa within the medicinal use category, together with the number of disease groups for which they are used.

According to Table 5, the most frequently used medicinal plant in Calabria is *Malva sylvestris*, with 143 records and applications in 8 different groups of ailments. It is widely used for gastrointestinal inflammation (1-Digestive) by preparing an infusion or decoction of the aerial parts, which is consumed hot to relieve abdominal pain. The aerial parts are also used as an anti-odontal agent: a paste is made and applied to the teeth to relieve pain. It also has healing properties, useful for treating small wounds (2-Skin). Its roots are used to treat bronchitis and to suppress coughs (5-Respiratory) by hot infusion or decoction. The aerial parts also have sedative properties (6-Nervous). *Malva sylvestris* is not only widespread in Calabria, but also in other Italian regions [31,66,67,78–82]. Phytochemical

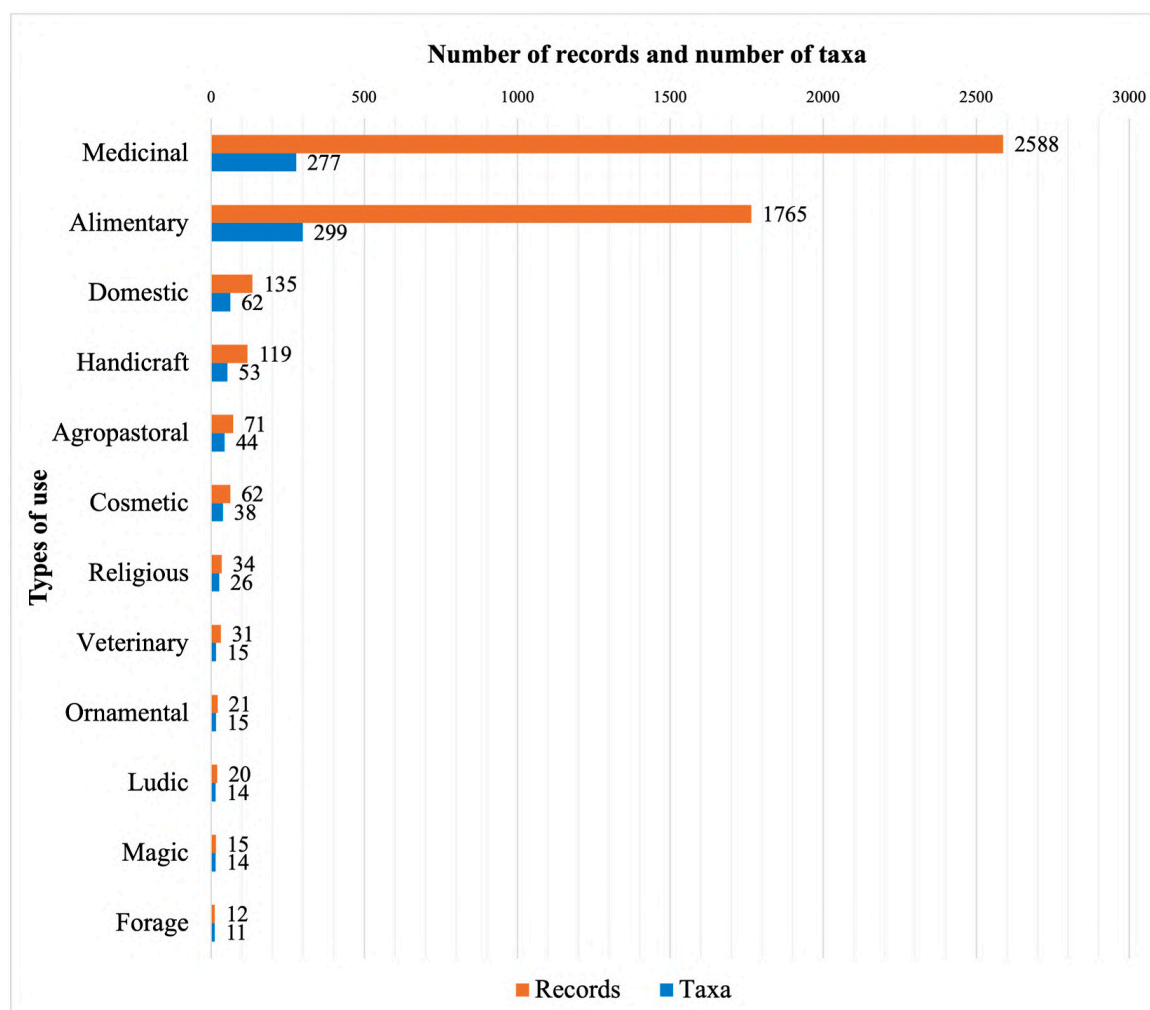


Fig. 7. Types of ethnobotanical use of taxa detected in Calabria (Southern Italy), sorted according to the number of records and taxa for each use.

studies also confirm the presence of bioactive compounds with various medicinal effects [83–85].

The second most used medicinal taxon is *Laurus nobilis* L. with 83 records for 8 different disease categories. Laurel is typically used in infusions and decoctions for abdominal pain and digestive problems (1-Digestive), menstrual pain (4-Genito-urinary) and as a mild sedative (6-Nervous). In Calabria, *L. nobilis* is often cultivated in gardens due to its widespread medicinal use. This plant is well known in the regions surrounding Calabria, such as Basilicata [85–88] and Sicily [67,89–91] as well as in other Italian regions, including Campania [92–95], Latium [96,97], Liguria [81,98], Lombardy [99,100], Marche [101], Piedmont [68], Apulia [102], Sardinia [103–107], and Tuscany [66,82,108].

A notable taxon is *Cynodon dactylon* (L.) Pers., a native species that commonly infests cultivated fields but has considerable medicinal value. It is mentioned 56 times in 6 different disease categories, mainly for its antispasmodic (1-Digestive), antipyretic (3-Systemic), and diuretic (4-Genito-urinary) properties. Decoctions made from its aerial parts or rhizome are commonly administered. This taxon is widely recognized for its medicinal applications in several Italian regions, including Basilicata [87,88], Campania [93,94,109], Latium [96,97], Liguria [110], Lombardy [100], Molise [111], Apulia [112], Sardinia [102], Sicily [67,89,113–115], and Tuscany [66,81,82,98].

Some taxa primarily known for their culinary use have also shown medicinal properties. *Salvia rosmarinus* Spenn and *Allium sativum* L. are two species that are widely used in cooking but also have medicinal interest. *Salvia rosmarinus* has 39 records for 6 different medicinal purposes; its aerial parts are mainly used to treat skin inflammations and wounds, including cuts, scratches, abscesses and sores. Methods of preparation include decoctions for topical application or the preparation of ointments from powdered aerial parts mixed with olive oil. The medicinal use of this plant is well documented, with studies highlighting its therapeutic potential [116–118]. *Allium sativum* has 40 records for 7 different disease groups. It is used mainly as a laxative (1-Digestive), either by boiling the bulb and drinking the water, or by eating it raw. Garlic bulbs are also used as a callifuge (2-Skin) by making a poultice with minced garlic and olive oil. It also has hypotensive (6-Nervous) and anti-rheumatic (8-Muscul.) properties. Numerous studies confirm the medicinal properties of *A. sativum* [119–121].

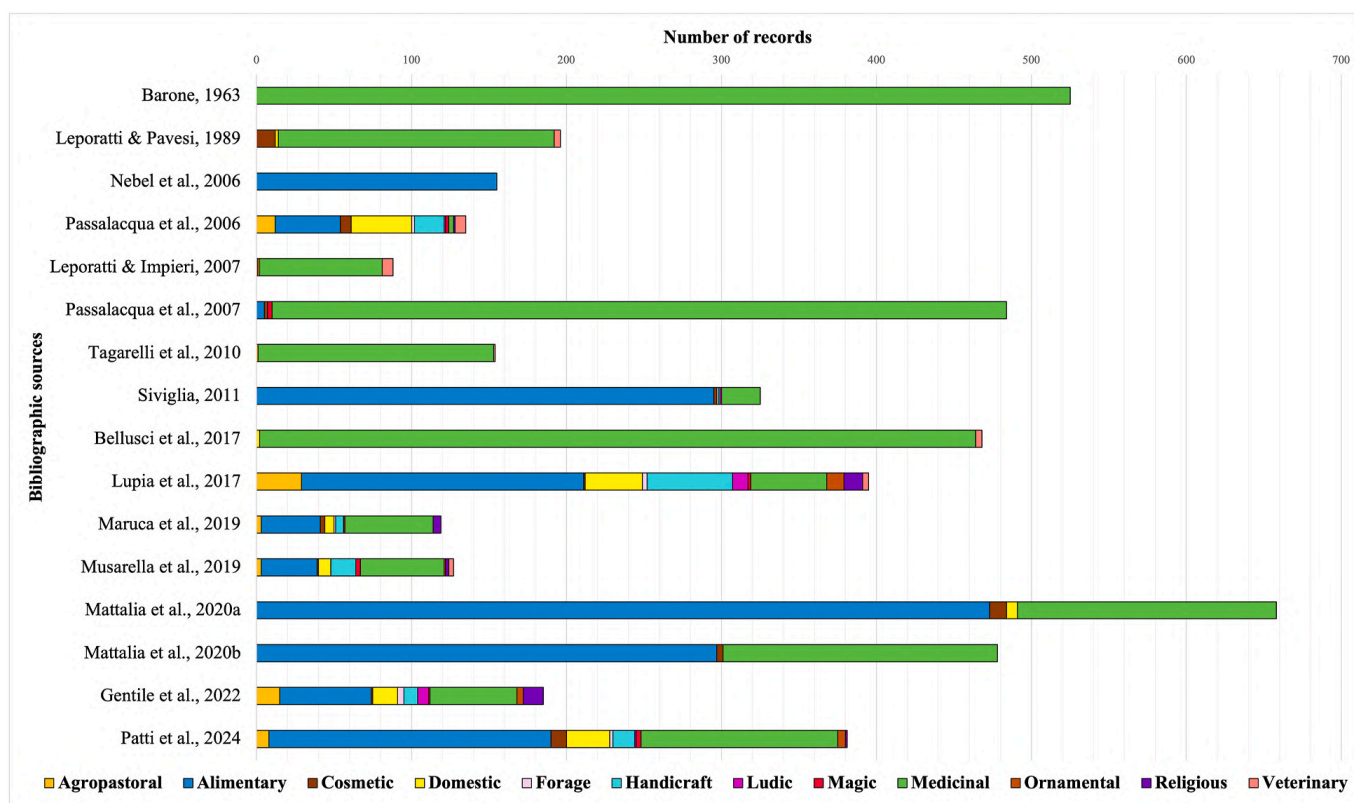


Fig. 8. Composition of the bibliographic sources analyzed, categorized by the number of records for each type of use of the taxa surveyed in Calabria (Southern Italy).

3.1.2. Food uses

The food category is defined as any substance that is used as food. This review subdivides the different food uses into categories, with the objective of identifying the most commonly occurring ones. The resulting categorization is illustrated in Fig. 10. The categories with the greatest significance are those related to soup preparation (269 records and 98 different taxa) and side dishes (236 records and 90 taxa). In Calabria, boiled vegetables are a common ingredient in soups and side dishes. They are often cooked with oil, salt, garlic and other spices [122].

The plants are widely used as a snack (234 records and 71 taxa), with the fruit often consumed directly from the plant. Examples of this include the fruits of *Arbutus unedo* L. (10 records) and *Ficus carica* L. (22 records).

Seasoning is also a common food use, with 206 records and 61 taxa. In this context, plant parts such as leaves, flowers, or twigs are added to dishes with the intention of enhancing their aroma or flavour. Notable examples include *Allium ursinum* L. (7 records), *Salvia officinalis* L. subsp. *officinalis* (6 records), *Salvia rosmarinus* (7 records) and *Anethum piperitum* Ucria (48 records). The latter is the most cited taxon within the food category with 71 records. Other frequently cited taxa include *Rubus ulmifolius* Schott (50 records), *Juglans regia* L. (43 records) and *Borago officinalis* L. (40 records).

The practice of preparing salads using a variety of plant species, typically consumed raw, is widespread (13 records and 93 taxa). The most frequently utilized species within this subcategory is *Portulaca oleracea* L., with 14 records. The raw aerial parts are consumed, and the plant is rich in antioxidant compounds, such as omega-3, which are essential for human health [123–125].

The preparation of omelettes and fritters with plants is a typical practice in Calabria, with 128 records and 54 different taxa. Leaves, shoots, young shoots, or flowers are incorporated into eggs and cheese mixtures (for omelettes) or (for fritters), which are then fried. The most frequently utilized taxon for this preparation is *Asparagus acutifolius* L. (15 records), with young shoots being incorporated into egg mixtures. Another frequently utilized taxon is *Clematis vitalba* L. (13 records), wherein shoots are boiled and subsequently incorporated into egg preparations.

The beverage category encompasses preparations related to the production of liqueurs and other alcoholic and non-alcoholic beverages, with a total of 126 records and 50 taxa. The most frequently utilized taxa are *Juglans regia* (12 records), *Myrtus communis* L. (12) and *Fragaria vesca* L. subsp. *vesca* (11). The fruits of *J. regia* employed in the production of “nocino”, a traditional liqueur. This is made by macerating the nuts in alcohol, filtering the resulting mixture, and then combining it with water and sugar. Additionally, the berries of *M. communis* and the conocarps of *F. vesca* subsp. *vesca* are also employed in the production of liqueurs through a comparable process.

3.1.3. Domestic uses

This category encompasses a variety of purposes related to home care and cleaning, with 143 records and 66 different taxa (Fig. 7),

Table 4

The most relevant taxa of ethnobotanical use in Calabria sorted according to Cultural Value (CV) index (2).

TAXON	BASIC VALUE			INDEXES					RANKING	
	FC	Us	UR	CI	CV	RFC	RI	UV	CV	RFC
<i>Urtica dioica</i> L.	13	6	115	7.188	2.920	0.813	0.717	0.500	1	4
<i>Laurus nobilis</i> L.	12	5	120	7.500	2.344	0.750	0.678	0.417	2	7
<i>Sambucus nigra</i> L.	14	4	108	6.750	1.969	0.875	0.582	0.333	3	3
<i>Juglans regia</i> L.	14	5	74	4.625	1.686	0.875	0.524	0.417	4	2
<i>Malva sylvestris</i> L.	11	3	150	9.375	1.611	0.688	0.667	0.250	5	13
<i>Opuntia ficus-indica</i> (L.) Mill.	12	5	62	3.875	1.211	0.750	0.484	0.417	6	6
<i>Borago officinalis</i> L.	14	3	79	4.938	1.080	0.875	0.430	0.250	7	1
<i>Parietaria judaica</i> L.	12	4	68	4.250	1.063	0.750	0.449	0.333	8	11
<i>Spartium junceum</i> L.	10	9	34	2.125	0.996	0.625	0.613	0.750	9	17
<i>Matricaria chamomilla</i> L.	11	3	84	5.250	0.902	0.688	0.447	0.250	10	12
<i>Olea europaea</i> L.	10	6	45	2.812	0.879	0.625	0.483	0.500	11	20
<i>Myrtus communis</i> L.	12	4	54	3.375	0.844	0.750	0.402	0.333	12	8
<i>Castanea sativa</i> Mill.	9	6	46	2.875	0.809	0.563	0.487	0.500	13	24
<i>Salvia officinalis</i> L. subsp. <i>officinalis</i>	10	4	59	3.688	0.768	0.625	0.419	0.333	14	19
<i>Cynodon dactylon</i> (L.) Pers.	12	2	64	4.000	0.500	0.750	0.324	0.167	15	9
<i>Salvia rosmarinus</i> Spenn.	9	3	56	3.500	0.492	0.563	0.353	0.250	16	25
<i>Arundo donax</i> L.	9	4	42	2.625	0.492	0.563	0.362	0.333	17	27
<i>Lavandula angustifolia</i> Mill.	7	5	39	2.438	0.444	0.438	0.408	0.417	18	41
<i>Arbutus unedo</i> L.	9	4	37	2.312	0.434	0.563	0.346	0.333	19	23
<i>Taraxacum</i> sp.pl.	8	3	54	3.375	0.422	0.500	0.347	0.250	20	30
<i>Cichorium intybus</i> L.	12	2	52	3.250	0.406	0.750	0.284	0.167	21	5
<i>Rubus idaeus</i> L. subsp. <i>idaeus</i>	5	3	34	5.000	0.391	0.313	0.433	0.250	22	73
<i>Clinopodium nepeta</i> (L.) Kuntze subsp. <i>nepeta</i>	10	3	38	2.375	0.371	0.625	0.293	0.250	23	18
<i>Anethum piperitum</i> Ucria	6	2	89	5.562	0.348	0.375	0.408	0.167	24	45
<i>Cynara cardunculus</i> L. subsp. <i>cardunculus</i>	9	3	36	2.250	0.316	0.563	0.287	0.250	25	22
<i>Ruscus aculeatus</i> L.	10	4	23	1.438	0.299	0.625	0.299	0.333	26	16
<i>Papaver rhoeas</i> L. subsp. <i>rhoeas</i>	9	3	34	2.125	0.299	0.563	0.280	0.250	27	26
<i>Anethum foeniculum</i> L.	7	2	65	4.062	0.296	0.438	0.328	0.167	28	37
<i>Asparagus acutifolius</i> L.	9	3	33	2.062	0.290	0.563	0.277	0.250	29	21
<i>Portulaca oleracea</i> L.	12	2	37	2.312	0.289	0.750	0.234	0.167	30	10

*Basic Value: Frequency of Citation (FC), Number of types of use (U_s), Use Reports (UR); Indexes: Cultural Importance Index (CI) (1), Cultural Value (CV) (2), Relative Frequency of Citation (RFC) (5), Relative Importance Index (RI) (6), Use Value (UV).

which demonstrates the continued prevalence of domestic traditions in Calabria. One of the most common practices is the utilization of plant-based substances for the cleansing of textiles and culinary items. For example, the epicarps of the fruits of *Solanum lycopersicum* L. fruits are employed as a cleansing agent for dirty dishes. It is noteworthy that this particular application has not been documented in other Italian regions or in foreign publications. Similarly, the aerial part of the plant *Parietaria judaica* L. is used for cleaning dishes, cutlery and glasses by rubbing it to polish and clean them. A comparable usage is documented for the related species *Parietaria officinalis* L. in Liguria [98], Tuscany [82], and Marche [101], whereas *P. judaica* is employed for this purpose in Latium [97] and Umbria [126]. Four distinct taxa are traditionally utilized for the cleansing of textiles: the seeds of *Phaseolus vulgaris* L., the leaves of *Saponaria officinalis* L., and the aerial parts of *Spinacia oleracea* L. and *Urtica dioica*. Of these, *S. officinalis* is the only species documented for which documentation exists in other regions, including Campania [93] and Latium [97].

Another significant domestic application involves the dyeing of fabrics. The plant materials were subjected to boiling, whereby the coloured pigments were released into the boiling water and subsequently employed for the purpose of dyeing fabrics. In Calabria, the species used for dyeing include *Isatis tinctoria* L. (entire plant), also reported in Abruzzo [127–129], Campania [95], Latium [130], and Sicily [115]. Additionally, other species employed in dyeing processes include the barks of *Quercus pubescens* Willd. subsp. *pubescens* and *Rhamnus alaternus* L. (Sardinia [131]), the roots of *Rubia peregrina* L. (Sardinia [131,132]; Sicily – [131]) and the fruits of *Sambucus nigra* (Italy [133]; Latium [97]; Marche [101]) and *Solanum melongena* L. No other publications were identified for *Q. pubescens* subsp. *pubescens* and *S. melongena* with the same purpose.

3.1.4. Handicraft uses

This category encompasses all activities in which plants are utilized to create professional-level products, comprising 119 records and 53 distinct taxa (Fig. 7). Typically, plant parts, primarily stems or small branches, are employed in the fabrication of a range of items, including furniture such as chairs and tables, baskets, and cutlery. The most frequently utilized species in this category is *Arundo donax* L. (10 records), an archaeophyte that is primarily employed in the manufacture of baskets, broom handles, and the “cannicciata”, a traditional support used for sun-drying tomatoes. These applications have been documented in other Italian regions, including Basilicata [134], Latium [97], Apulia [112] and Sicily [67,90,114,115,135], as well as in other European countries, such as Spain [136, 137].

Spartium junceum L. is another plant that has been widely used for handicraft purposes, with 13 documented records. This species has a long history, with the name “*Spartium*” deriving from ancient Greek (Σπαρτον = rope), reflecting its traditional use in the production of textile fibres. These fibres were employed by the Phoenicians, Romans, and Greeks to make sails [102]. In Calabria, the

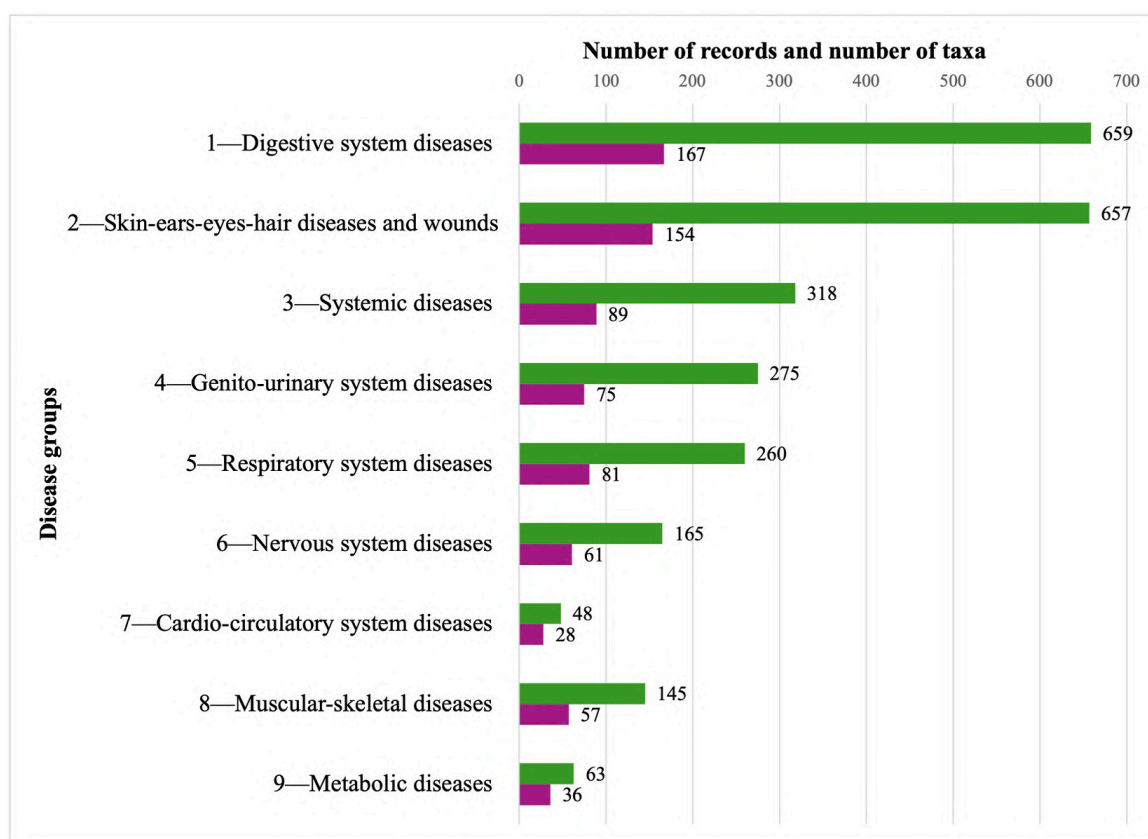


Fig. 9. Number of records and taxa divided categorized by to medicinal purposes. The medicinal categories follow the classification by Cook [51].

Table 5

List of the most used taxa within the medicinal category, ordered by number of records.

Taxa	Number of citations	Number of disease groups
<i>Malva sylvestris</i> L.	143	8
<i>Laurus nobilis</i> L.	83	8
<i>Matricaria chamomilla</i> L.	81	7
<i>Urtica dioica</i> L.	79	8
<i>Sambucus nigra</i> L.	70	7
<i>Cynodon dactylon</i> (L.) Pers.	56	6
<i>Parietaria judaica</i> L.	53	7
<i>Ficus carica</i> L.	43	5
<i>Achillea millefolium</i> L.	40	8
<i>Allium sativum</i> L.	40	7
<i>Salvia rosmarinus</i> Spenn.	39	6
<i>Borago officinalis</i> L.	38	9
<i>Salvia officinalis</i> L. subsp. <i>officinalis</i>	38	6
<i>Clinopodium nepeta</i> (L.) Kuntze subsp. <i>nepeta</i>	35	3

branches of *S. junceum* were collected for the fabrication of textiles utilized in the manufacture of mattresses, blankets, clothing, and even undergarments. The process entailed softening the material in a stream and subsequently drying it in the sun for a several days. Once the branches had been dried, they were subjected to manual treatment or processing with stones or wooden sticks in order to separate the fibrous components from the non-fibrous materials, such as the pith. Once the fibres had been cleaned, they were collected and woven into fabrics using community looms. This traditional method, though exhibiting variations in its specific execution, represents an ingenious and sustainable approach to utilize local plant resources for textile production. Furthermore, the utilization of *S. junceum* for textile purposes has been documented in other regions worldwide, including Lebanon [138], Marche [101] and Apulia [112]. Furthermore, the branches were employed directly in the production of rope, a use that has been well documented [66,115].

3.1.5. Agropastoral uses

A total of 71 records and 44 different taxa were identified in the agropastoral uses category (Fig. 7). These encompass a range of activities related to the care of cultivated land and pastures, including the application of natural fertilisers or repellents, as well as the use of plants for the creation of bedding for animals. One of the most frequently utilized species is *Ampelodesmos mauritanicus* (Poir.) T.

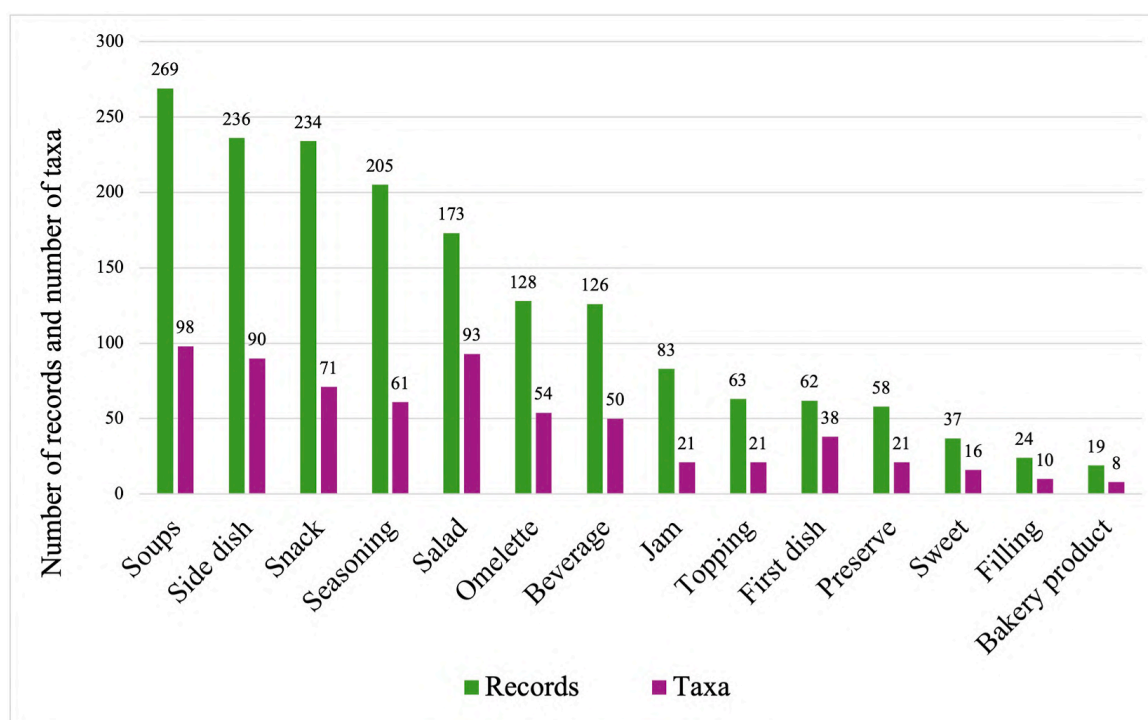


Fig. 10. Food purposes ordered by decreasing number of records and number of taxa.

Durand & Schinz, whose branches are employed in the fabrication of ties for crops or ropes for livestock. This use has been documented in other Italian regions, including Basilicata [134], Campania [93,94,139,140], Marche [101], Apulia [112] and Sicily [114,115,135], as well as in Spain [137].

Another noteworthy species is *Daphne gnidium* L., whose roots were historically employed in poaching. The roots were submerged in waterways to stun eels, which, due to the plant's toxicity, would rise to the surface. Furthermore, this practice has also been documented in Apulia [112], Spain [137,141], Sicily [90,135] and across Italy [9].

3.1.6. Cosmetic uses

The category of cosmetic uses encompasses applications related to aesthetic care and personal hygiene, including the formulation of body creams and facial and hair masks (62 records and 38 different taxa) (Fig. 7). Of particular note among the species identified in Calabria for this category is *Urtica dioica*, which is primarily utilized for hair care. The aerial parts were pulverised to create a paste-like mask, which was then applied to the hair to soften and strengthen it. This use has been documented in other Italian regions, including Campania [94], Emilia Romagna [142], Lombardy [21], Marche [101], Molise [111,143], Piedmont [144] and Tuscany [82,108], as well as in foreign countries such as Albania [145] and Algeria [146]. Furthermore, numerous ethnobotanical studies have documented the use of *U. dioica* in addressing hair loss [6,68,90,98,100,101,106,129,142,144], treating dandruff [93,95,101,106], and even colouring dark hair [81].

3.1.7. Religious uses

The category of religious uses encompasses activities where plants are incorporated into votive rites, prayers, or religious celebrations that are linked to traditions (34 records and 26 different taxa) (Fig. 7). For example, *Hypericum perforatum* L. and *Hypericum perforatum* L. were historically employed on St. John's Day (June 24th) to strengthen a religious bond between individuals. Women would gather bouquets of St. John's wort flowers and exchange them with a close friend, linking their little fingers while reciting a phrase to seal an indissoluble bond of friendship. From that moment on, the two women became "flower wives".

Pseudodictamnus mediterraneus Salmaki & Siadati subsp. *mediterraneus* was employed as a votive lamp, where the flowers being lit like as wicks in the home, especially during the "novena" period.

The inflorescences of *Daucus carota* L., *Spartium junceum*, and *Helichrysum italicum* (Roth) G.Don subsp. *italicum* were scattered as religious offerings during the Corpus Christi procession.

3.1.8. Veterinary uses

Veterinary uses refer to the use of plant parts for the treatment of animals (31 records and 15 different taxa) (Fig. 7). Among the most used plants for this purpose are *Helleborus foetidus* L. subsp. *foetidus* and *Helleborus viridis* L. subsp. *bocconei* (Ten.) Peruzzi, both of the Ranunculaceae family, used mainly for pain relief in cattle by placing the root on the affected area to alleviate discomfort [66]. *Dittrichia viscosa* (L.) Greuter was used as a pesticide: the whole plant was inserted into the rectum of donkeys to eliminate intestinal parasites. For flea control, *Lupinus albus* L. was used by rubbing the plant on the body of chickens as an anti-flea treatment. In addition,

the stems of *Triticum aestivum* L. were burned to produce ash, which was mixed with olive oil to make a paste that was applied to wounds and inflammations.

3.1.9. Ornamental uses

Ornamental use refers to the utilization of plants for purposes of home and garden beautification, as evidenced by 21 records and 15 different taxa (Fig. 7). The species commonly utilized for decorative purposes include *Acanthus mollis* L., *Antirrhinum majus* L., *Arbutus unedo*, *Cestrum parqui* L'Hér., *Convolvulus soldanella* L., *Hedera helix* L. subsp. *helix*, *Helichrysum italicum* subsp. *italicum*, *Verbascum sinuatum* L. and *Vinca major* L.

3.1.10. Ludic uses

The ludic category encompasses all uses where plants were employed for the fabrication of small toys or the enactment of social games (20 records and 14 different taxa) (Fig. 7). One of the most utilized species is *Avena barbata* Pott ex Link, which features in two distinct games. In one game, children would collect the spikelet and throw it onto other individuals' clothing to determine the number of romantic partners based on how many spikelets stuck. In the other, the plant was used to fashion small nooses, which were then used to catch lizards and take them for a walk. Another species employed in children's games was *Convolvulus silvaticus* Kit. Its flowers were closed in a manner akin to a balloon and burst on children's foreheads. Concurrently, a nursery rhyme, "cuccu, cuccaritu, dimmi a quale via mu mi maritu" with the intention of predicting the future spouse's location based on the flower's direction after bursting [43]. Furthermore, the explosive capsules of *Echallium elaterium* (L.) A.Rich. were utilized as a source of play, with children throwing them at each other to trigger an explosion.

3.1.11. Magic uses

The category of magical uses includes all purposes involving plants in spells or rituals, such as those meant to ward off the evil eye (15 records and 14 different taxa) (Fig. 7). The most used taxa for the purpose of protection against the evil eye include *Olea europaea* L., *Phoenix dactylifera* L. and *Capsicum annuum* L. In the case of *O. europaea*, a common ritual involved the preparation a dish with water and the addition of drops of oil, accompanied by the recital of a prayer and a magic formula with the intention of dispelling the evil eye. Another protective use of this species involved the preparation of small bags containing three pieces of olive leaves, three pieces of *P. dactylifera* leaves, a pinch of salt, and some sand, which were taken in front of a consecrated church. Such bags were subsequently attached to children's clothing in order to provide protection from negative influences. Regarding *C. annuum*, its fruits were simply retained in a pocket with the intention of warding off negative energies.

The branches of *Spartium junceum* were employed in a magical ritual for the removal of warts. This involved tying a branch behind the back of the individual concerned, with the number of knots corresponding to the number of warts. Subsequently, the branch was provided to an individual who would conceal it in an area that the person with the warts did not regularly frequent. It was believed that the warts would fall off the person's body as if by magic when they passed by the location where the branch was hidden [44].

3.1.12. Forage uses

The forage category encompasses all plants utilized as animal fodder, comprising 12 records and 12 distinct taxa (Fig. 7). The most commonly utilized species belong to the Fabaceae family, including *Genista monspessulana* (L.) L.A.S.Johnson, *Medicago sativa* L., *Robinia pseudoacacia* L., *S. junceum*, *Sulla coronaria* (L.) B.H.Choi & H.Ohashi, *Trifolium repens* L. and *Vicia faba* L. These species are primarily utilized for the nourishment of rabbits and sheep, offering indispensable nutrition for these animals within agricultural and pastoral contexts.

4. Concluding remarks and future perspectives

The objective of this review was to synthesize the ethnobotanical knowledge of the Calabria region, elucidating the region's profound history and cultural heritage pertaining to plants. Over centuries, local communities have developed a sophisticated understanding of the nutritional, therapeutic, ritual, and cultural significance of plants, reflecting a strong connection between local biodiversity and daily practices. However, this knowledge is fragmented, with some provinces receiving minimal study, thereby increasing the risk of this valuable cultural and biological heritage at risk of being lost due to socio-economic changes and time. It is of the utmost importance to preserve and promote this heritage in order to safeguard biodiversity and recover local traditions. The data obtained from this review could inform scientific research and the development of new pharmaceutical, food, and cosmetic products, thereby bridging the gap between local culture and scientific progress.

Further research is required to enhance comprehension of the ethnobotanical applications in Calabria, with a particular emphasis on the involvement of local communities in the collection and dissemination of data. An integrated approach that combines traditional knowledge with modern scientific methods is essential for the sustainable management of natural resources and for maintaining the profound connection between people and their environment. This approach promises to enhance both biodiversity conservation and the well-being of local communities, thereby paving the way for a more sustainable and culturally vibrant future.

CRedit authorship contribution statement

Miriam Patti: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Investigation, Formal analysis, Data curation. **Carmelo Maria Musarella:** Writing – review & editing, Visualization, Validation, Supervision, Resources,

Methodology, Investigation, Data curation, Conceptualization. **Giovanni Spampinato**: Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Data availability statement

The datasets generated and/or analyzed during the current study are available in the file [SUPPLEMENTARY MATERIAL 1](#). Other materials can be asked to the corresponding author.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Miriam Patti reports financial support was provided by National Operational Program (PON). We declare that the corresponding author Carmelo Maria Musarella is Associate Editor of the section Plant Biology in that journal. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2025.e42050>.

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CHAPTER 3. An overview of ethnobotanical knowledge for the enhancement of typical plant food and the development of a local economy: the case of Calabria region (Southern Italy)

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An overview of ethnobotanical knowledge for the enhancement of typical plant food and the development of a local economy: the case of Calabria region (Southern Italy)

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Abstract

The Mediterranean basin harbours a vast number of plant species, many of which are endemic and hold various traditional uses for food purposes. Calabria is one of the Italian regions partially studied from an ethnobotanical point of view. The objective of this work is to provide an overview of the food uses of plants known up to now in Calabria. We considered 9 published papers and 11 unpublished sources from field interviews. The data collected were entered into a Microsoft Access® database. The RFC and CI indices were then calculated for quantitative analysis. We collected a total of 1727 records related to 296 taxa, of which 39 subspecies, from 70 botanical families. The most frequently cited families were Asteraceae with 60 taxa (20.2%, 402 records), followed by Rosaceae (27, 9.1%, 203 records). The taxa with the higher RFC are *Borago officinalis* (RFC: 0.80), *Cichorium intybus* (0.70), and *Portulaca oleracea* (0.65); regarding the CI the highest values were found for *Borago officinalis* (CI: 3), *Rubus ulmifolius* (2.20) and *Asparagus acutifolius* (2.10).

Keywords Ethnobotany · Natural foods · Natural resources · Phytoalimurgy · Traditional plant food

Introduction

The ongoing climate change and its consequences on agroecosystems require greater attention on the plant species useful for food purposes (Semeraro et al. 2023): these species can represent an important genetic resource strategically utilized also to draw upon ancient knowledge for the development of new agriculture and to envision the future of the next generations (Jensen and Plissock 2023; Perrino and Perrino 2020). This involves the creation of a new economic strategy at the local level (Lovrić et al. 2023). For this reason, the recovery of ethnobotanical knowledge in territories all over the world still plays an important role in building a sustainable future with a decreasing impact on the planet (Estrada-Castillón et al. 2022; Zocchi et al. 2022; Mongalo and Raletsena 2023). This becomes particularly

relevant considering the continuous increase in the world population (Hadush et al. 2019).

The Mediterranean basin harbours a remarkable richness of plant species (Comes 2004; Musarella et al. 2020), many of which are endemic (Caruso 2022), and hold various traditional uses for food purposes (Camarda et al. 2017; Baydoun et al. 2023; Laface et al. 2023). Italian regions boast an enormous number of ethnobotanically important species, the knowledge of which has been highlighted by various ethnobotanical studies in recent years (Pasta et al. 2020; Monari et al. 2022; Motti et al. 2022; Lombardi et al. 2023). Calabria is one of the Italian regions richest in species, including many endemism (Bernardo 2000; Spampinato 2014): however, it has only been partially studied from an ethnobotanical point of view, considering several aspects of food and medical purposes (i.e. Nebel et al. 2006; Passalacqua et al. 2006; Mattalia et al. 2020a, b).

The objective of this work is to provide an overview of the food uses of plants known up to now in Calabria. This study is aimed to determine whether the studies conducted so far are sufficient or if there is a need to initiate new ones. Additionally, it aims to uncover the potential implications for the development of a new, local, and more sustainable economy.

Carmelo M. Musarella and Miriam Patti have contributed equally to this work.

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Materials and methods

Study area

Calabria is a region in southern Italy known for its rich biodiversity and unique cultural history (Marziliano et al. 2016; Mattalia et al. 2020a; Cantasano et al. 2021).

The Calabria region, with an area of 15,080 km², is located in the central Mediterranean Sea and stretches approximately 250 kilometres from north to south (Fig. 1). It is bordered by the Ionian Sea to the south and east, the Tyrrhenian Sea to the west and Basilicata region to the north. Most of Calabrian territory is mountainous, with two parts of the Apennine chain occupying almost all of its land mass (Barbaro et al. 2022).

According to the classification of Rivas-Martínez et al. (2002), also taken up by other authors (Spampinato 2014), the climate of the Calabria region is classified as Mediterranean, with considerable mesoclimatic variations

influenced by altitude, topography and position in relation to the sea.

This region is a fascinating place to conduct research that is related to ancient local cultures and involves the study of traditional knowledge of plants, their names and uses by local communities (Spampinato et al. 2017, 2022).

Ethnobotanical surveys and data analysis

We considered and analysed 9 published works and 11 unpublished sources from field interviews. The published data were obtained from online platforms such as Google Scholar and Scopus and cover the period 2006 to 2022. The unpublished data were collected through semi-structured interviews that follow the model of Musarella et al. (2019) conducted between 2012 and 2020. These sources are related to the ethnobotanical knowledge of the Calabria region, focusing on wild and cultivated plants used for food based on local traditions across different parts of the region. The collected data was entered into a Microsoft Access® database having the same structure as the paper interview sheet. All

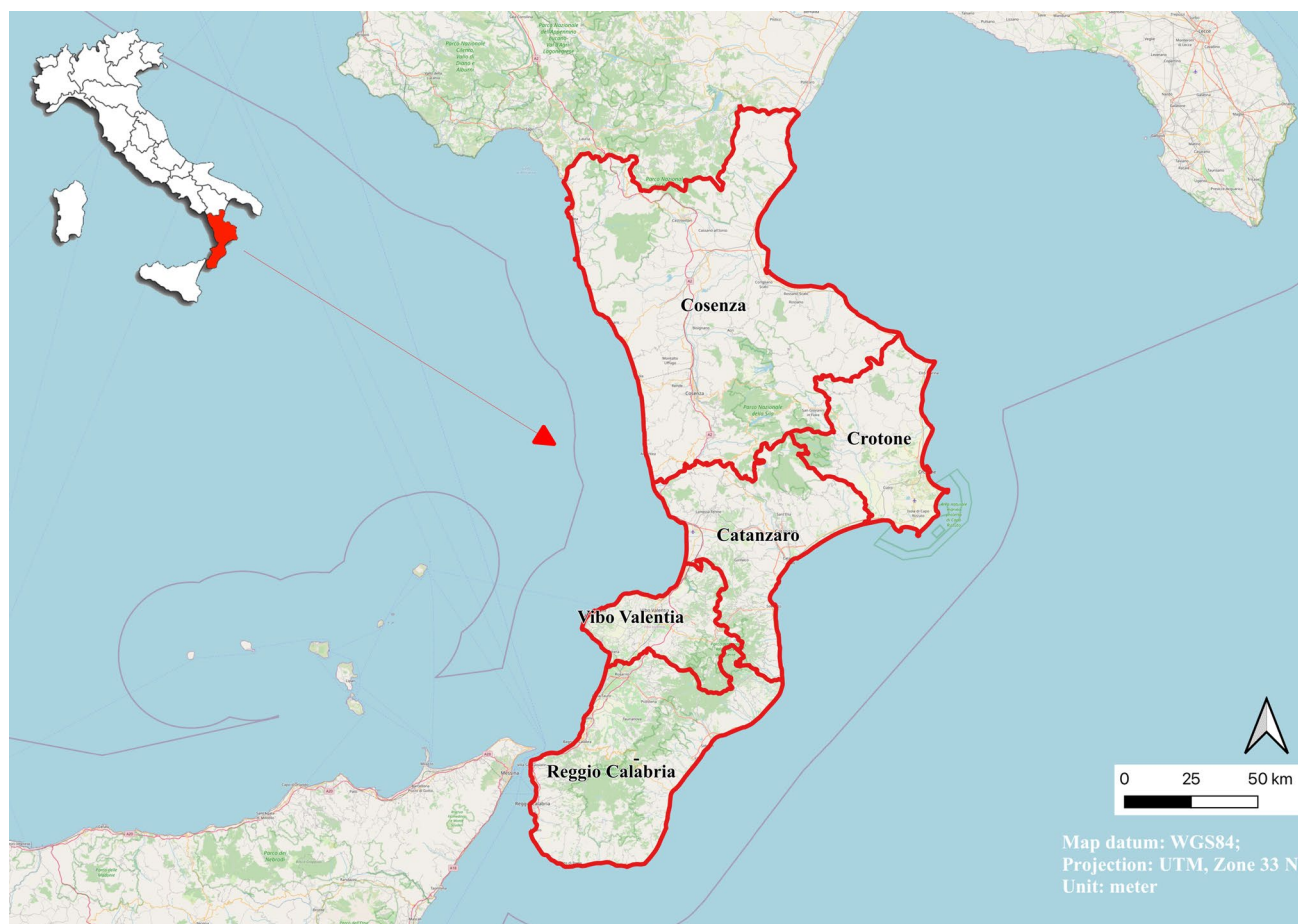


Fig. 1 Calabria region. In red are highlighted the provinces of Catanzaro, Cosenza, Crotona, Vibo Valentia and the Metropolitan City of Reggio Calabria

the recorded information encompassed, among others: type of use, purpose, plant organs, origin, chorology, life form, method of preparation, and method of conservation. The life forms of the taxa follow the classification of Raunkiaer (1934), instead, the chorological type is according to Pignatti (1982). Scientific nomenclature follows the second edition of “Flora d’Italia” (Pignatti et al. 2017a, 2017b, 2018, 2019). For all the taxa, we calculated quantitative indices to highlight their ethnobotanical value: the Frequency of Citation (FC), a basic value in according to Tardío and Pardo-de-Santayana (2008), that indicates the number of informants mentioning a species, Relative Frequency of Citation (RFC), in according to Tardío and Pardo-de-Santayana (2008), which is used to calculate the frequency with which a taxon is cited by informants in relation to the total number of informants and has a value between 0 and 1, and Citation Index (CI) in according to Monari et al. (2022) that indicate the value of the taxa based by the number of citations.

Results and discussion

We collected a total of 1726 records related to 296 taxa, of which 39 subspecies, from 70 botanical families (Table 1 in Online Resource 1). The list of the botanical families with the number of citations and the taxa of each family are given in Online Resource 2 (Table 2).

The most frequently cited families were Asteraceae (60 taxa, 20.2%, 402 records), followed by Rosaceae (27 taxa, 9.1%, 203 records), Brassicaceae (25 taxa, 8.4%, 133 records), and Asparagaceae (7 taxa, 2.4%, 101 records). Not surprisingly, the Asteraceae is the family with the highest number of taxa recorded in Calabria: in fact, this family is the most abundant in the region in terms of number of taxa, like in the whole Italy (Bartolucci et al. 2024; Galasso et al. 2024) and in the world (Cano et al. 2019).

In total, we recorded 296 taxa of food interest. The list of all taxa is shown in Online Resource 1 (Table 1) together with the quantitative indices. The taxa with the higher RFC are *Borago officinalis* L. (RFC: 0.80), *Cichorium intybus* L. (0.70), *Portulaca oleracea* L. (0.70), *Asparagus acutifolius* L. (0.60), *Sambucus nigra* L. (0.60), *Ficus carica* L. (0.50), *Hypochaeris radicata* L. (0.50) and *Rubus ulmifolius* Schott (0.50). Regarding the CI, the highest values were found for *Borago officinalis* (CI: 3), *Rubus ulmifolius* (2.20), *Asparagus acutifolius* (2.10), *Cichorium intybus* (2.10), *Ficus carica* (2.05), *Taraxacum* sp.pl. (2), *Clematis vitalba* L. (1.80) and *Muscari comosum* (L.) Mill. (1.60). With the most citations (60), the highest RFC and CI values and the largest number of food uses (12), *B. officinalis* is the most relevant taxon.

The most common life forms of the recorded taxa are Hemicryptophytes (37%), followed by Therophytes (27%) and Phanerophytes (27%) (Fig. 2).

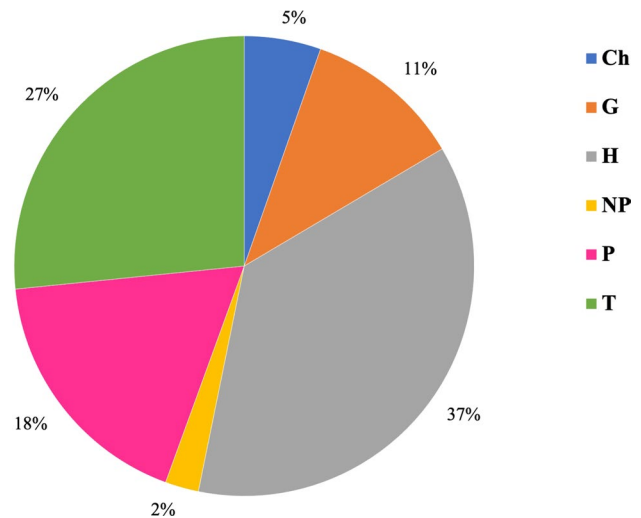


Fig. 2 Life forms spectrum of recorded taxa. *Ch* Chamaephytes, *G* Geophytes, *H* Hemicryptophytes, *NP* Nanophanerophytes, *P* Phanerophytes, *T* Therophytes

Regarding the chorological types (Fig. 3), the most relevant are Stenomediterranean (24%), Cosmopolitan (24%) and Eurasiatic (23%).

Another interesting information from this study was the part of the plant consumed by the informants. Figure 4 shows that the parts of the plant most commonly used as a food are the leaves (with 519 citations) followed by fruits (422) and aerial parts (226).

Within the food purposes, subcategories have been established to clearly distinguish the intended use of each plant species. Figure 5 presents the most prevalent purposes.

In general, the taxa with the highest number of reported uses belongs to the “side dishes” subcategory (encompassing 134 taxa mentioned in 436 interviews), followed by “snacks” (with 74 taxa mentioned in 248 interviews) and “salads” (with 107 taxa mentioned in 209 interviews).

Side dishes

The category of side dishes includes all those preparations in which the plants, mostly the leaves, basal rosettes and aerial parts, are cooked in a pan with the addition of salt, oil, garlic and sometimes even breadcrumbs. It is a poor and ancient dish, typical of the Mediterranean area, which has remained constant despite globalization (Helstosky 2009; Kremezi 2000; Renna et al. 2015). The most commonly used taxon for this type of use was *Borago officinalis* with 26 citations (Fig. 6).

There are several data available worldwide regarding *B. officinalis* for this purpose, especially in Italy (Nebel et al. 2006; Passalacqua et al. 2006; Bellusci 2017; Mattalia et al. 2020b; Gentile et al. 2022 (Calabria); Pieroni and Cattero

Fig. 3 Chorological spectrum of recorded taxa

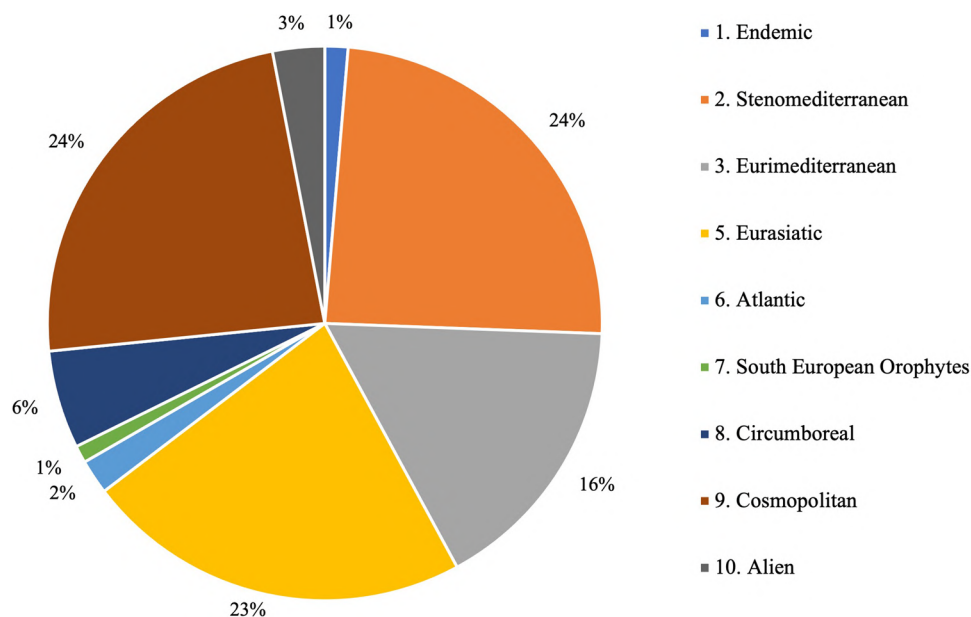
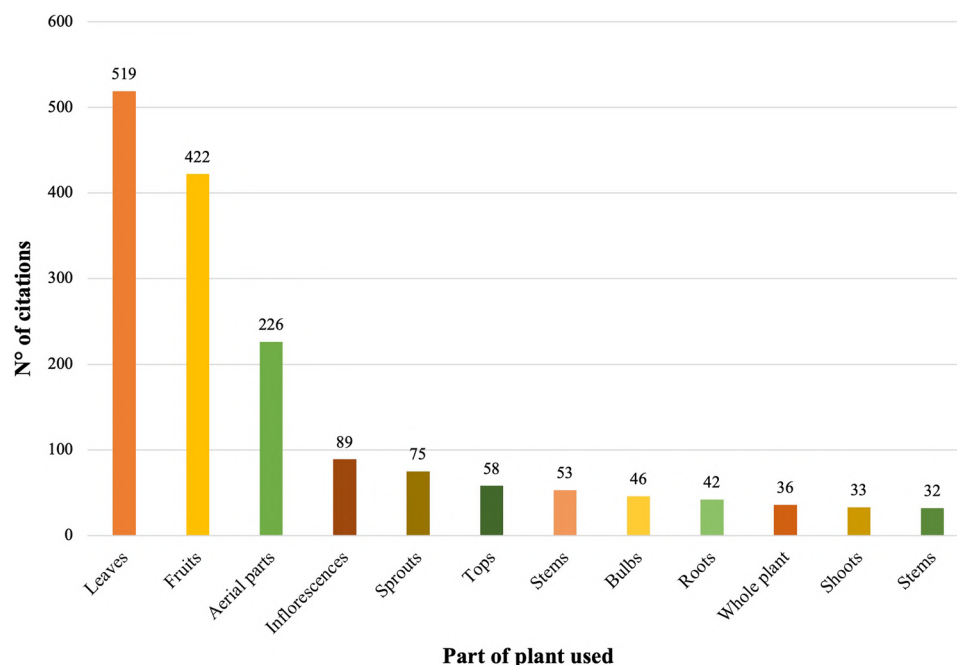


Fig. 4 The most relevant part of plants used for food purposes



2019 (Puglia); Guarrera et al. 2006 (Basilicata); Menale et al. 2006 (Molise); Ardenghi et al. 2017 (Piemonte and Lombardia); Cornara et al. 2009 (Liguria); Lentini and Venza 2007; Licata et al. 2016 (Sicily); Lucchetti et al. 2019 (Marche); Uncini Manganelli et al. 2002; Signorini et al. 2008 (Toscana)) and in Spain (Tardío et al. 2006; Aceituno Mata 2010).

The second most recurrent taxon is *Cichorium intybus* (25 citations) (Fig. 6); its use as a side dish is very common in Calabria: in fact, many scientific works confirm its use in different parts of Calabria (Bernardo 2000; Nebel et al.

2006; Bellusci 2017; Mattalia 2020b; Gentile et al. 2022). In the regions bordering Calabria, such as Basilicata, this species is also commonly used for side dish (Pieroni and Quave 2005; Sansanelli et al. 2017). This species is also used in other Italian regions: Liguria (Cornara et al. 2009), Puglia (Pieroni and Cattero 2019), Sardegna (Signorini et al. 2009), Sicilia (Licata et al. 2016), Toscana (Signorini et al. 2008) and Umbria (Uncini Manganelli et al. 2002; Ranfa and Bodesmo 2017). Regarding other countries, the same use was recorded in Spain (Tardío et al. 2006, Aceituno

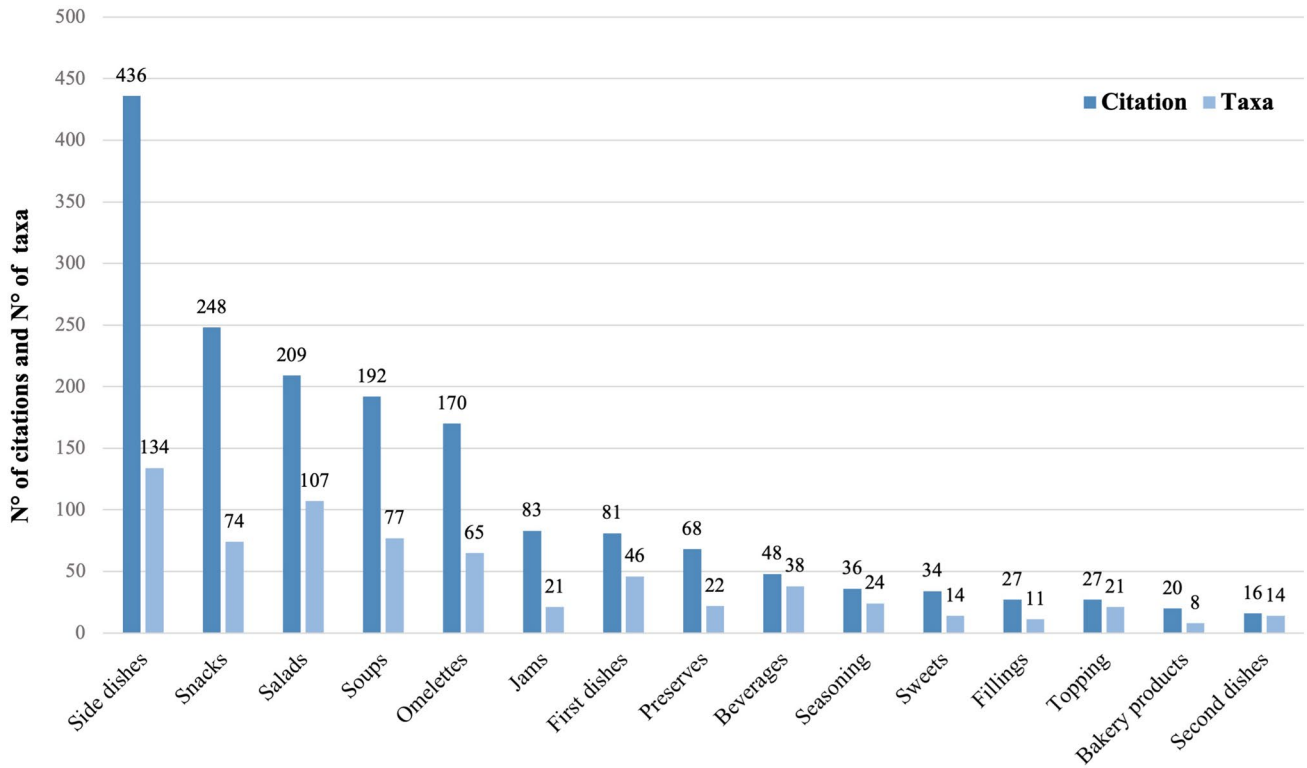


Fig. 5 Food purposes with the number of citations and number of taxa for each, ordered by number of citations

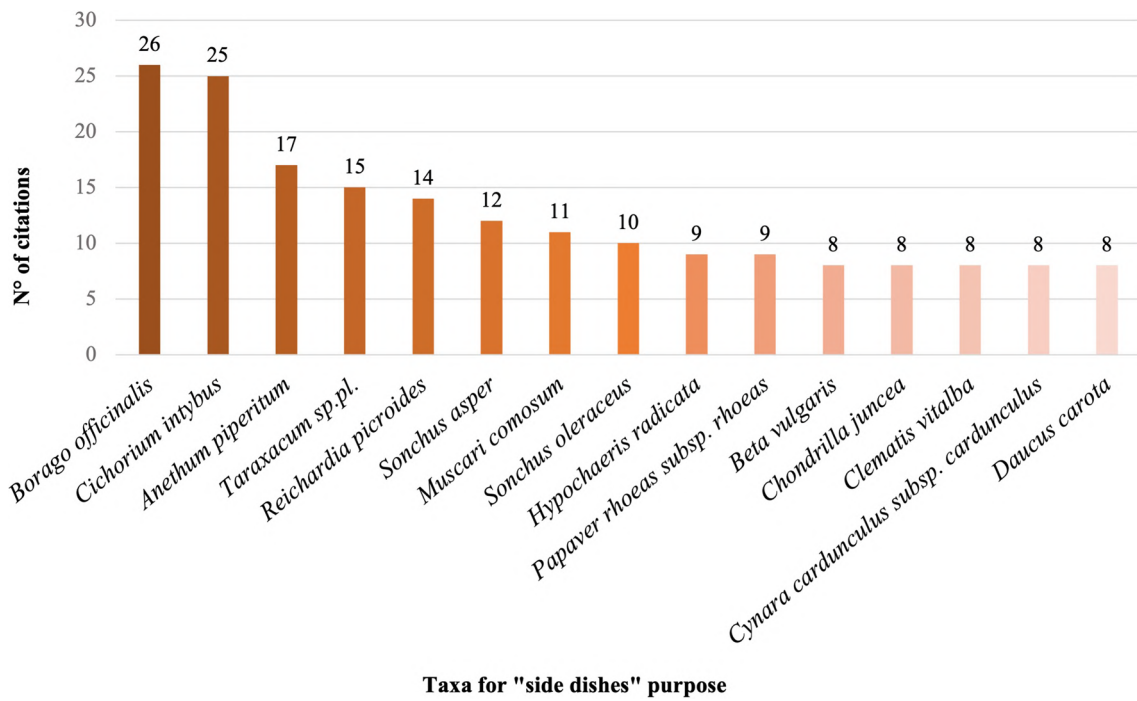


Fig. 6 Most recurrent taxa used as a side dish sorted by number of citations

Mata 2010; Morales et al. 2011) and Lebanon (Baydoun et al. 2017).

Anethum piperitum Ucria (17 citations) is also used for side dishes purpose. This use is commonly known in Italy: Calabria (Nebel et al. 2006; Patti et al. 2024), Sicilia (Licata et al. 2016), Sardegna (Signorini et al. 2009) and Toscana (Signorini et al. 2008). Further data regarding its use was found in Spain (Aceituno Mata 2010).

Snacks

The "snacks" category encompasses all species that are consumed raw without any prior preparation. Typically, these consist of fruits which are often plucked straight from the plant and directly consumed. The taxon most frequently found in this category is *Ficus carica* with 22 citations (Fig. 7).

The use of *F. carica* fruits as snacks is well-known both in Italy and abroad. Within the Graecanic area (Southern Italy), *F. carica* fruits are used as snacks both fresh and dried: the fruits are dried and then eaten in winter and are called 'còzsula' in dialect (Nebel et al. 2006). In Italy, its fruits are also consumed in Liguria (Cornara et al. 2009), Basilicata (Sansanelli et al. 2017), Marche (Lucchetti et al. 2019) and Toscana (Uncini Manganeli et al. 2002). The

same use has also been found in Spain (Aceituno Mata 2010), Lebanon (Baydoun et al. 2017) and Pakistan (Khan et al. 2021).

The second taxon commonly used as a snacks is *Juglans regia* L., whose kernels, or nuts, are eaten. In Calabria, there are numerous reported uses (Passalacqua et al. 2006; Siviglia 2011; Lupia and Lupia 2013; Mattalia et al. 2020a); in addition, some studies have reported the specific use of nuts together with *F. carica* to produce a snack called 'stuffed figs' (Nebel et al. 2006; Mattalia 2020b).

Juglans regia is consumed as a snack in Marche (Lucchetti et al. 2019) and Lombardia (Vitalini et al. 2015). Moreover, Vitalini et al. (2015) describe it as an energizing snack. This species is consumed as a snack also in Spain (Aceituno Mata 2010; Rigat et al. 2016).

Rubus ulmifolius (13 citations) (Fig. 7) is known in Calabria for producing exceptionally sweet fruits that are picked and consumed directly from the tree, a characteristic that has been well documented in the scientific literature (Nebel et al. 2006; Mattalia et al. 2020b; Gentile et al. 2022). Furthermore, *R. ulmifolius* is also utilized in other regions of Italy such as Basilicata (Sansanelli et al. 2017), Sicilia (Tavilla et al. 2022), Sardegna (Signorini et al. 2009) and Marche (Lucchetti et al. 2019). In Toscana, Signorini et al. (2008) reported that the young shoots of *R. ulmifolius* can be peeled and consumed raw, like the way liquorice sticks are

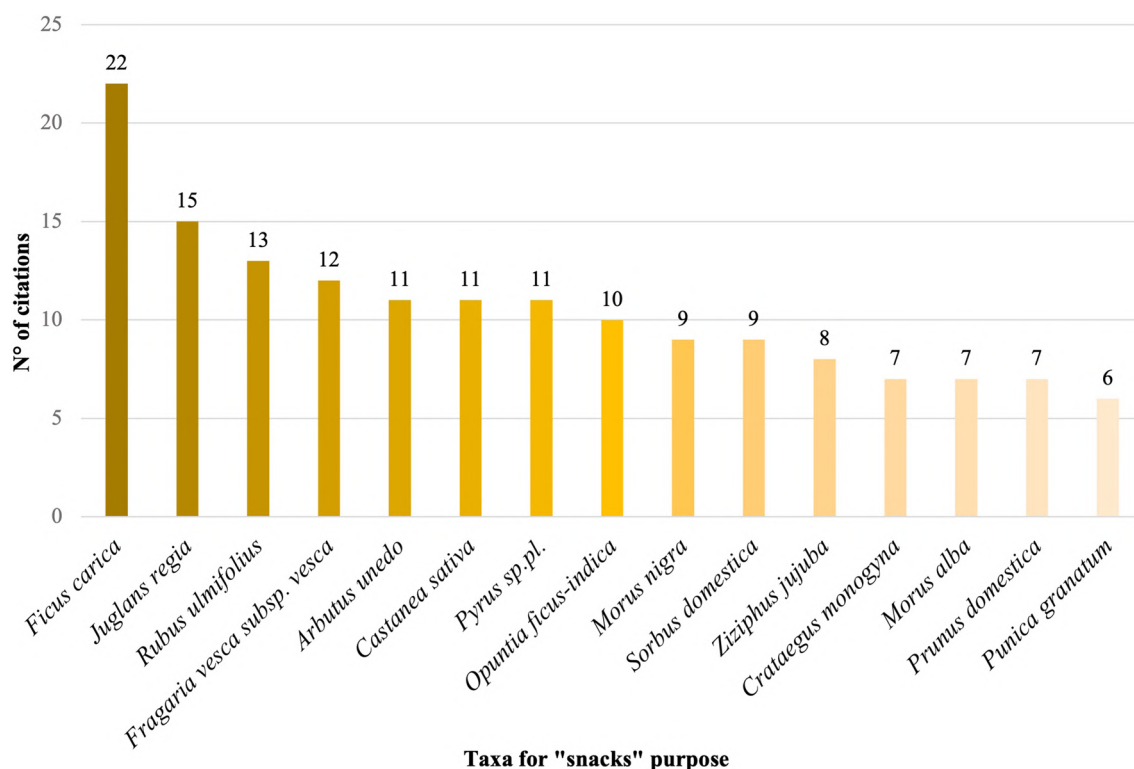


Fig. 7 Most recurrent taxa for snack purpose ordered by number of citations

eaten; the same use is recorded in Spain (Tardío et al. 2006). Other results have been recorded in Spain regarding the fresh use of the fruit (Aceituno Mata 2010; Morales et al. 2011). The use of this species as a snack is however confirmed for the entire Mediterranean area (Luczaj et al. 2012).

Salads

The subcategories of 'salads' include all plants eaten raw, seasoned with oil, salt or vinegar. They can be eaten alone or mixed to make them taste bitter, sweet, or whatever else you like.

The species frequently used for this purpose are grouped in Fig. 8.

The most commonly used species in the 'salads' category is *Portulaca oleracea*, which has been mentioned 20 times (Fig. 8). This species is widely used for this purpose both in Italy and abroad. Numerous works have been made across different regions of Italy—Calabria (Nebel et al. 2006; Passalacqua et al. 2006; Lupia and Lupia 2013; Siviglia 2011; Bellusci 2017; Musarella et al. 2019; Mattalia et al. 2020b), Sicilia (Licata et al. 2016; Tavilla et al. 2022), Basilicata (Sansanelli et al. 2017), Puglia (Pieroni and Cattero 2019), Umbria (Ranfa and Bodesmo 2017), and Toscana (Uncini Manganelli et al. 2002; Signorini et al. 2008).

In other parts of Europe, *P. oleracea* has been used in the same way: in Spain, its taste is highly appreciated (Tardío et al. 2006; Aceituno Mata 2010; Rigat et al. 2016).

Clematis vitalba was mentioned six times for its use in salads. The plant's shoots are consumed in salads but must first be boiled due to their toxicity when eaten raw. This toxicity is common among all plants in the Ranunculaceae family. Boiling the shoots reduces or eliminates the presence of protoanemonin, a compound that can cause skin and gastrointestinal irritation, as well as reducing the bitter taste of young shoots (Corsi and Pagni 1978; Corsi et al. 1981; Bellomaria 1982; Pieroni 1999; Guarrera et al. 2006; Lentini and Venza 2007; Guarrera and Savo 2016). The same use was recorded in Calabria (Mattalia et al. 2020a, b), Campania (Guarino et al. 2008; Savo 2009; Savo et al. 2019), Sicilia (Arcidiacono et al. 2007; Licata et al. 2016), Toscana (Uncini Manganelli et al. 2002), Marche (Lucchetti et al. 2019), Molise (di Tizio et al. 2012) and Sicilia (Biscotti et al. 2018) regions, and the state of Spain (Tardío et al. 2006). In other ethnobotanical research, however, the species is used for other food uses, such as the preparation of omelettes (Corsi et al. 1981; Pieroni 1999; Cornara et al. 2009; Signorini et al. 2008; Ranfa & Bodesmo 2017; Sansanelli et al. 2017), soups (Passalacqua et al. 2006) or as snacks (Scherrer et al. 2005).

Another popular taxon used widely in the food category is *Borago officinalis*. During this research, it emerged that it is widely used for the preparation of salads (5 citations). Typically, the entire aerial part of the plant is used, but both the leaves and the flowers are also used for decoration. When the leaves are eaten raw, it is advisable to add lemon juice, which softens the stiff, prickly bristles that make the plant shaggy. The plant is often used to alleviate gastrointestinal

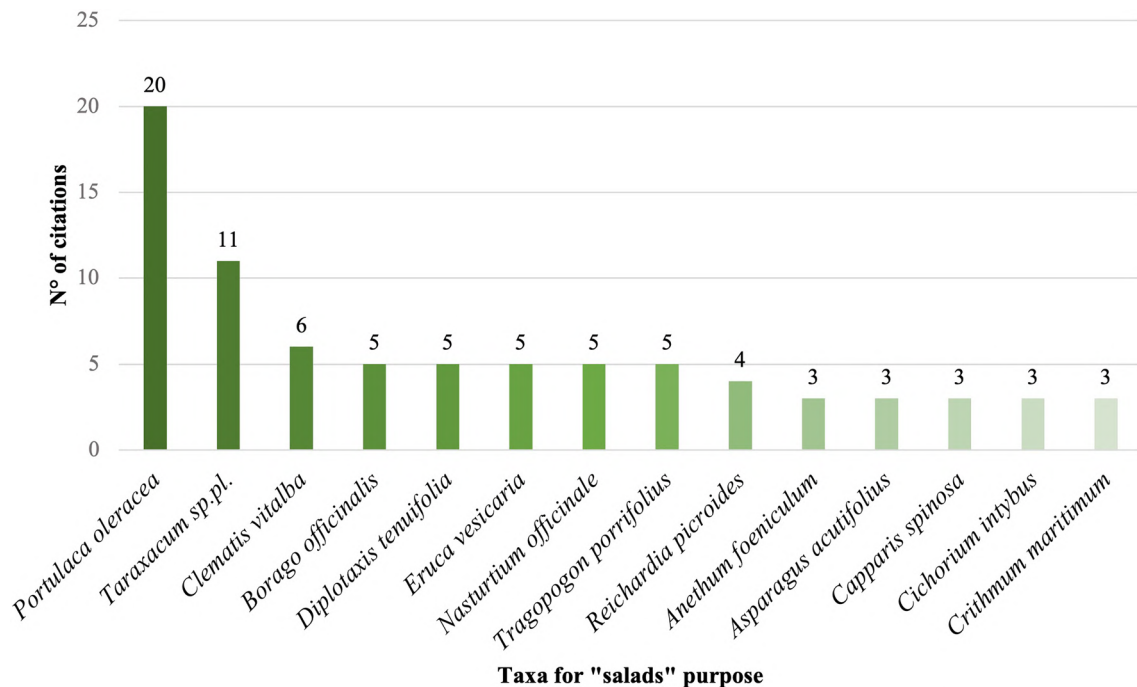


Fig. 8 Most common taxa recorded with the "salads" purpose sorted by number of citations

distress, with edible use associated with therapeutic effects on the digestive system (Arcidiacono et al. 2007). The same use has been found in Calabria (Passalacqua et al. 2006; Bellusci 2017; Mattalia et al. 2020a, b), Campania (Guarino et al. 2008; Savo et al. 2019), Puglia (Leporatti and Guarrera 2007), Sardegna (Lancioni et al. 2007), Toscana (Corsi et al. 1981; Uncini Manganelli et al. 2002), Lombardia (Peroni 2010), Marche (Lucchetti et al. 2019), Liguria (Maccioni et al. 2004), Abruzzo (Tammaro 1984; Manzi 1999) and, in general, throughout the Mediterranean basin (Hadjichambis et al. 2008; Motti et al. 2022). *Borago officinalis* is, in fact, one of the most widely used species in both northern and southern Italy (Ghirardini et al. 2007).

Omelettes

The use of plants in omelette preparation is widespread in Calabria, with 209 citations and 104 taxa reported in this survey (Fig. 5). The shoots of *Asparagus acutifolius* make this species the most significant used for this purpose (23 citations) (Fig. 9).

In a study carried out in Spain, shoots of wild *A. acutifolius* was found to have a more palatable taste than the cultivated *Asparagus officinalis* L. (Aceituno-Mata 2010).

The use of *A. acutifolius* turions to prepare omelettes has been found in several Italian regions (Basilicata—Pieroni

et al. 2005, Sansanelli et al. 2017, Guarrera et al. 2006; Calabria—Nebel et al. 2006, Musarella et al. 2019; Campania—Savo 2009, Scherrer et al. 2005, Salerno and Guarrera 2008, Savo et al. 2019; Liguria—Cornara et al. 2009; Marche—Taffetani 2005, Lucchetti et al. 2019; Molise—di Tizio et al. 2012; Puglia—Pieroni and Cattero 2019, Biscotti et al. 2018; Sardegna—Lancioni et al. 2007, Signorini et al. 2009; Sicilia—Lentini 2000, Napoli and Giglio 2002, Arcidiacono et al. 2007, 2010, Lentini and Venza 2007, Licata et al. 2016; Toscana—Corsi et al. 1981, Pieroni 1999, Uncini Manganelli et al. 2002, Signorini et al. 2008; Umbria—Ranfa and Bodesmo 2017) but also in Spain (Tardío et al. 2006; Aceituno Mata 2010; Rigat et al. 2016) and the Mediterranean basin (Hadjichambis et al. 2008; Idolo et al. 2010).

Ruscus aculeatus L. is a commonly cited taxon in the preparation of 'omelettes', with 14 references (Fig. 9). Its shoots are utilized similarly to wild asparagus; additionally, researchers have reported that the shoots of *R. aculeatus* are more bitter and preferred compared to those of *A. acutifolius* (Arcidiacono et al. 2007).

The use of this taxon has been documented in various regions in southern Italy (Basilicata—Pieroni et al. 2005, Sansanelli et al. 2017; Calabria—Musarella et al. 2019, Mattalia et al. 2020a, b; Campania—Scherrer et al. 2005,

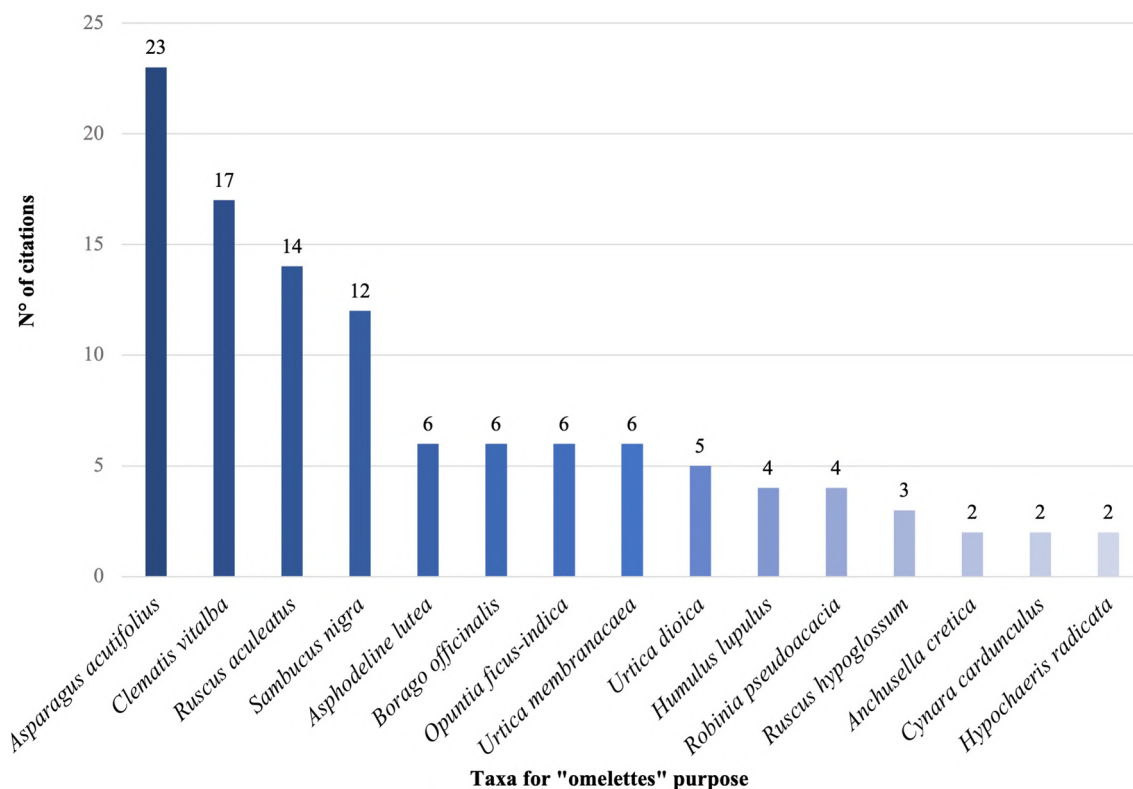


Fig. 9 Taxa most used for the "omelettes" purpose in order of number of citations

Guarino et al. 2008, Savo et al. 2019; Molise—di Tizio et al. 2012; Puglia—Biscotti et al. 2018; Sicilia—Arcidicono et al. 2007, Lentini and Venza 2007, Licata et al. 2016), slightly less in central and northern Italy (Lombardia—Peroni 2010; Marche—Guarrera 1990, Lucchetti et al. 2019; Toscana—Uncini Manganelli et al. 2002, Signorini et al. 2008; Umbria—Ranfa & Bodesmo 2017). The same traditional use of this plant has been found in Spain (Tardío et al. 2006).

Sambucus nigra L., commonly called elderberry, is a plant utilized for various ethnobotanical purposes: it is considered a medicinal plant for its healing, expectorant and antispasmodic properties (Camangi et al. 2003; Guarrera et al. 2005; Cornara et al. 2014).

The plant is also known in Calabria for the aromatic use of its flowers: these are added to a flatbread to flavour it, called '*pitta china*' in Calabrian dialect (Mattalia et al. 2020b; Gentile et al. 2022). This species is globally utilized, and specifically, for this purpose, the use of inflorescences of *S. nigra* has been recorded in Italy (Italy, in general—Idolo et al. 2010; Basilicata—Sansanelli et al. 2017; Calabria—Passalacqua et al. 2006, Bellusci et al. 2017, Musarella et al. 2019, Mattalia et al. 2020a; Campania - Scherrer et al. 2005, Savo 2009, Savo et al. 2019, Motti et al. 2020; Marche—Lucchetti et al. 2019; Liguria—Cornara et al. 2009, 2014; Lombardia—Peroni 2010, Vitalini et al. 2015; Piemonte—Mattalia et al. 2013, Bellia et al. 2015; Sardegna—Lancioni et al. 2007; Toscana—Pieroni 1999, Uncini Manganelli et al. 2002) and internationally (Aларcon et al. 2015; Rigat et al. 2016; Motti et al. 2022).

Conclusions

The results highlight the importance that plants have played and currently play in the ethnobotanical field in Calabria, which, although it is now a globalised territory, still maintains and preserves ancient food traditions. This study is an important contribution to the ethnobotanical knowledge of many plant species: it reports numerous food uses of native and allochthonous plants. Some species native to the study area may be allochthonous in other countries. These data can therefore be a valuable indication of their possible food use, which is currently neglected or underestimated.

Based on the results of this survey, many species could benefit from re-evaluation and further investigation from a phytochemical point of view. In fact, among the information collected, there are numerous confirmations of the presence of nutraceutical compounds in plants used as food, as confirmed by various phytochemical studies. For this reason, studies of this type are becoming increasingly desirable on a global scale to discover the nutraceutical potential of many other plants that have so far only been used as food.

Even in present times, the utilization of wild and cultivated plants remains prevalent among the populations living in Calabria. This practice was observed across groups with different historical origins such as Arbëreshë, Occitans, Graecanic, and the autochthonous Calabrians. The multifaceted Calabrian people demonstrate to have a large and diversified knowledge about the use of plants for food purposes. While some species appear to be favoured over others, this preference likely arises from their greater prevalence and wider distribution not only within Calabria but also throughout Italy and the broader Mediterranean region.

Among the various strategies that could serve to revalue and enhance ethnobotanical information is the domestication of wild species that are still widely used. This idea can facilitate the possibility of making the use of these plants more accessible and, above all, through the study of specific cultivation protocols, make these plants more resistant to climate change and all anthropic and other threats. Additionally, these species could be considered for commercialization, thereby expanding the range of options available to local consumers. Such an approach holds the promise of fostering a more localized and equitable economy, while concurrently mitigating production costs in agriculture. Plants that are discovered as food can be used by local farms and agrotourism establishments to promote the domestication of the species or to create new dishes that would have typical local characteristics. This strategy would have the added advantage of reducing water consumption, positively impacting the reduction of CO₂ emissions. By leveraging the innate attributes of these species, which are already well-adapted to the local climate, this initiative can maximize their potential. Despite the evident effects of climate change, this agricultural model based on ethnobotany studies could be adapted to other regions worldwide with positive outcomes on a planetary scale, according to the urgent directive of “thinking globally, acting locally”.

Unfortunately, this work is not enough to fill the gap in knowledge regarding the food use of plants in the Calabria region, however, new studies are already being conducted to implement this knowledge.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s42535-024-00975-4>.

Authors contribution CMM: had the idea for the article, performed the literature search, drafted the original manuscript, provided resources and supervised the project; MP: performed the literature search and data analysis, wrote, reviewed and edited the manuscript; VLAL: provided resources and drafted the original manuscript; GS: supervised, provided resources and performed formal analysis. All authors read and approved the final draft of the manuscript.

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Data availability All the data are available in the Supplementary files.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval Ethical approval was not applicable in this study.

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CHAPTER 4. Ethnobotanical survey in the Graecanic Area of Reggio Calabria (Southern Italy): a treasure chest of biodiversity and traditions at risk of extinction

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Research

Abstract

Background: In many rural areas of the Mediterranean, spontaneous plants play an essential role in everyday sustenance. However, knowledge of the use of spontaneous plants is gradually disappearing owing to socioeconomic changes that do not allow the enhancement of ethnobotanical traditions. The aim of this work was to collect, preserve, and enhance the ethnobotanical knowledge of the Graecanic Area of Reggio Calabria (Southern Italy), a marginal area rich in traditions and ethnobotanical knowledge that are at risk of extinction.

Methods: Data related to the botanical species known and used by the Graecanic populations were collected and analysed.

Results: In total, 632 records concerning current and past ethnobotanical use were gathered based on interviews with 24 informants. A total of 157 taxa belonging to 50 different families were identified, along with 22 subspecies and 3 genera utilised for ethnobotanical purposes. The most frequently mentioned families were Asteraceae (105 interviews and 26 taxa), Lamiaceae (69 interviews and 12 taxa), and Apiaceae (56 interviews and 8 taxa). The most frequent use was related to nutrition (263 interviews and 83 taxa). The most used taxon was *Clinopodium nepeta* (L.) Kuntze subsp. *nepeta*, known as **nipiteddha** in dialect, cited by 14 informants for 5 different uses and totalling 34 interviews, showing high values for CV (0.72) and RFC (0.58).

Conclusions: These findings highlight the significance of ethnobotanical knowledge in preserving cultural traditions and promoting sustainable local practices, while also identifying potential new quality products.

Keywords: Traditional Knowledge; Wild Plants; Cultural Heritage; Food Plants; Medicinal Plants; Wild Resources.

Background

Cultural practices involving the utilization of plants for food, medicine, and rituals have long been a cornerstone of human societies, underscoring the necessity for the preservation of traditional knowledge and fostering sustainable resource management (Balick and Cox 2020, Cruz-Garcia 2012). These practices contribute not only to biodiversity conservation but

also to environmental sustainability and food security (Kumar *et al.* 2021, Pei *et al.* 2009, Shisanya 2017). Furthermore, the innovative potential of traditional plant uses offers valuable insights for sustainable agriculture and natural resource management, promoting ecosystem resilience and safeguarding biodiversity (Ali *et al.* 2024, Caneva *et al.* 2013, Ulian *et al.* 2020). Ancient plant varieties are noteworthy for their contributions to both sustainability and human health, as they frequently exhibit distinctive agronomic and nutritional advantages (Abenavoli *et al.* 2021, Perrino 2022).

Documenting and researching ethnobotanical knowledge may also lead to the discovery of new chemical compounds useful for drug development and therapeutic products (Domingo-Fernández *et al.* 2023, Chaachouay & Zidane 2024, Süntar 2020). Many plants traditionally used in folk medicine contain active compounds with potential applications in modern medicine (Jamal 2023, Liu *et al.* 2023, Savo *et al.* 2019). These ethnobotanical practices constitute an invaluable intangible heritage, critical for preserving cultural diversity, advancing the sustainable development of local communities and discover new plant uses (Bhattacharya 2024, Caneva *et al.* 2013, Novais *et al.* 2004, Söukand *et al.* 2024). Wild plants continue to be used today, not merely as a continuation of past traditions but also for their significant nutraceutical and dietary benefits (Khan *et al.* 2024, Pardo de Santayana *et al.* 2010, Sicari *et al.* 2021). Wild vegetables are prized for their high mineral and vitamin content (Ansari *et al.* 2005, Mahmoud *et al.* 2024, Pardo-de-Santayana *et al.* 2007).

Ethnobotanical research holds relevance in Mediterranean regions, where the rich local flora is closely tied to the traditional practices of indigenous communities (Caruso 2022, Heinrich *et al.* 2009, Otero *et al.* 2013, Plieninger *et al.* 2023). In the Mediterranean context, the use of spontaneous plants has been extensively documented in various ethnobotanical studies, highlighting the wealth of traditional knowledge passed down through generations (Hadjichambis *et al.* 2008, Rivera *et al.* 2006, Savo *et al.* 2019). In many rural Mediterranean communities, wild plants are used not only for daily nutrition but also as medicinal remedies for a range of human and animal ailments, as well as for cultural and religious practices (Azaizeh *et al.* 2006, Castagna *et al.* 2021, Pardo-De-Santayana *et al.* 2005, Passalacqua *et al.* 2006, Rivera *et al.* 2005).

Italy has a long and very rich ethnobotanical tradition (Pieroni & Giusti 2009, Motti *et al.* 2019, Motti 2021). Calabria, located in the far south of Italy, is a region rich in biodiversity and ancient cultural heritage that reflect the millennia-long history of its inhabitants and their territories (Gentile *et al.* 2022, Musarella *et al.* 2019, 2024, Passalacqua *et al.* 2006, 2007, Patti *et al.* 2024c,d). However, this traditional knowledge is gradually fading due to socioeconomic, landscape and cultural changes affecting the region (Maruca *et al.* 2019, Spampinato *et al.* 2022). Previous studies have shown that traditional plant-related practices, while still prevalent, are steadily vanishing as younger generations lose interest (Idolo *et al.* 2010, Kalle & Söukand 2016, Kidane & Kejela 2021, Pawera *et al.* 2020). Particularly significant from an ethnobotanical perspective are the marginal areas of Southern Italy, where cultural traditions are closely tied to the history of human settlement (Alhajj Ali *et al.* 2024). Among these areas is the Graecanic Area of Calabria, located on the Ionian side of the Metropolitan City of Reggio Calabria. This territory is distinguished by its strong cultural and linguistic identity, with roots dating back to ancient Magna Graecia (8th century BC). During the Magna Graecia period, Greek culture dominated the entire Eastern Mediterranean. Today, the Graecanic Area of Reggio Calabria is concentrated in the Aspromonte mountains at the southernmost tip of the Italian Peninsula (Calabria region) and in Salento, located in the Puglia region (Pieroni & Cattero 2019). The Greek ethnic communities currently residing in Southern Italy are a remnant of the stable and autonomous Greek colonial settlements founded in antiquity. When the Greeks established these colonies, they brought with them traditional crops such as olives and grapes (Dalby 1998, Lombardo 1995, Sallares 1991), which was a common practice during migrations and trade exchanges, as populations often transported their own crops (Prance 2005).

The Graecanic communities have developed a deep symbiotic relationship with their local flora, utilizing a wide variety of wild plants for food, medicine, veterinary care, craftsmanship, and rituals (Pieroni & Cattero 2019).

At present, pastoralism and subsistence farming remain traditional means of livelihood in the region. However, economic transformations, emigration, and natural disasters—such as the devastating floods and earthquakes of 1951 and 1971—have led to a gradual abandonment of these activities and a sharp decline in population. Over time, new coastal settlements, known as “*la marina*”, have emerged, prompting many residents to leave the mountain villages and relocate there (Kish 1953). Despite these changes, the gathering of wild plants continues to play an important role in the traditional diet and remains a vital element of Graecanic culture.

The inhabitants of the Graecanic Area, unlike the surrounding Italian population, are characterized by their use of the ancient “*Graecanico*” language (Martino 1980, Spampinato *et al.* 2017), as well as a distinct culture and history as an ethnic and linguistic minority (Alessio 1939, Rohlfs 1974). This distinction is largely due to the geographical isolation of the villages and

the marginality of the territory, which has helped preserve many aspects of their historical, cultural and landscape heritage (Condemi *et al.* 1999, Spampinato *et al.* 2022). It preserves a valuable heritage of ethnobotanical knowledge but is increasingly threatened by the forces of modernization and cultural homogenization (Nebel *et al.* 2006, Nebel & Heinrich 2009, 2010).

The primary aim of this study is to collect, preserve, and promote the ethnobotanical knowledge of the Graecanic Area of Reggio Calabria (GARC), documenting the traditional uses of wild plants and assessing their potential for the development of new quality products, thereby ensuring that the knowledge and traditions linked to the local flora are not lost.

Materials and Methods

Study area

The study area for this ethnobotanical investigation is the Graecanic Area situated on the Ionian side of the Metropolitan City of Reggio Calabria, in Southern Calabria (Italy) (Fig. 1). This region is distinguished by a strong cultural and anthropological identity that has withstood various global changes for centuries (Nebel *et al.* 2006).

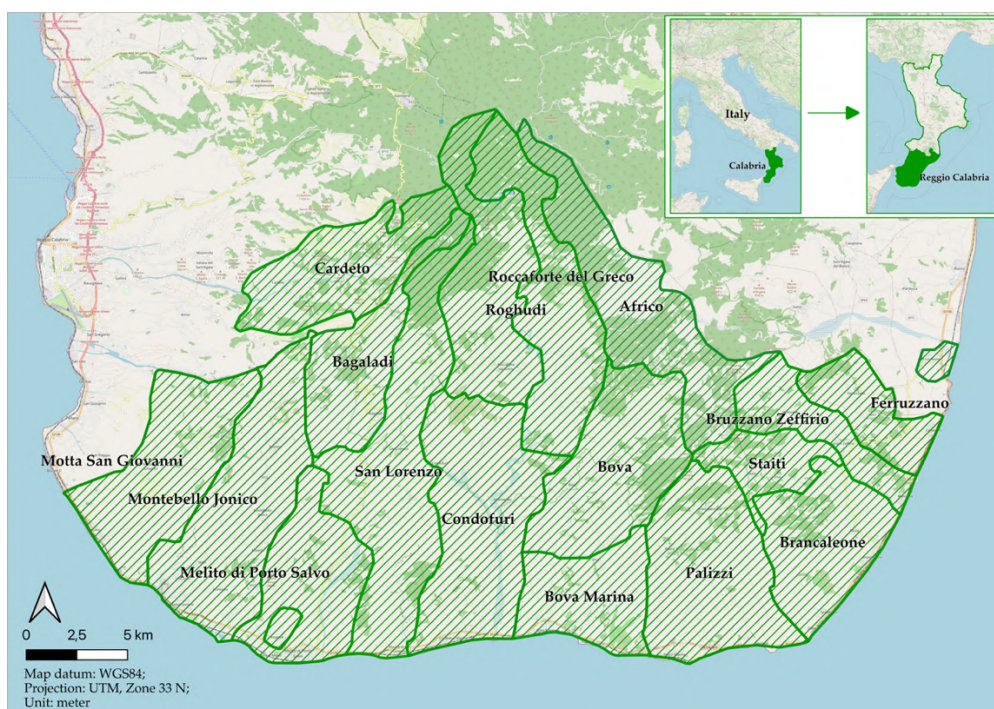


Figure 1. Highlight in green are the borders of the municipalities belonging to the Graecanic area of the Metropolitan City of Reggio Calabria (Calabria, Southern Italy): Africo, Bagaladi, Bova, Bova Marina, Brancaleone, Bruzzano Zeffirio, Cardeto, Condofuri, Ferruzzano, Melito di Porto Salvo, Montebello Jonico, Motta San Giovanni, Palizzi, Roccaforte del Greco, Roghudi, San Lorenzo, Staiti.

Ethnobotanical survey

Ethnobotanical information for the GARC was collected during 2022 and 2023 through semi-structured field interviews with residents. We focused on individuals living in rural areas, relatively insulated from the effects of globalization, who continue to practice the traditional use of wild plants and are not influenced by personal studies or mass media, relying solely on their cultural heritage. Additional informants were identified through word of mouth and recommendations from local agricultural businesses.

The interviews were conducted in compliance with the Ethical Code of the International Society of Ethnobiology (ISE), which promotes ethical practices and equitable relationships (ISE 2006). Following the methodology of Musarella *et al.* (2019), interviews were held in both Italian and the local dialect, allowing respondents to express themselves freely without feeling judged. Information was gathered on plant taxa and their parts used, local dialect names, frequency of use, and methods of preparation and purposes. During fieldwork, we also collected plant samples and took photographs to ensure accurate species identification.

In the laboratory, collected samples were dried by pressing them between sheets of newspaper and placing them in a heater at 42 °C. Once dried, the specimens were catalogued into a herbarium and identified using “*Flora d’Italia*” (Pignatti *et al.* 2017a,b, 2018, 2019). The samples were subsequently deposited at the Herbarium of the Mediterranean University of Reggio Calabria (REGGIO), as per Thiers (2024). For updated scientific nomenclature, we referred to Bartolucci *et al.* (2024) for native species and Galasso *et al.* (2024) for allochthonous taxa. The origin of the allochthonous taxa was verified according to Galasso *et al.* (2024).

The life form of the taxa was classified following Raunkiaer’s life-form criteria (Raunkiaer 1934), while chorological types were determined based on Pignatti (1982). For the chorological categories “Cryptogenic” and “Allochthonous”, the glossary of Pyšek *et al.* (2009) was consulted.

Ethnobotanical data were stored in a database using Microsoft Access®, with a digital copy containing all fields from the ethnobotanical interview forms. The results were exported to Microsoft Excel® for statistical analysis. Medicinal uses were categorized into nine distinct groups of diseases and disorders according to the classification system by Cook (1995).

Data analysis

Quantitative indices were calculated to statistically analyse the significance of each taxon or family within the overall data set, with the aim of highlighting their ethnobotanical value. To quantify the importance of the taxa in the study area, we applied the following indices:

Cultural Importance Index (CI), in accordance with Tardío and Pardo-de-Santayana (2008) and Whitney *et al.* (2018), which calculates the cultural significance of plants using the formula:

$$CI = \sum_{u=u_i}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} / N \quad (1)$$

where:

- UR_{ui} is the number of use categories for each taxon;
- N is the total number of informants.

Cultural Value (CV), according to Reyes-García *et al.* (2006), calculates the cultural value of taxa as:

$$CV = \frac{U_s}{U_{tot}} * \frac{FC}{N} * \left[\sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} / N \right] \quad (2)$$

where:

- U_s is the number of uses for taxon ‘s’;
- U_{tot} is the total number of potential uses considered in the study;
- FC is the number of informants mentioning the taxon;
- N is the total number of informants;
- UR_{ui} is the sum of all Use Reports (UR) for the taxon, divided by N.

Family Importance Value (FIV) according to Vitalini *et al.* (2013), represents the frequency with which a botanical family is mentioned by informants, calculated as:

$$FIV = \frac{FC_{(family)}}{N} \quad (3)$$

where:

- FC (family) is the number of informants citing a given family;
- N is the total number of informants.

Frequency of Citation (FC) according to Prance *et al.* (1987), calculates how frequently a taxon is cited by informants.

Plant Part Value (PPV) according to Chaachouay *et al.* (2019), highlights the most used plant part in interviews using the formula:

$$PPV = \frac{RU_{\text{plant part}}}{RU} \quad (4)$$

where:

- $RU_{\text{plant part}}$ is the sum of records for that plant part;
- RU is the total numbers of records for all plant parts.

Relative Frequency of Citation (RFC), according to Tardío and Pardo-de-Santayana (2008), functions similarly to FC but is normalized to the total number of informants, producing a value between 0 and 1:

$$RFC = \frac{FC}{N} = \frac{\sum_{i=1}^{i_N} UR_i}{N} \quad (5)$$

where:

- FC is the number of informants citing the taxon;
- N is the total number of informants.

Relative Importance Index (RI), also from Tardío and Pardo-de-Santayana (2008), measures the relative importance of each taxon as:

$$RI = \frac{RFC_{(max)} + RNU_{(max)}}{2} \quad (6)$$

where:

- $RFC_{(max)}$ is the maximum RFC value, calculated by dividing FC by the maximum FC across all taxa;
- $RNU_{(max)}$ is the maximum value of the Relative Number of Use Categories, calculated by dividing the number of uses for the taxon by the maximum number of uses across all taxa.

Use Value (UV), according to Tardío and Pardo-de-Santayana (2008), is calculated as:

$$UV = \sum_{i=1}^{i_N} \sum_{u=u_i}^{u_{NC}} UR_{iu} / N \quad (7)$$

where:

- UR_{iu} represents the number of use categories for each taxon;
- N is the total number of informants.

While the formulas for CI and UV appear similar, the data are grouped differently. For CI, Use Reports (URs) are first aggregated by use categories (i.e., the number of informants citing each use) and then summed. For UV, URs are first aggregated by informants (i.e., the number of uses cited by each informant) and then summed.

The indices CI, CV, RI, and UV were calculated using R software (v2024.04.2+764) (R Core Team 2021) with the EthnobotanyR package (v0.1.9) (Whitney 2022) following the guidelines of Tardío and Pardo-de-Santayana (2008). The indices FC, FIV, PPV, and RFC were calculated using Microsoft Excel®.

Additionally, a chord diagram was generated using the “EthnoChord” function within the EthnobotanyR package, which visualizes the medicinal information collected and highlights the most relevant species (Haq *et al.* 2022, Whitney *et al.* 2018).

Results

A total of 632 records documenting current and past ethnobotanical uses within the GARC were collected. Twenty-four individuals were interviewed (informants), comprising 15 men (63%) and 9 women (37%), ranging from 21 and 82 years of age. The informants were grouped into three age categories, and their ethnobotanical knowledge was assessed by comparing the number of interviews conducted and the taxa mentioned (Fig. 2). Notably, most informants were aged 61-82 years (19 individuals), contributing the highest number of interviews (515) and cited taxa (141).

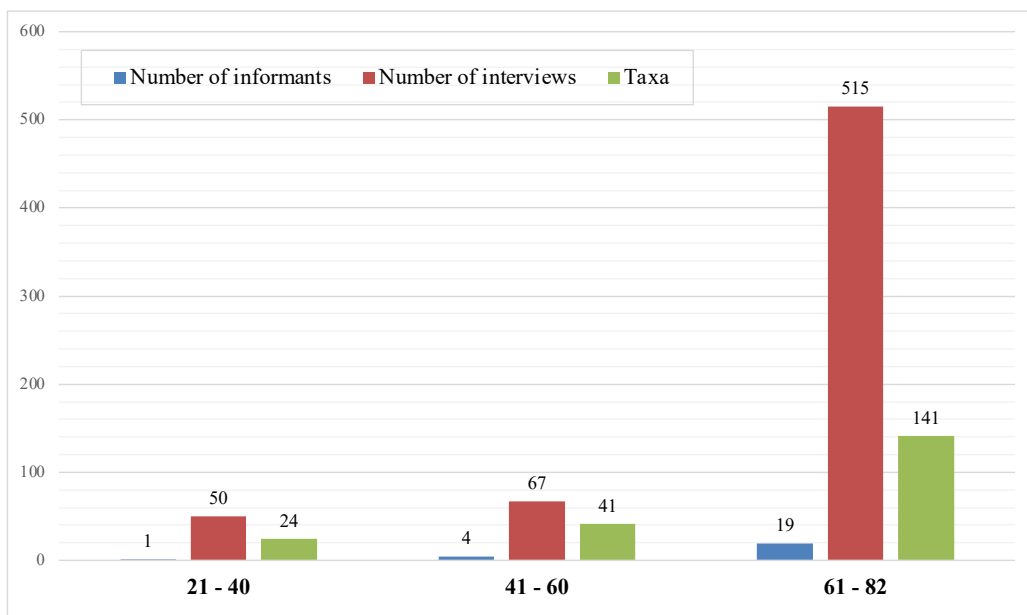


Figure 1. Distribution of the informants and their ethnobotanical knowledge in three age groups: 21-40, 41-60 and 61-82. The relationship between age and ethnobotanical knowledge was established through the number of interviews and the number of taxa.

Although most of the knowledge comes from older adults, it was noted that younger individuals, such as a 21-year-old, still contributed valuable insights, with 50 interviews discussing 24 different taxa.

Informants were also categorized by municipality of residence (Tab. 1). The municipality of Condofuri had the highest number of informants (11) and interviews (253), followed by Bova with 4 informants and 134 interviews, and Bruzzano Zeffirio with 3 informants and 78 interviews.

Table 1. Number of interviews and informants by municipality within the Graecanic Area of Reggio Calabria (Southern Italy).

	Municipalities	N° of interviews	N° of informants
1	Bova	135	4
2	Bova Marina	47	3
3	Bruzzano Zeffirio	78	3
4	Condofuri	253	11
5	San Lorenzo	58	1
6	Staiti	61	3
TOT	6	632	24

In total, 157 taxa from 50 different families were identified, along with 22 subspecies and 3 genera used for ethnobotanical purposes. Table 2 lists the families, the number of taxa, the number of informants, and the Family Importance Value (FIV). The most cited families were Asteraceae (105 interviews, 26 taxa), Lamiaceae (69 interviews, 12 taxa), and Apiaceae (56 interviews, 8 taxa).

Table 2. List of the all the botanical families sorted in alphabetical order. For each family, the following information is provided: the number of interviews (out of a total of 632), the number of taxa (out of a total of 157), the Frequency of Citation (FC), and the Family Importance Value (FIV).

N°	Family	N° of interviews	N° of taxa	FC (family)	FIV (%)
1	Acanthaceae	1	1	1	4.17
2	Amaranthaceae	15	2	9	37.50
3	Anacardiaceae	23	2	8	33.33
4	Apiaceae	56	8	15	62.50
5	Apocynaceae	4	1	3	12.50
6	Araceae	3	2	2	8.33
7	Asparagaceae	15	6	10	41.67

8	Asphodelaceae	9	2	6	25.00
9	Asteraceae	105	26	21	87.50
10	Boraginaceae	15	3	9	37.50
11	Brassicaceae	14	8	10	41.67
12	Cactaceae	23	1	7	29.17
13	Capparaceae	6	1	4	16.67
14	Cistaceae	2	1	2	8.33
15	Crassulaceae	1	1	1	4.17
16	Cucurbitaceae	2	2	2	8.33
17	Dipsacaceae	1	1	1	4.17
18	Ericaceae	8	2	6	25.00
19	Euphorbiaceae	5	2	4	16.67
20	Fabaceae	51	14	18	75.00
21	Fagaceae	16	4	8	33.33
22	Hypericaceae	4	1	3	12.50
23	Iridaceae	1	1	1	4.17
24	Juglandaceae	3	1	2	8.33
25	Juncaceae	2	1	2	8.33
26	Lamiaceae	69	12	17	70.83
27	Lauraceae	23	1	11	45.83
28	Linaceae	3	2	2	8.33
29	Lythraceae	3	1	3	12.50
30	Malvaceae	6	2	5	20.83
31	Moraceae	13	2	8	33.33
32	Myrtaceae	4	1	2	8.33
33	Oleaceae	13	3	8	33.33
34	Orobanchaceae	1	1	1	4.17
35	Oxalidaceae	1	1	1	4.17
36	Papaveraceae	1	1	1	4.17
37	Pinaceae	1	1	1	4.17
38	Poaceae	33	10	14	58.33
39	Polygonaceae	6	3	5	20.83
40	Portulacaceae	4	1	4	16.67
41	Resedaceae	1	1	1	4.17
42	Rosaceae	26	6	12	50.00
43	Rubiaceae	1	1	1	4.17
44	Rutaceae	10	3	5	20.83
45	Scrophulariaceae	6	2	4	16.67
46	Solanaceae	3	3	2	8.33
47	Tamaricaceae	1	1	1	4.17
48	Typhaceae	7	1	3	12.50
49	Urticaceae	10	2	9	37.50
50	Vitaceae	1	1	1	4.17
TOT	50	632	157	-	-

The FIV index confirms the following as the most used families: Asteraceae (87.50%), Lamiaceae (70.83%), and Apiaceae (62.50%).

Figure 3 presents the life forms spectrum of the taxa, showing that Hemicryptophytes (33%), Chamaephytes (31%), and Therophytes (15%) were the most frequent, consistent with previous studies from the Tyrrhenian side of Calabria (Patti *et al.* 2024c).

The chorological spectrum (Fig. 4) shows a predominance of Mediterranean chorotypes *sensu lato* (51%), with further division into Stenomediterranean (30%) and Eurimediterranean (21%). Other significant chorotypes include Eurasian (19%) and a smaller percentage of cultivated (10%), alien (4%), and endemic plants (4%).

Regarding the origin of the taxa (Fig. 5), the native ones accounted for the majority (81%), while alien (16%) and cryptogenic ones (3%) were also detected.

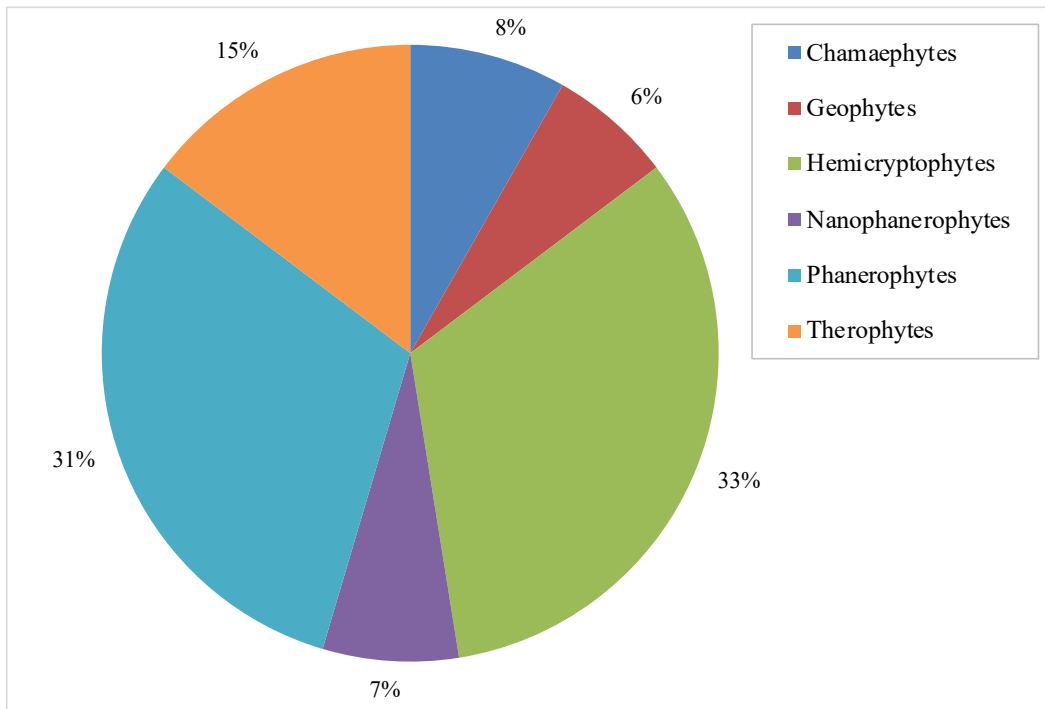


Figure 2. Life forms spectrum of the taxa recorded during the interviews detected the Graecanic Area of Reggio Calabria (Southern Italy) according to Raunkiaer (1934).

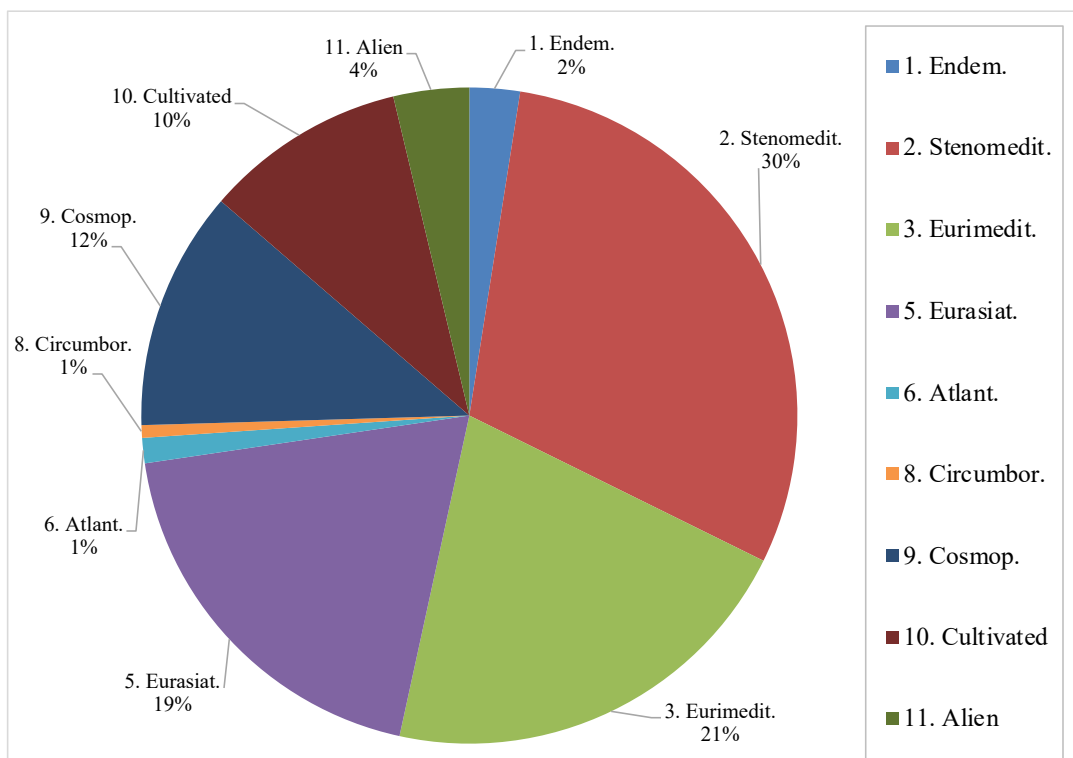


Figure 3. Chorological spectrum of the taxa recorded from the interviews detected the Graecanic Area of Reggio Calabria (Southern Italy) according to Pignatti (1982).

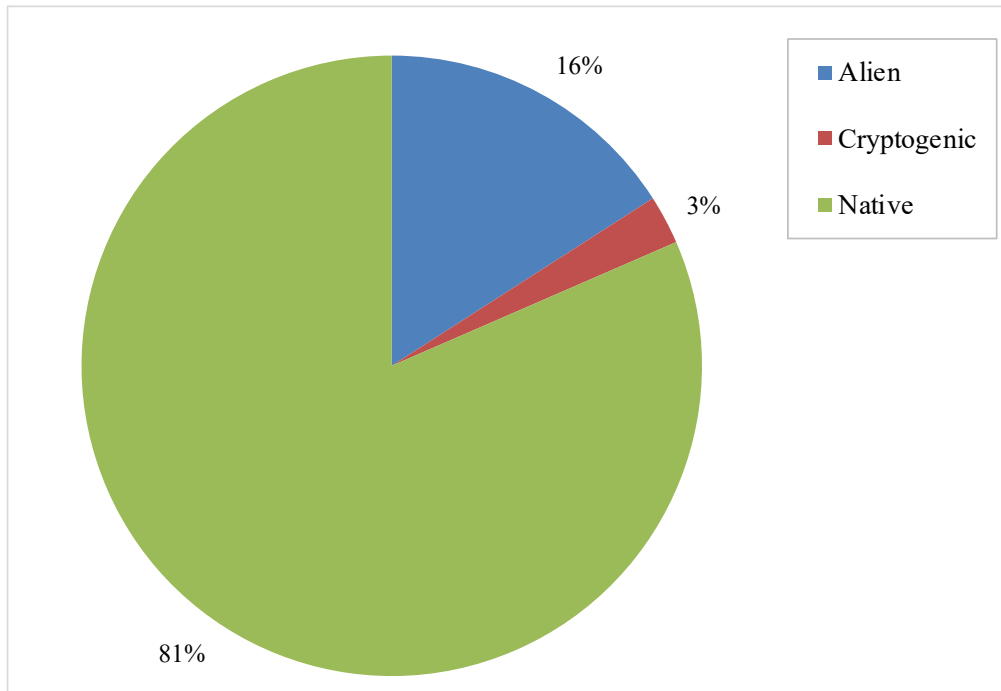


Figure 4. Origin of ethnobotanical taxa detected within the Graecanic Area of Reggio Calabria (Southern Italy). The origin is in accordance with Galasso *et al.* (2024).

Plant parts used were recorded during interviews (Fig. 6). The most used parts were leaves (213 interviews), fruits (109), and stems (107).

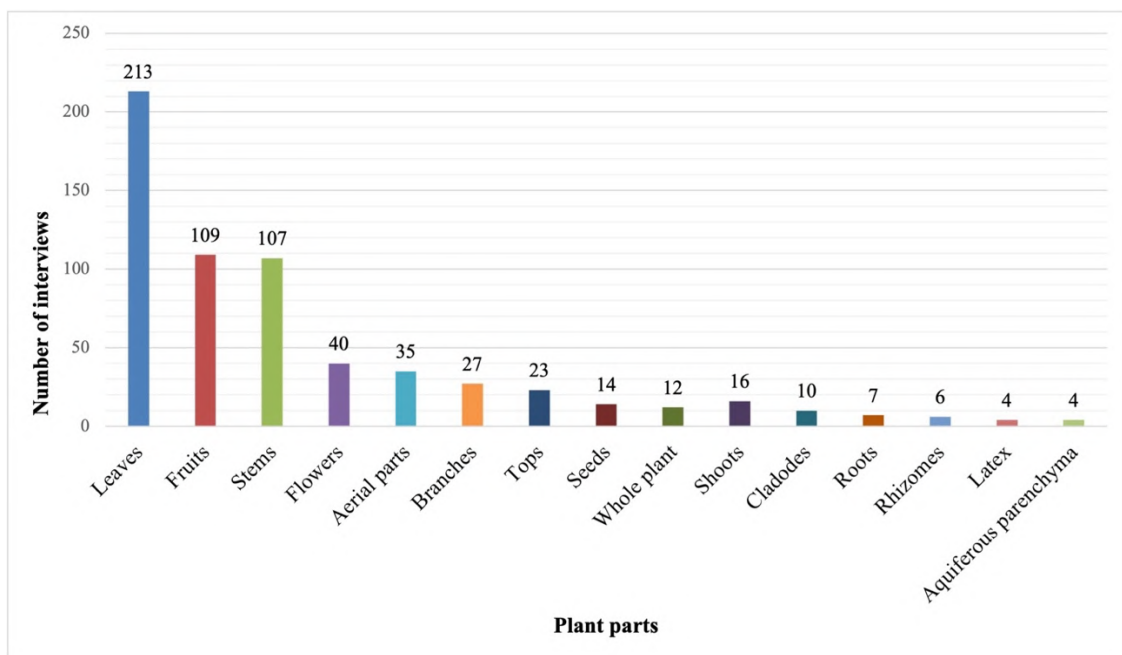


Figure 5. Plant parts most used for ethnobotanical purposes within the Graecanic Area of Reggio Calabria (Southern Italy).

The Plant Part Value (PPV) index (Tab. 3) confirmed the most used plant parts, with leaves having the highest PPV (0.34), followed by fruits (0.17) and stems (0.17). Leaves are widely recognized as the most frequently used plant part in ethnobotanical practices throughout Calabria (Patti *et al.* 2025).

Table 3. Plant parts most used for ethnobotanical purposes within the Graecanic Area of Reggio Calabria (Southern Italy) ordered by Plant Part Value (PPV) index.

Plant parts	Records	PPV
Leaves	213	34.00
Fruits	109	0.17
Stems	107	0.17
Flowers	40	0.06
Aerial parts	35	0.06
Branches	27	0.04
Tops	23	0.04
Seeds	14	0.02
Whole plant	12	0.02
Shoots	16	0.03
Cladodes	10	0.02
Roots	7	0.01
Rhizomes	6	0.01
Latex	4	0.01
Aquifer parenchyma	4	0.01

During the ethnobotanical survey, it emerged that plants are still used for various purposes today. Figure 7 summarizes all ethnobotanical uses identified in the GARC along with the number of taxa for each use. The most common use is related to food (263 interviews and 83 different taxa): as is well known, plants are a cornerstone of the Mediterranean diet, and people continue to maintain the tradition of consuming wild plants for their daily intake of nutrients and protective substances for health (Papageorgiou *et al.* 2022).

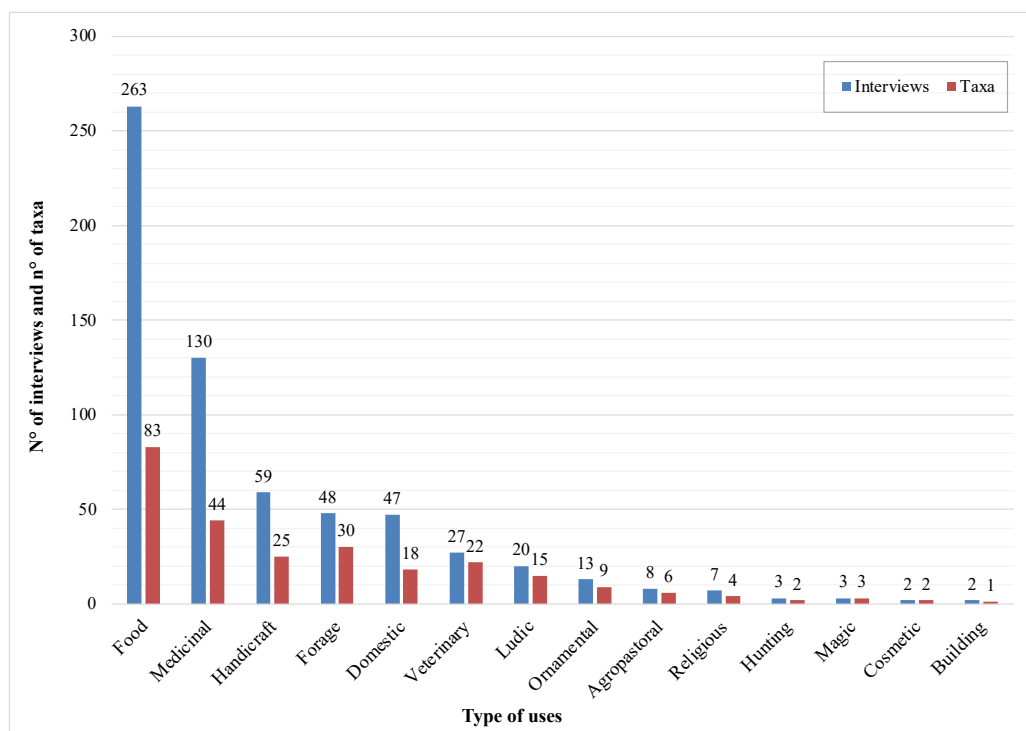


Figure 6. Types of ethnobotanical use of taxa detected within the Graecanic area of Reggio Calabria (Southern Italy), sorted by the number of records and taxa for each use.

The second most common use is medicinal (130 interviews and 44 taxa): plants, which have always been a primary source of active ingredients beneficial to human health, are still considered one of many natural options for medicinal purposes. Handicraft uses are also currently present in the GARC (59 interviews and 25 taxa): parts of plants are used to prepare various tools, which are then used at home, given as gifts or in some cases even sold.

Less common uses were also reported, such as religious (7 interviews) and magical (3), referring to traditional practices related to religion or the occult. In addition, uses related to hunting (3) and building practices (2) were also mentioned (Patti *et al.* 2022).

To highlight the most used taxa in this area, quantitative ethnobotanical indices were calculated. Table 4 presents the most used taxa in decreasing order based on the CV index, while the complete list of all taxa together with botanical information (life form, chorological type, origin) and ethnobotanical use can be found in the Supplementary material 1.

Table 4. The most relevant taxa of ethnobotanical use within the Graecanic Area of Reggio Calabria sorted according to the descending Cultural Value (CV) index.

Taxa	BASIC VALUE				INDEXES				RANKING	
	FC	U _s	UR	CI	CV	RFC	RI	UV	CV	RFC
<i>Clinopodium nepeta</i> (L.) Kuntze subsp. <i>nepeta</i>	14	5	34	1.42	0.72	0.58	0.81	0.31	1	1
<i>Opuntia ficus-indica</i> (L.) Mill.	7	6	23	0.96	0.39	0.29	0.73	0.38	2	9
<i>Spartium junceum</i> L.	12	8	21	0.88	0.38	0.50	0.78	0.50	3	2
<i>Anethum piperitum</i> Ucria	12	2	38	1.58	0.36	0.50	0.64	0.13	4	3
<i>Pistacia lentiscus</i> L.	8	7	19	0.79	0.27	0.33	0.68	0.44	5	5
<i>Arundo donax</i> L.	8	6	14	0.58	0.15	0.33	0.61	0.38	6	6
<i>Laurus nobilis</i> L.	11	2	23	0.96	0.13	0.46	0.45	0.13	7	4
<i>Olea europea</i> L.	7	6	9	0.38	0.06	0.29	0.55	0.38	8	10
<i>Pyrus spinosa</i> Forssk.	7	4	11	0.46	0.06	0.29	0.43	0.25	9	11
<i>Beta vulgaris</i> L. subsp. <i>vulgaris</i>	8	2	14	0.58	0.05	0.33	0.33	0.13	10	7
<i>Quercus pubescens</i> Willd. subsp. <i>pubescens</i>	6	3	11	0.46	0.05	0.25	0.36	0.19	11	14
<i>Borago officinalis</i> L.	7	2	12	0.50	0.04	0.29	0.30	0.13	12	12
<i>Dittrichia viscosa</i> (L.) Greuter	6	2	11	0.46	0.03	0.25	0.29	0.13	13	15
<i>Ampelodesmos mauritanicus</i> (Poir.) T. Durand & Schinz	4	4	7	0.29	0.02	0.17	0.38	0.25	14	28
<i>Reichardia picroides</i> (L.) Roth	8	2	9	0.38	0.02	0.33	0.26	0.13	15	8
<i>Cynara cardunculus</i> L. subsp. <i>cardunculus</i>	6	2	9	0.38	0.02	0.25	0.26	0.13	16	16
<i>Matricaria chamomilla</i> L.	6	2	9	0.38	0.02	0.25	0.26	0.13	17	17
<i>Typha domingensis</i> (Pers.) Steud.	3	3	7	0.29	0.02	0.13	0.31	0.19	18	39
<i>Crepis aspromontana</i> Brullo, Scelsi & Spamp.	6	2	8	0.33	0.02	0.25	0.25	0.13	19	18
<i>Origanum vulgare</i> L. subsp. <i>vulgare</i>	5	2	8	0.33	0.02	0.21	0.25	0.13	20	20
<i>Sulla coronaria</i> (L.) B.H. Choi & H. Ohashi	5	2	8	0.33	0.02	0.21	0.25	0.13	21	21
<i>Morus nigra</i> L.	4	3	6	0.25	0.01	0.17	0.29	0.19	22	29
<i>Artemisia arborescens</i> (Vaill.) L.	6	2	7	0.29	0.01	0.25	0.24	0.13	23	19
<i>Cichorium intybus</i> L.	5	2	7	0.29	0.01	0.21	0.24	0.13	24	22
<i>Erica arborea</i> L.	5	2	7	0.29	0.01	0.21	0.24	0.13	25	23
<i>Ficus carica</i> L.	5	2	7	0.29	0.01	0.21	0.24	0.13	26	24
<i>Parietaria judaica</i> L.	5	3	5	0.21	0.01	0.21	0.28	0.19	27	25
<i>Urtica membranacea</i> Poir.	5	3	5	0.21	0.01	0.21	0.28	0.19	28	26

*Basic Value: Frequency of Citation (FC), Number of types of use (U_s), Use Reports (UR); Indexes: Cultural Importance Index (CI), Cultural Value (CV), Relative Frequency of Citation (RFC), Relative Importance Index (RI), Use Value (UV).

As shown in Table 4, the most used taxon is *Clinopodium nepeta* (L.) Kuntze subsp. *nepeta*, known as **nipiteddha** in the local language. It was mentioned by 14 informants (FC) for 5 different uses (U_s), with a total of 34 interviews (UR). It has the highest CV and RFC indices (CV 0.72; RFC 0.58), and its other indices are also quite high (CI 1.42; RI 0.81; UV 0.31). The most common uses of this taxon are medicinal, culinary and domestic. Medicinally, the aerial part is used as a natural wound healer by rubbing the plant directly on the injury; this action also has disinfectant properties. It is also used as a digestive aid in infusions and decoctions, and as a relaxant. Numerous studies have demonstrated the presence of essential oils in this plant, which are useful for medicinal purposes (Beddiar *et al.* 2021, Debbabi *et al.* 2020; In the culinary world, *C. nepeta* subsp. *nepeta* is used to flavour various dishes; the use of this taxon as a food is well known (Pieroni & Giusti 2009, Sansanelli & Tassoni 2014, Vitalini *et al.* 2015). In the household, the plant is used to perfume the home and to scent home-made soap.

The second most utilised species, according to the Cultural Value index (CV), is *Opuntia ficus-indica* (L.) Mill. (0.72). This species was cited by seven informants, resulting in a total of 23 interviews. The remaining indices are similarly elevated (CI 0.96; RFC 0.29; RI 0.73; UV 0.38). This species is subject to extensive exploitation in the GARC, with six distinct types of uses: agricultural, culinary, domestic, fodder, recreational, and medicinal. The fruits are eaten as a snack, frequently in the field itself. This practice is well documented, and the edible parts of the species were the subject of extensive study (Barba *et al.* 2022, Gago *et al.* 2021, Patti *et al.* 2024a). In the field of medicine, the aquifer parenchyma located within the cladodes is used to soothe burns and frostbite of the skin. Furthermore, a more specific use involves the preparation of a decoction made from the flowers, which is drunk to eliminate kidney stones (Aragona *et al.* 2018, Kaur *et al.* 2012, Sinicropi *et al.* 2022, Tilahun & Welegerima 2018). A unique use of the cladodes of *O. ficus-indica* is the creation of the “**carrocciulu**”, which is a three-piece tricycle-like toy made from the cladode. It is formed by cutting three round pieces from the cladode and joining them together with a piece of cane (Musarella *et al.* 2019, 2018).

Spartium junceum L. exhibits the greatest variability in terms of types of use (U_s), with eight different purposes for which it is utilised. A total of 12 informants (FC) and 21 interviews (UR) were included in the study. According to the RFC index, it is the second most important taxon (0.78), while it ranks third based on the CV (0.38). Other indices also highlight its significance, including the CI (0.88), RI (0.78), and UV (0.50). This species is predominantly utilised in the production of craft items, with fibres extracted from the broom employed in the manufacture of textiles, blankets, and undergarments (Brandolino & Mediati 2019). Once dried, the branches are soaked in a river or other watercourse until they soften. They are then flattened and beaten with a mallet, or “**mannatore**”, until they become “**stoppa**”, or threads of cloth. These are then collected and spun on a loom. This practice is widely prevalent throughout Italy, as evidenced by numerous sources (Lucchetti *et al.* 2019, Maruca *et al.* 2019, Passalacqua *et al.* 2006, Salerno *et al.* 2005). Another common utilisation of *S. junceum* is the sale of its flowers. Historically, women would rise at dawn to gather broom flowers and take them to market for sale. These flowers were known for their pleasant fragrance and were purchased for the purpose of scenting and decorating homes. Furthermore, the flowers held religious significance, as they were scattered in the streets during the procession for the *Corpus Christi* (Maruca *et al.* 2019). Furthermore, the brooms had veterinary purposes. The bark was removed and used as a plaster cast for treating animal fractures. Following a period of several weeks, the plaster would naturally detach, indicating that the fracture had healed. This particular use is unique and has not been identified in any published sources.

The taxon with the highest number of interviews (UR 38) is *Anethum piperitum* Ucria, which is one of the most utilised taxa within the GARC (CI 1.58; CV 0.36; RFC 0.50; RI 0.64; UV 0.13). The primary purposes of this species are culinary and medicinal. In the culinary arts, the fruits of *A. piperitum* are employed to impart flavour to a variety of dishes, including cured meats, legumes, soups, and broths. Additionally, the fruits are used in the production of a liqueur known as “**finocchello**”, which is typical to the region. In contrast, the aerial parts are eaten as a side dish and added to first courses and soups. In terms of medicinal purposes, the fruits are employed in the preparation of decoctions that exhibit anti-inflammatory, antitussive, digestive, and diuretic properties. The therapeutic potential of this plant was substantiated by a several scientific evidence (Ilardi & Troia 2021, Patti *et al.* 2024c).

Among the most frequently used species listed in Table 4, it is also an endemic Calabrian species, *Crepis aspromontana* Brullo, Scelsi & Spamp. (CI 0.33; CV 0.02; RFC 0.25; RI 0.25; UV 0.13), which is notably prevalent in the GARC and is frequently employed as a side dish (Patti *et al.* 2024b). The local name, “**pricomaruddha**”, translates to “very bitter” in the *Grecanico* language. Furthermore, the plant has medicinal purposes, with its leaves employed in the preparation of digestive decoctions.

Food uses

The most significant category among ethnobotanical uses is that of food plants, with 263 interviews and 83 taxa recorded (Fig. 7). The most prevalent purpose within this category is for side dishes (69 interviews and 33 taxa) (Fig. 8), which encompasses vegetable preparations that are typically eaten with a main course or as a principal dish. The taxa most used as side dishes include *Beta vulgaris* subsp. *vulgaris* (7 interviews), *Reichardia picroides* (6), and *Crepis aspromontana* (5). This category of food is of great significance in the culinary traditions of Calabria (Patti *et al.* 2024c) and in other regions of the Mediterranean basin (Pieroni & Cattero 2019, Renna *et al.* 2015).

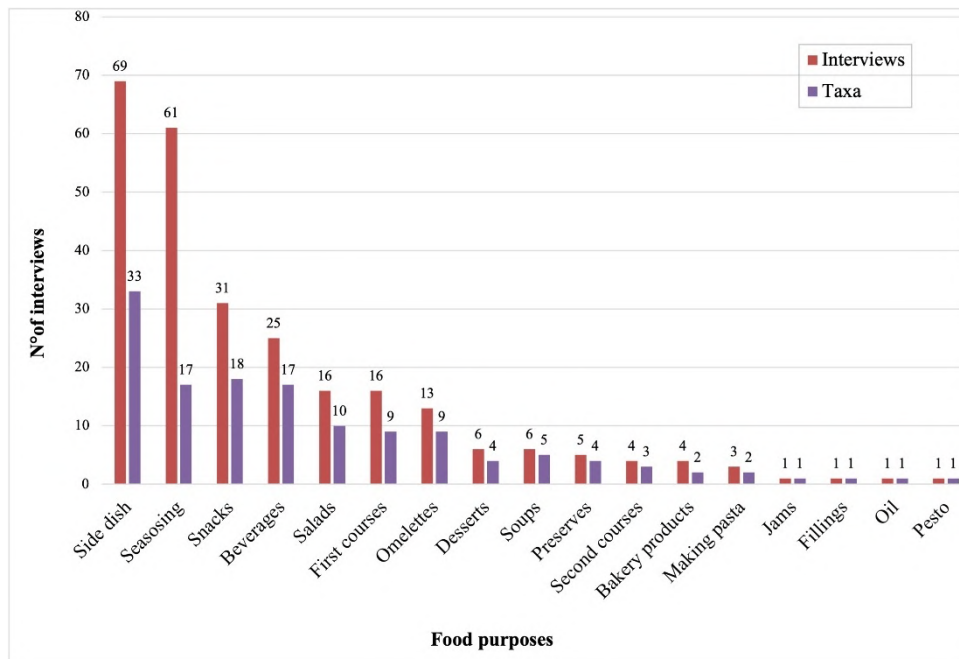


Figure 8. Food purposes detected within the Graecanic area of Reggio Calabria (Southern Italy) sorted by number of interviews.

The seasoning category encompasses all taxa employed for the purpose of enhancing and strengthening the aroma of a dish. The most frequently used taxa in this category are *Anethum piperitum* Ucria with 17 interviews, *Laurus nobilis* L. with six interviews, and *Origanum vulgare* L. subsp. *vulgare* with six interviews.

It is widely acknowledged that communities value the consumption of herbaceous plants, and the Asteraceae family is particularly rich in edible species. Figure 9 shows the four taxa eaten by the Graecanic community as food. The leaves and basal rosettes of all these taxa are employed in culinary practices. In the case of plants with spiny leaves, such as *Cynara cardunculus* L. subsp. *cardunculus* (Fig. 9a) and *Scolymus hispanicus* L. (Fig. 9b), the thorns are manually removed, and only the central vein of the leaf is eaten after boiling to soften it for easier consumption. The remaining two species, *Hypochaeris radicata* L. (Fig. 9c) and *Crepis vesicaria* L. (Fig. 9d), are eaten after being boiled or sautéed in oil and seasonings. These preparation methods enhance the flavour of the plants while rendering them more tender and preserving their nutritional properties. These culinary practices are deeply rooted in the food traditions of the Graecanic community, which has utilised the spontaneous resources of the territory for centuries to enrich its diet (Nebel *et al.* 2006, Nebel & Heinrich 2009, 2010, Pieroni & Cattero 2019).

A further common use is the consumption of plants as snacks (as evidenced in 31 interviews on 18 taxa and showed in Fig. 8). This category encompasses all plant parts that are typically eaten raw as a snack, typically in the morning or afternoon, to satiate hunger. One of the most used fruits for this purpose is that of *O. ficus-indica* (8 interviews). The fruits are peeled from their spiny exocarp with a small knife directly in the field and eaten in their unprocessed state (Fig. 10). This practice is well documented in the southern Italian regions (Biscotti *et al.* 2021, De Natale *et al.* 2021, Di Novella *et al.* 2013, Mattalia *et al.* 2020a,b, Menale *et al.* 2016, Nebel *et al.* 2006).



Figure 9. Some species belonging to the Asteraceae family eaten as food: *Cynara cardunculus* L. subsp. *cardunculus* (a), *Scolymus hispanicus* L. (b), *Hypochaeris radicata* L. (c), and *Crepis vesicaria* L. (d) (Ph. Miriam Patti and Valentina Lucia Astrid Laface).



Figure 10. On the left, a cladode of *Opuntia ficus-indica* L. (Cactaceae) with fruits; on the right, *O. ficus-indica* fruits cleaned from the spiny epicarp with a knife and eaten during an ethnobotanical interview in the Graecanic Area (Ph: Valentina Lucia Astrid Laface).

Another species eaten directly in the field as a snack is *Sulla coronaria* (L.) B.H. Choi & H. Ohashi (3 interviews): the soft stems of the plant are stripped of their outer layer and eaten as they are, as they have a sweet flavour that is highly appreciated by the population of the GARC.

The preparation of beverages from plants is a common practice (25 interviews on 17 taxa) (Fig. 8). Beverages made with plants include liqueurs (11 interviews): the fruits of the plants used are macerated in alcohol for several days, then the mixture is filtered and combined with a solution of water and alcohol. The species used for this purpose include *A. piperitum*, *Citrus xlimon* (L.) Osbeck, *Juglans regia* L., *Morus nigra* L., *Myrtus communis* L., *O. ficus-indica*, *Pimpinella anisoides* V.Br., *Pistacia lentiscus* L., and *Punica granatum* L.

The preparation of omelettes and fritters is also quite common (13 interviews and 9 taxa) (Fig. 8). Among the most used species are *Asparagus acutifolius* L. and *Asparagus albus* L., whose shoots are used to cook asparagus omelettes. This use is particularly widespread and has also been observed in other areas inhabited by Greek populations, such as Puglia and Macedonia (Pieroni & Cattero 2019).

Among the recipes collected, there are many related to the traditional use of plants. For example, among the baked products, two recipes stand out. The first is the preparation of bread with acorns of *Quercus pubescens* Willd. subsp. *pubescens*: the acorns are dried, ground and the flour obtained is used to make traditional bread. The use of acorns to make flour is a well-known tradition (Caneva *et al.* 1997, Guarrera 1994, Maruca *et al.* 2019, Pieroni 2000, Wang *et al.* 2022, Zocchi *et al.* 2022). The second preparation currently practised is “scaddateddhe”, typical biscuits made from flour, yeast, vermouth and fruits of *P. anisoides*. The dough is formed into round shapes, boiled for a few minutes and then baked in the oven (Fig. 11).



Figure 11. “Scaddateddhe”, typical Calabrian baked products prepared with the fruits of *Pimpinella anisoides* V.Br. (Apiaceae) (Ph. Miriam Patti).

In addition to the more common uses, the interviews revealed the use of parts of the plant to prepare pasta dough (3 interviews) (Fig. 8). The leaves are boiled and then mixed with eggs and flour to prepare green tagliatelle. The species used are *Beta vulgaris* L. subsp. *vulgaris* and *Borago officinalis* L.

Medicinal uses

The category of medicinal use is the second most important in terms of number of interviews, with 130 interviews and 44 different taxa (Figure 7). Figure 12 shows the breakdown of diseases into subcategories. The subcategory with the highest number of interviews and taxa is 1-Digestive system diseases, which includes all diseases related to the digestive tract, mouth and teeth. The most used species for this subgroup of disorders is *Clinopodium nepeta* subsp. *nepeta*, with nine interviews. Infusions or decoctions of the aerial parts are used for digestive and anti-inflammatory purposes, and the leaves are chewed for a few seconds and spat out for the same purpose. To relieve toothache, a poultice is prepared from the decoction of the plant and applied to the affected area.

Another important species in this subcategory is *Artemisia arborescens* (Vaill.) L. (5 interviews), locally known as “erba janca”. According to informants, in the past the plant was hung near children’s beds or placed under their pillows to help them recover from stomatitis; another method was to burn the plant and allow the children to inhale the fumes. This particular use for this taxon is not documented in any bibliographical source, but numerous studies support its medicinal properties, particularly its anti-inflammatory, antimicrobial and antispasmodic activities, which may justify its use against stomatitis (Beyrouthy *et al.* 2011, Jaradat *et al.* 2022, Militello *et al.* 2011).

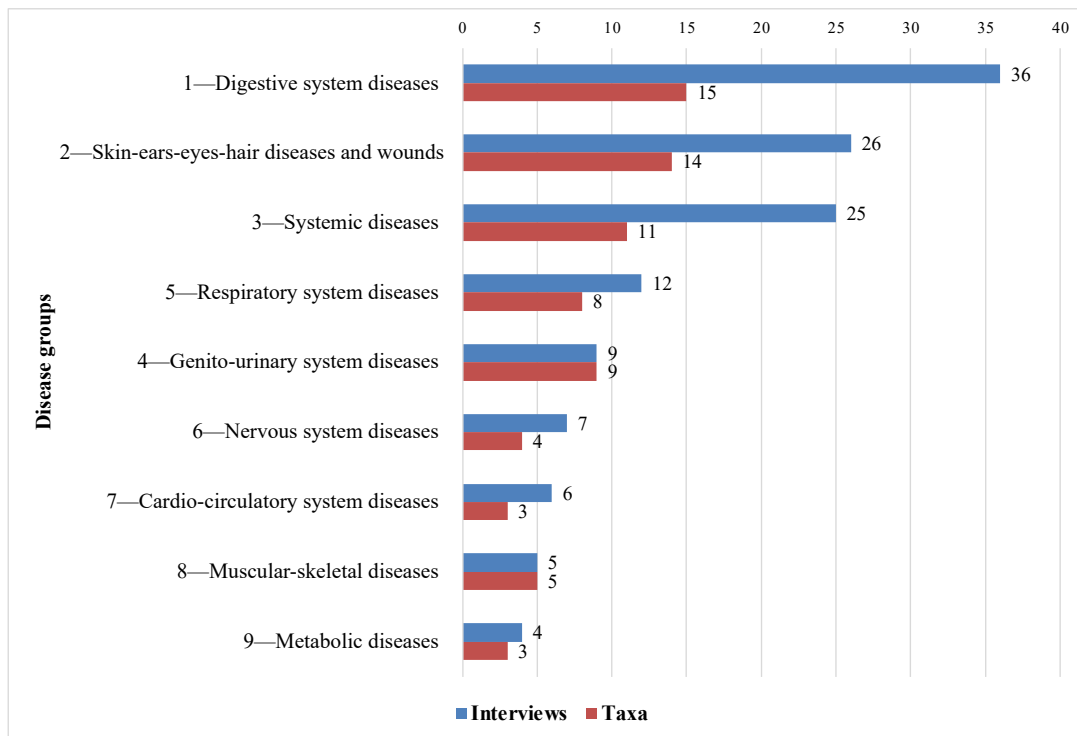


Figure 12. Medicinal purposes and taxa used detected within the Graecanic area of Reggio Calabria (Southern Italy) sorted by number of interviews. The disease groups follow the classification of Cook (1995).

Parietaria judaica L. (3 interviews) has an anthelmintic effect: a decoction was prepared from the aerial parts of the plant and drunk for two consecutive days, followed by two days of fasting and another two days of drinking the decoction. This method was said to be effective in eliminating worms in the stomach.

The second subcategory, 2-Skin-ears-eyes-hair, includes all problems related to the skin, eyes, ears and hair (26 interviews and 14 taxa) (Fig. 11). For these conditions, *C. nepeta* subsp. *nepeta* is the most used species for its healing properties (6 interviews): a paste or decoction made from the leaves was applied to wounds. *Dittichia viscosa* (L.) Greuter, locally called “clizza”, was used for the same purpose and in a similar way (5 interviews). The use of *D. viscosa* is well documented (Hani *et al.* 2022).

One particular use is the bark of *Pyrus spinosa* Forssk: in the past, in cases of viper bites, the venom was sucked out and the inner part of the bark applied to the bite to relieve the pain.

The category of 9-metabolic diseases includes all uses related to the body’s metabolism. These include plants used to treat hyperglycaemia, diabetes, hypoglycaemia and high cholesterol. For the treatment of hyperglycaemia or diabetes, the seeds of *Lupinus albus* L. subsp. *albus* were consumed for seven consecutive days, with the daily dose increasing by one lupin per day until a total of seven lupins were reached. From the eighth day, the dose was reduced by one lupin per day. The same method of use was also applied for hypoglycaemia. The medicinal properties of *L. albus* subsp. *albus* in relation to diabetes were confirmed by numerous phytochemical and medicinal studies (Bouchoucha *et al.* 2016, Helal *et al.* 2013, Kinder & Knecht 2011). In addition, *Cucurbita maxima* Duchesne sprouts were boiled and eaten without seasoning for the treatment of diabetes. The use of the seeds for other medicinal purposes is documented in various ethnobotanical publications (Aleo *et al.* 2013, Barbagallo *et al.* 2004, Idm’hand *et al.* 2020, Motti R. & Motti P. 2017, Patti *et al.* 2024c); however, the antidiabetic use wasn’t found in other published sources. Finally, to treat diabetes and cholesterol, the central veins of the leaves of *Cynara cardunculus* L. subsp. *cardunculus* were boiled and the decoction was preserved and drunk daily. This medicinal use was reported in other publications (Aleo *et al.* 2013, Barbagallo *et al.* 2004, Bendif 2021, Jouad *et al.* 2001, Miara *et al.* 2019).

Figure 13 shows all the medicinal taxa associated with their respective pathology groups within a chord diagram. As highlighted earlier, a species of particular importance in the medicinal field is *Clinopodium nepeta* subsp. *nepeta*, which is

widely used especially in the first (1-Digestive) and second (2-Skin) medicinal subcategories. However, it is also used in the third (3-Syst.), fifth (5-Respir.), sixth (6-Nerv.), seventh (7-Cardio.) and eighth (9-Metab.) subcategories. It is therefore a versatile species in the medicinal field, endowed with numerous healing properties (Beddiar *et al.* 2021, Debbabi *et al.* 2020).

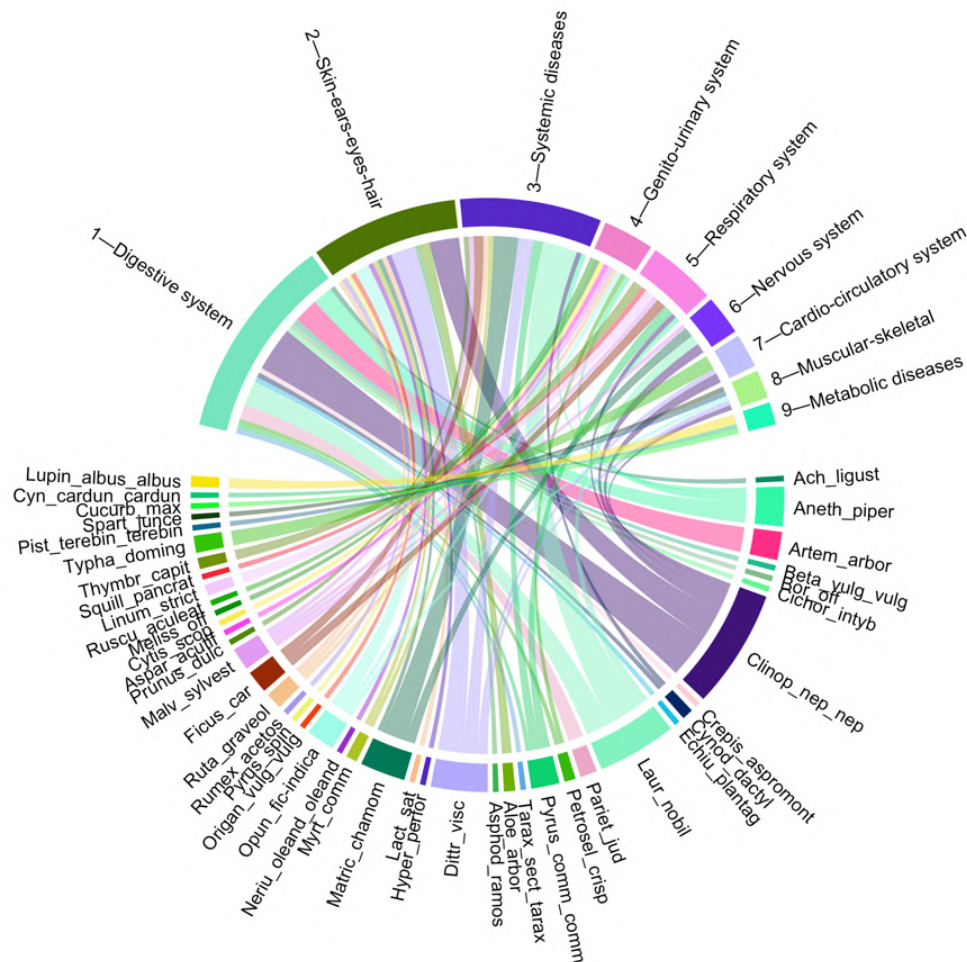


Figure 13. Chord diagram showing all medicinal taxa identified during the interviews within the Graecanic area of Reggio Calabria (Southern Italy), categorized into nine medicinal use groups. The diagram was processed using R software (version 2024.04.2+764) and the 'ethnobotany' package. The medicinal use groups follow the classification of Cook (1995).

Another species that appears more prominently in Figure 13 is *Laurus nobilis* L., whose decoctions are mainly used as a digestive (1-Digest.), as an analgesic for stomach disorders (3-Syst.) and for their relaxing and calming properties (6-Nerv.).

Dittrichia viscosa (L.) Greuter is another important species represented in the graph in Figure 13, with a wide range of medicinal uses. It is mainly used as a healing and disinfecting agent for skin wounds (2-Skin), as an analgesic for stomach pain (3-Syst.) and as a haemostatic agent (7-Cardio). It is also used as a soothing remedy for muscle pains (8-Musc.).

Matricaria chamomilla L. has many purposes in medicine. It is mainly used for its anti-inflammatory properties in skin disorders (2-Skin). It also has a significant analgesic effect for stomach pain (3-Syst.), for which it is mentioned several times. Finally, it is used for its relaxing and calming properties in nervous system disorders (6-Nerv.), making it a very versatile plant in traditional medicine.

Ficus carica L. is another important species, as showed in Figure 13, with various medicinal uses. It is known for its anti-inflammatory properties through decoctions made with the fruits (3-Syst.). It also plays an important role as a decongestant (5-Respir.) and as an anti-influenza remedy (3-Syst.). Finally, the plant is also used for its antitussive properties, helping to treat respiratory disorders (5-Respir.). Numerous studies confirm the excellent medicinal properties of this species (Badgajar *et al.* 2014, Barolo *et al.* 2014, Bouyahya *et al.* 2016, Kahramanoglu *et al.* 2020, Mawa *et al.* 2013, Salma *et al.* 2020).

Handicraft uses

Within this category of uses, all handicrafts made from plant parts are reported (59 interviews, 25 taxa) (Fig. 7). One of the most used species in this area is *Arundo donax* L. (6 interviews): the stems were dried, soaked, cut and woven into baskets and wickerwork. Other uses include making pseudo-hives for bees and making flutes by drilling holes in the reed stalk. Traditional uses include the use of reed to make the resonating body (soundbox) of the Calabrian lyra, a traditional musical instrument: a piece of the stem was inserted into the instrument to produce sound.

The wood of *Morus nigra* L. has many uses (3 interviews): it is used to make cheese moulds, traditionally called “*musulupu*” (Brandolino & Mediati 2019), walking sticks and collars for goats. A plank of wood was prepared, boiled, bent and shaped into a collar, then a bell was attached, and the wood was carved by hand (Fig. 14a) (Brandolino & Mediati 2019). The same use is found in Sicily (Tavilla *et al.* 2022).

Erica arborea L. is a common species in this category of uses (6 interviews). One of the most important uses is to make a spoon and fork for *ricotta* cheese (Fig. 14b).



Figure 14. On the left (a) goat collars made from *Morus nigra* L. (Moraceae) wood. On the right (b) spoon and fork for *ricotta* cheese made from *Erica arborea* L. (Ericaceae) wood (Ph. Valentina Lucia Astrid Laface).

The roots of *E. arborea* have dyeing properties. They were boiled together with the epicarp of the pomegranate; the blankets were then dipped in the water until it cooled, and the dye was obtained. *Euphorbia dendroides* L. served the same purpose: its bark was collected in August to make a yellow dye.

The stems of *Ferula communis* L. were used to make plugs and walking sticks by carving them to size (5 interviews). The wood of *Fraxinus ornus* L. subsp. *ornus* (**middhéu**) was used to make the handles of various tools, including hatchets and hoes (**marrùggi**); it was also used to build the plough and to make walking sticks.

Ludic uses

A very interesting and fun category is that of ludic uses, which is a collection of information about the use of plants for play, such as the use of *Opuntia ficus-indica* to make “**carrocciulu**”. These are often childhood memories of the informants.

One of the most unique games is associated with the nursery rhyme of “**spronu**” (*Verbascum thapsus* L. subsp. *thapsus*): during the recitation of the rhyme, the plant was shaken and at the end the flowers would fall. The rhyme went: “*Spronu, spronu, spronu, mi ti pigghia un lampu n’tronu, mi ti cadì la fiurima e mi ti resta la piantina*” (trad.: “*Oh, mullein, mullein, mullein, I do hope lightning strikes you in the head, that all your flowers fall off, and that you’re left with the plant*”) (Fig. 15).

The fruits of *Capparis sicula* Veill. were used to make a toy: the larger fruits were chosen, and wooden sticks were inserted on four sides, creating a kind of cow that children used to play with.

The flowers of *Papaver rhoeas* L. subsp. *rhoeas* were used to make a kind of small firecracker: the petals were gathered and placed on the palm of the hand, trapping the air, and then the “balloon” formed was popped with the other hand, producing a sound like that of a small explosion.



Figure 15. *Verbascum thapsus* L. subsp. *thapsus* (Scrophulariaceae) used as a nursery rhyme by an informant within the Graecanic Area of Reggio Calabria (Ph. Valentina Lucia Astrid Laface).

The *Quercus pubescens* Willd. subsp. *pubescens* acorns were used to make toy pipes: an acorn was hollowed out to remove the inner pulp and a side hole was made into which a small twig was inserted. In this way, children pretended to have a pipe to play with (Fig. 16).



Figure 16. *Quercus pubescens* Willd. subsp. *pubescens* (Fagaceae) acorn used to make a toy pipe (Ph. Miriam Patti).

Other uses

There are also other uses, less common but no less important. One example is the production of “*Pupazze di Bova*”, for which the stems of *Arundo donax* L. and the leaves of *Olea europaea* L. are still used today. During the annual religious festivals, female figures resembling dolls are made: the skeleton is built with *A. donax* stems, while the “*stiddhe*” (stars), made by intertwining pairs of olive leaves, are attached to the structure.

Domestically, the fruits of *Pistacia lentiscus* L. were used to make oil for lamps (called “*lumèra*”). The fruits were gathered, placed in a hollowed trunk and then stomped with the feet to extract the oil, which was then used to keep the lamp lit (Trabut 1935). The branches of *Pistacia lentiscus* were burned, and the ash obtained was used to scent soap and laundry. Several taxa are used for forage purposes. The most important include *Q. pubescens* subsp. *pubescens* (acorns), *O. ficus-indica* (cladodes and fruits), *Pyrus spinosa* (fruits), and *S. coronaria* (stems).

Ruta graveolens L. was widely used in veterinary medicine for its digestive properties: a decoction was prepared and given to animals with stomach problems.

Finally, the fruits of two species of Anacardiaceae, *Pistacia lentiscus* L. and *Pistacia terebinthus* L., were given to hens to stimulate egg production.

Conclusion

The Graecanic Area of Reggio Calabria (GARC) is a treasure chest of biodiversity and cultural traditions, where wild plants have played and continue to play a fundamental role in the daily sustenance of local communities. This ethnobotanical study has allowed the collection, documentation and analysis of a large body of traditional knowledge on the use of these plants, highlighting not only the richness of the local flora, but also the deep bond that the Greek populations have developed with their environment.

The 632 interviews conducted with 24 informants identified 157 taxa belonging to 50 different families, demonstrating the extraordinary diversity of plants used for food, medicinal, handicraft, veterinary and other purposes. The study found that the most frequently mentioned botanical families were Asteraceae, Lamiaceae and Apiaceae, and that the use of plants for food remains the most widespread. In fact, wild species are not only part of an ancient tradition, but are now an important source of nutrients, vitamins and minerals, as well as having recognised therapeutic properties (Grivetti & Ogle 2000, Sánchez-Mata *et al.* 2016).

The wild plants of the GARC are not only used as food resources; many of them play an essential role in folk medicine, with numerous informants describing the use of decoctions, infusions and compresses to treat various ailments. *Clinopodium nepeta* subsp. *nepeta*, for example, was the most frequently cited taxon for its medicinal properties, confirming the importance of these species not only for physical health, but also for the cultural and social sphere of communities.

In addition to practical and everyday uses, the study also highlighted the symbolic and ritual significance of plants in the lives of Graecanic communities. Religious and magical uses, although less common, remain significant and demonstrate how plants are an integral part of intangible knowledge passed down through generations. The creation of the “*Pupazze di Bova*” or the use of species such as *Verbascum thapsus* for children’s games are examples of how the local flora is a living and dynamic part of the cultural heritage.

However, despite the wealth of this knowledge, our study also highlighted the risk of losing these traditions. An ageing population, the gradual abandonment of rural areas and socio-economic changes are all contributing to the gradual disappearance of this knowledge. The new generations, increasingly distanced from traditional practices, are in danger of not inheriting this cultural heritage, which, once lost, would be extremely difficult to recover.

It is therefore essential to continue promoting ethnobotanical research in this area and in other regions with similar characteristics. The recovery, conservation and valorisation of traditional knowledge is not only a means of safeguarding cultural diversity, but also a resource for developing sustainable lifestyles and promoting new quality products, both in the gastronomic and medicinal fields.

In conclusion, this study represents another step forward in the valorisation of Calabria's ethnobotanical resources, but there is still a long way to go. Wild plants, with their multiple uses and meanings, can be a lever for local economic development through the promotion of entrepreneurship related to the use and transformation of wild plants. More importantly, they symbolise the cultural resilience of Graecanic communities, which deserves to be protected and passed on to future generations. The challenge now is to find the right balance between modernity and tradition, so that the richness of this knowledge is not lost but continues to prosper over time.

Declarations

List of abbreviations: CI - Cultural Importance Index, CV - Cultural Value, FIV - Family Importance Value, FC - Frequency of Citation, GARC - Graecanic Area of Reggio Calabria, PPV - Plant Part Value, RFC - Relative Frequency of Citation, RI - Relative Importance Index, UR - Use Reports, Us - Number of types of use, UV - Use Value.

Ethics approval and consent to participate: Before conducting interviews, prior informed consent was obtained from all.

Consent for publication: Prior and informed consent of local people's pictures had been obtained.

Availability of data and materials: All data generated or analysed during this study was included in this published article (along with the supplementary file).

Competing interests: The authors declare that they have no potential competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions: M.P. collected the data, performed the formal analysis, carried out the investigation, developed the methodology, and drafted the original manuscript. C.M.M. contributed to the investigation, methodology, supervision, validation, and writing - review and editing. V.L.A.L. was involved in the investigation. G.S. led the conceptualization, investigation, methodology, project administration, supervision, validation, visualization, and writing - review and editing. All authors read and approved the final version of the manuscript.

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CHAPTER 5. Target Species Selection and Morphometric Analyses: A Study on *Asparagus albus*, *A. acutifolius*, *Crepis aspromontana*, *Hypochaeris radicata*, and *Pimpinella anisoides*

1. Introduction

The second part of the thesis focuses on utilizing the information collected during the ethnobotanical survey. After analysing a wide range of ethnobotanical data gathered through interviews conducted in the Graecanic Area, certain plant species used as food were selected.

The objective was to conserve and domesticate these species to stimulate the interest of the local population. This approach could enable the partner company in the doctoral project to commercialize these species, should it choose to do so.

It is evident that in situ conservation of plant biodiversity should be complemented by ex situ actions, such as:

- conserving seed lots in germplasm banks to ensure a broader representation of the genetic diversity of priority plant species;
- conducting propagation experiments using various methods to develop species-specific propagation protocols;
- applying domestication methods for high-risk, high-value plant stocks;
- reinforcing populations of targeted species in wild habitats [1-4].

Wild relatives of crops, known as Crop Wild Relatives (CWRs), are wild plants that share a close genetic relationship with cultivated crops. Numerous studies have highlighted the importance of conserving and enhancing CWRs [5-9].

A significant number of taxa are at risk of extinction due to habitat fragmentation, the small number of populations, and, most critically, anthropogenic causes. This is especially problematic in the Mediterranean region [10-16].

Calabria is culturally significant due to numerous influences from different populations that have settled in the region over time, creating a unique cultural layering [17]. Additionally, the territory boasts a vast heterogeneity of wild species, including numerous endemic species, making it a small treasure worth preserving [18].

The aim of this phase of the research was to investigate the species mentioned during ethnobotanical interviews and evaluate which among them could attract the company's economic interest.

The ultimate goal is to develop specific protocols for the domestication of wild taxa, comparing domesticated species with their wild counterparts at the morphometric and phytochemical levels. This phase is expected to represent a significant step toward implementing conservation and valorization strategies for both the studied territory and the selected species.

2. Materials and Methods

2.1. Selection of target species

In collaboration with the company's owners, various hypotheses were evaluated regarding the potential domestication of the species discussed during the interviews. Specifically, many wild plants are commonly consumed by the Graecanic population and, in some cases, are preferred over commonly cultivated herbs available in local markets.

The selection of wild plants offers the potential for economic gain through the sale of domesticated species, while also facilitating significant territorial recognition, which in turn promotes the valorization and protection of endemic species. To achieve this objective, five species of Italian flora have been identified, three of which are typical of Mediterranean territories (*Asparagus acutifolius* L., *A. albus* L., *Hypochaeris radicata* L.) and two which are endemic to southern Italy (*Pimpinella anisoides* V.Brìg.) and Calabria (*Crepis aspromontana* Brullo, Spamp.).

2.1.1. *Asparagus acutifolius* L. and *Asparagus albus* L.

Asparagus acutifolius and *Asparagus albus* (Fig. 1a,b) are two species belonging to the Asparagaceae family, known for their culinary uses and unique characteristics. These species are locally known as “*sparaci*” or “*sparaciara*”. Such wild asparagus varieties are particularly prized for their shoots, which are harvested and prepared similarly to cultivated asparagus. Their versatility allows them to be used in a variety of dishes, from salads to soups, making them a valuable ingredient in local culinary traditions [21-27].

Both species are characterized by their widespread distribution across the region, thriving in a range of environmental conditions. They grow in various soil types, from sandy to clay-rich soils, and are often found near the partner company, which aims to domesticate these plants for added value.

In addition to their culinary utility, these wild asparagus varieties are appreciated for their nutritional properties. Rich in vitamins and minerals, they are a healthy addition to the diet [28,29]. Interest in wild asparagus harvesting is growing, driven by the rediscovery of local ingredients and the promotion of gastronomic traditions. This trend not only supports sustainability but also helps preserve traditional foraging practices, ensuring that local knowledge is transmitted and valued [30].



Figure 1a,b. Wild plants of *Asparagus acutifolius* L. (Asparagaceae) (a) (Ph. Giovanni Lento) and *Asparagus albus* L. (b) (Asparagaceae) (Ph. Miriam Patti).

2.1.2. *Hypochaeris radicata* L.

Hypochaeris radicata (Fig. 2) is an herbaceous plant from the Asteraceae family, widely distributed and recognized for its use as food. The dialectal name for this taxon is “*costa di vecchia*”. This species is especially valued as a boiled vegetable, with its tender and nutritious leaves being incorporated into various culinary preparations. The plant is notable for its sweet flavor, making it a preferred alternative to other wild herbs and granting it a special place in traditional cuisine [21,23,27,31].

Hypochaeris radicata is also consumed raw, with its fresh leaves adding a refreshing touch and a contrast of flavors to salads. Its versatility allows it to enhance a variety of dishes, highlighting the richness of local gastronomy. Moreover, it is rich in nutrients and health-promoting properties, including antioxidants, making it a functional food [32].

This species is easily identifiable by its rosette-shaped leaves and yellow flowers, which bloom in spring and summer (Fig. 2). The widespread availability of *H. radicata* in various areas, including suburban settings, makes it accessible to those interested in exploring the potential of wild plants in their diet. With increasing interest in foraging practices and the use of local and sustainable ingredients, the popularity of this plant is growing, emphasizing the importance of valuing and preserving culinary traditions tied to native plant resources.



Figure 2. Plants of *Hypochaeris radicata* L. (Asteraceae) (Ph. Miriam Patti).

2.1.3. *Crepis aspromontana* Brullo, Scelsi & Spamp.

Crepis aspromontana (Fig. 3a,b) is a perennial plant belonging to the Asteraceae family. It is notable for its adaptability and predominant presence in the Aspromonte area, a distinctive mountainous region of Calabria. This species is endemic to the region, meaning it is exclusive to this territory and does not naturally occur elsewhere. Among the Graecanic population, it is commonly referred to as "*pricomaruḍḍha*", a term reflecting its cultural and culinary significance.

Crepis aspromontana is widely appreciated for its intense and pungent flavor, which makes it a preferred ingredient compared to other wild herbs. It is often used as a side dish or included in mixed greens, adding a distinctive touch to traditional dishes. Its versatility and organoleptic properties make it a valuable resource in the local diet.

According to IUCN assessments, *C. aspromontana* is currently classified as “Least Concern” within the Italian Red List of Flora [33]. This indicates that, for the time being, the species is relatively stable and faces no immediate threats to its survival. However, it remains crucial to adopt management strategies that support its conservation and protect local biodiversity, ensuring that this valuable plant resource continues to thrive in the local ecosystem.

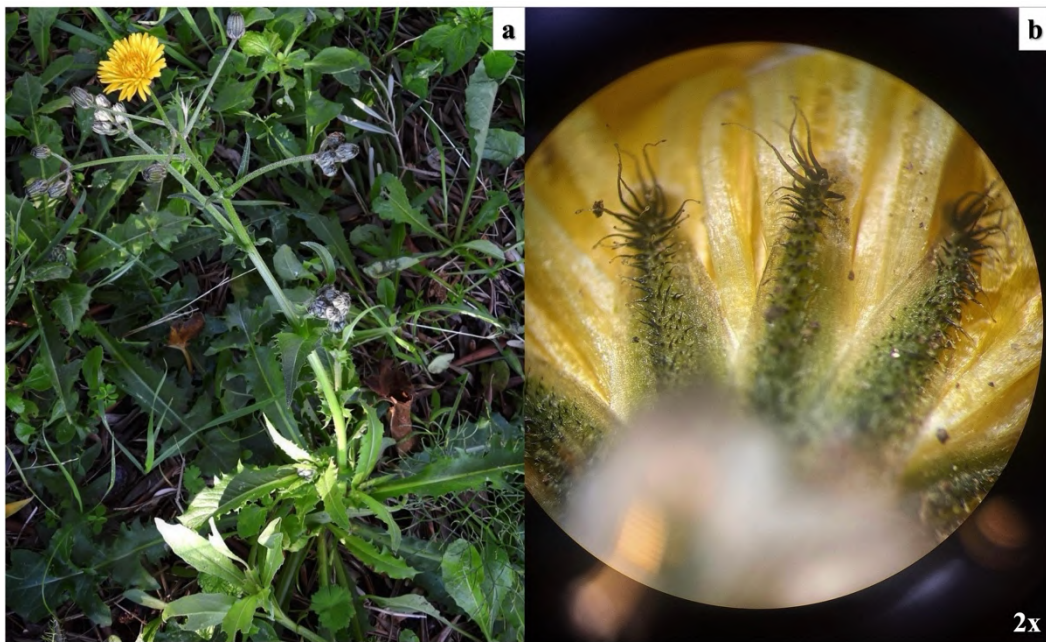


Figure 3a,b. Plant of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) in wild habitat (a) (Ph. Valentina Lucia Astrid Laface) and flower bracts of *Crepis aspromontana* with typical blackish bristles (Ph. Miriam Patti; image obtained with a stereoscope at 2x magnification).

2.1.4. *Pimpinella anisoides* V. Brig.

Pimpinella anisoides (Fig. 4) is a taxon belonging to the Apiaceae family, notable for its significant culinary and cultural importance. This aromatic plant,

characterized by its distinctive and pleasant fragrance, is widely used in the production of a liqueur (known as “*ananzu*” in the province of Catanzaro [23]), a typical specialty of Calabria. However, its uses are not limited to beverages but extend to various culinary applications, particularly in baked goods, where its fruits enrich traditional dishes and local recipes.

According to the IUCN, *P. anisoides* is classified as “Least Concern” (LC) [33], indicating that the species is not currently at risk of extinction. However, it is worth noting that in Calabria, the widespread practice of uprooting *P. anisoides* plants has been observed. This activity is often driven by the high commercial demand for its fruits, which are used not only in liqueur production but also in other culinary and medicinal applications. The intense harvesting and large-scale commercialization may pose a threat to the sustainability of natural populations of *P. anisoides*, necessitating proper management to ensure the conservation of this valuable plant resource [34].



Figure 4. Plants of *Pimpinella anisoides* V.Brig. (Apiaceae) (Ph. Valentina Lucia Astrid Laface).

2.2. Collection of target species

Following the selection of taxa, activities were divided between the company site and laboratory work.

In March 2023, field surveys were conducted to monitor the presence and frequency of these species. Subsequently, 20 specimens each of *Asparagus albus* and *A. acutifolius*, as well as 40 of *Hypochaeris radicata*, were collected using a randomized system. Morphometric measurements of ten plants from each group were carried out following the protocol of Bacchetta et al. [35], assessing traits such as height, crown diameter, clump density, number of flowering and fruiting stems, number of vegetative stems, and fruit count per clump (Fig. 5a,b).



Figures 5a,b. Collection of morphometric measurements (a) and measurement of *Asparagus albus* L. (Asparagaceae) specimen (b) according to the protocol of Bacchetta et al. [35] (Ph. Miriam Patti).

The plants were numbered and potted in 15 cm diameter containers with soil from the collection area (Fig. 6a,b).



Figure 6a,b. Specimens of *Asparagus albus* L. (Asparagaceae) (a) and *Hypochaeris radicata* L. (Asteraceae) (b) domesticated in pots (Ph. Miriam Patti).

They were watered every two days to ensure rooting and were maintained in pots for two months to test pot domestication.

After this period, the plants were transplanted into a dedicated plot on the company premises. For *A. acutifolius* and *A. albus*, furrows were spaced 90 cm apart to promote proper root establishment (Fig. 7).



Figure 7. Row of *Asparagus acutifolius* L. (Asparagaceae) on the left and *Asparagus albus* L. (Asparagaceae) on the right planted 90 cm apart in each furrow (Ph. Miriam Patti).

For *H. radicata*, the plants were placed 30 cm apart and subjected to three management conditions (Fig. 8a,b,c):

- a) *Controlled*: 20 plants were planted in tilled soil with furrows, and weeds were regularly removed (fully managed by humans);
- b) *Semi-controlled*: 20 plants were placed in tilled soil without furrows, and weeds were not removed (partially managed by humans).
- c) *Wild*: a section of uncultivated land where the species naturally occurs was left unmanaged.



Figure 8a,b,c. Division of plots of *Hypochaeris radicata* L. (Asteraceae) plants into *Controlled* (a), *Semi-controlled* (b) and *Wild* (c) conditions (Ph. Miriam Patti).

Domestication trials for *Crepis aspromontana* and *Pimpinella anisoides* are detailed in Chapter 6.

3. Results and discussion

The measurements taken before transplanting the plants were compared with those recorded during the domestication trial within the company. Regarding *A. acutifolius* and *A. albus*, Figure 9 shows the average growth differences of the two species under two different conditions.

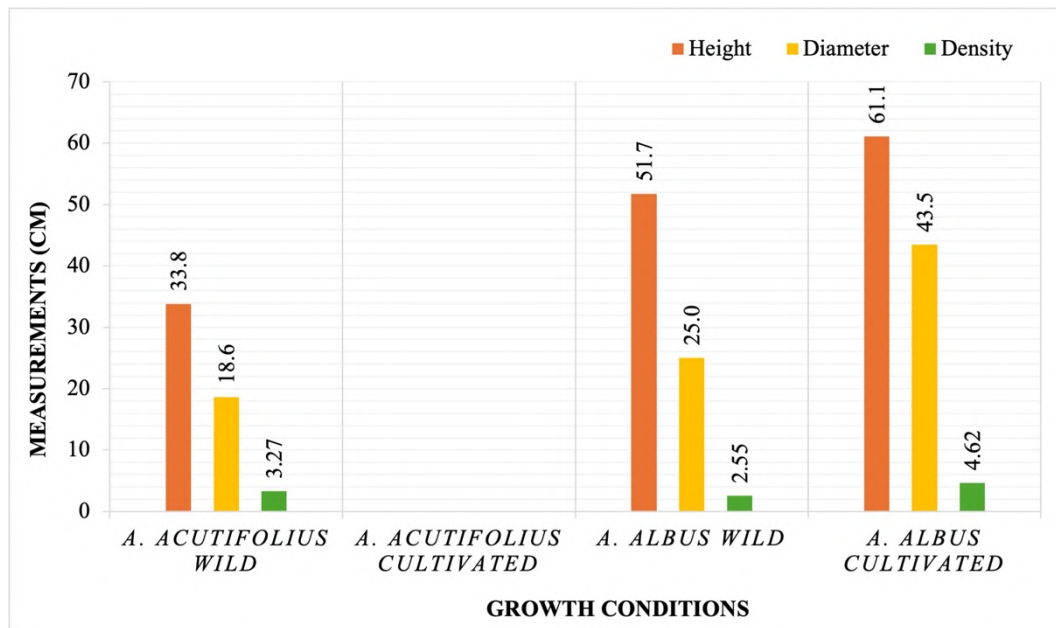


Figure 9. Growth comparison of *Asparagus acutifolius* L. (Asparagaceae) and *Asparagus albus* L.'s (Asparagaceae) plants in wild and cultivated conditions.

For *A. acutifolius*, the plants did not adequately establish in the soil, likely due to the stress caused by uprooting (given the development of their root systems). Upon inspection, most of the plants were found to be dead.

In contrast, for *A. albus*, as highlighted in Figure 9, the plants grown under cultivated conditions exhibited greater height, larger diameter, and increased density. This indicates that, in this case, domestication yielded positive results, with the plants demonstrating better growth under controlled conditions.

For *Hypochoeris radicata*, the average measurements of plants grown under the three different conditions—controlled, semi-controlled, and wild—were compared (Fig. 10).

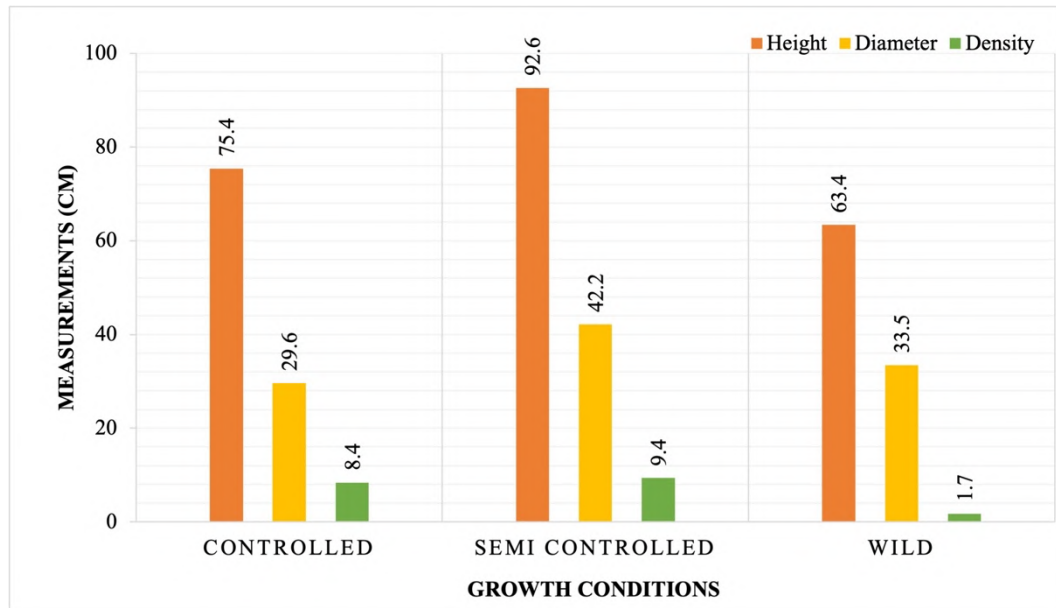


Figure 10. Growth comparison of *Hypochaeris radicata* L.'s (Asteraceae) plants in different conditions.

As shown in Figure 10, all measured characteristics were significantly greater under controlled and semi-controlled conditions. In general, the average plant height (92.6 cm), diameter (42.2 cm), and density (9.4 stems) were higher under semi-controlled conditions. Regarding density, understood as the number of stems emerging from the same clump, there was a notable difference between controlled/semi-controlled and wild conditions. This suggests that, in the wild, the plant produces fewer stems, resulting in lower reproductive capacity (fewer flower heads = fewer fruits).

4. Conclusions

The Graecanic Area stands out as a territory particularly rich in wild plants, which continue to be used by the local population for both food purposes and a range of other uses tied to traditions and practices passed down over time. Many of these plants not only have high gastronomic potential but also represent a tangible opportunity for local economic development. Their domestication could contribute not only to biodiversity conservation but also to the territorial expansion of the agri-food sector, fostering the creation of new markets for distinctive products with unique properties.

The experiments conducted at the partner farm of this research project have confirmed the feasibility of domesticating some of these species, opening new perspectives for local agriculture. The data collected, particularly for *Hypochaeris radicata* L., demonstrated significant growth improvements under controlled conditions compared to natural conditions. This suggests that optimizing the cultivation environment could be a key element in maximizing the potential of these resources. These findings highlight not only the possibility of integrating new species into agricultural production but also the importance of targeted interventions that can enhance the growth and adaptability of these plants in cultivated settings.

In conclusion, the results obtained indicate that the domestication of native species, combined with controlled agricultural practices, can be an effective strategy for enhancing and promoting the botanical heritage of the Graecanic Area. This approach contributes not only to the protection and valorization of local biodiversity but also offers new opportunities for sustainable development. It can strengthen the cultural and culinary identity of the territory while simultaneously supporting its economic revitalization.

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CHAPTER 6. Conservation and Valorization of two endemic Calabrian species used as food within the Graecanic area (Southern-Italy) through domestication trials

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Conservation and Valorization of Two Endemic Calabrian Species Used as Food Within the Graecanic Area (Southern-Italy) Through Domestication Trials

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Abstract. The potential use of plants in Mediterranean diets based on local cuisines is of great interest to nutritionists because of their numerous nutraceutical compounds. In many Mediterranean regions, including Italy, these traditions are at risk of disappearing. Therefore, an ethnobotanical survey was conducted in the Graecanic area of the province of Reggio Calabria, which has unique linguistic and cultural characteristics. Two species, due to its exceptional nature, stood out from all the information gathered as a food source: *Crepis aspromontana* Brullo, Scelsi & Spamp. and *Pimpinella anisoides* V.Brigh., which are both threatened with extinction. Therefore, this study aimed to enhance and conserve *C. aspromontana* and *P. anisoides* through domestication of these species and their cultivation from germplasm collected in the wild. Plants germplasm was collected, preliminary viability tests of the collected germplasm were carried out, followed by *in vivo* and *in vitro* tests to assess germination. These initial tests have shown that domestication of the species is possible, that ethnobotany is a valuable tool for the discovery of important species that are still used by some rural populations.

Keywords: Ethnobotany · Biodiversity · Endemic Species · Natural Resources

1 Ethnobotanical Background

Biological diversity is the outcome of millions of years of evolutionary processes, which can be measured in terms of genetic, species, and ecosystem diversity. Cultural diversity is influenced by biological diversity, and knowledge of ethnic groups can be valuable for humanity as it helps us understand the value of plant resources. Many cultural and domestic activities involve a wide range of plant species, which are essential for sustaining life [1].

Ethnobotany is a field of study that explores the complex relationships between humans and the plant kingdom [2, 3]. Schultes [4] defined ethnobotany as “the study of the relationship which exists between people of primitive societies and their plant environment”. Several scientifically significant study [5–8] have contributed to making

ethnobotany an inexhaustible source of information, providing valuable insights into the use of wild and cultivated plants in also in remote areas [9, 10].

Regarding food plants, Naska and Trichopoulou [11] state that wild species are a key component of the Mediterranean diet; wild plants, in fact, are used to make typical dishes by mixing them with cultivated plants and other ingredients. This tradition is a response to the fact that, in the past, wild food plants were the only food during times of famine [12–17]. However, the rapid shift towards technological models, pre-packaged foods, and the growing reliance on synthetic remedies has led to a decline in our cultural heritage [18].

Crop Wild Relatives (CWR) are wild plants that are closely related genetically to cultivated crops. The conservation and enhancement of CWRs has been emphasized in several works [19–22]. A significant number of plant species, known as CWR, are at risk of extinction due to causes such as habitat fragmentation, low population numbers, and predominantly anthropogenic factors. The Mediterranean region is particularly affected [23–29]. Some species are considered “endemic species” due to their very small range of distribution [30]. In this case, the loss of a single population or group of populations may endanger the entire species. It is recommended to give priority to conserving endemic species before conserving wide-ranging species [21, 31–33].

The Calabria region is rich in wild species, including several endemics, making it a valuable resource to conserve. The tradition of collecting and using wild plants is still strongly rooted in many rural communities in Calabria [9, 34–47]. Specifically, the Graecanic area, located on the Ionian side of the Metropolitan City of Reggio Calabria, is characterized by a strong cultural and anthropological identity that has resisted various global changes for several centuries [37].

The aim of this work is to enhance and try to conserve two endemic species (*Crepis aspromontana* Brullo, Scelsi & Spamp. And *Pimpinella anisoides* V.Brigh.) whose food use was discovered during ethnobotanical interviews carried out in the area, which demonstrated how these species have value for rural populations. This approach aims to make endangered endemic species more accessible to people while, at the same time, preserving their presence in the area.

2 Selected Species

2.1 *Crepis Aspromontana* Brullo, Scelsi & Spamp.

Crepis aspromontana is a perennial herbaceous species belonging to the Asteraceae family; it is mainly found in the Aspromonte area and is a Calabrian endemic plant [48]. The taxon is locally known as “*pricomaruddha*”; its leaves are consumed as a side dish, by boiling and sauteing them with seasonings, but also used as a decoction to aid digestion; it is favored over other wild herbs for its very strong and pungent taste. According to the IUCN criteria, this species is in the Least Concern category within the Red Lists of the Italian Flora [49].

2.2 *Pimpinella Anisoides* V.Brigh.

Pimpinella anisoides is a taxon belonging to the Apiaceae family, endemic to southern Italy; it is an aromatic perennial herbaceous plant used to produce the famous aniseed

liqueur, a typical product of southern Calabria [41, 50, 51]. According to the IUCN criteria, it is assessed as Least Concern species (LC) [49]; furthermore, in the Calabrian territory, the extirpation of this plants for the use of the fruits and their massive commercialization is very common [51].

3 Domestication Trials

Germplasm was collected from two distinct sites within the Graecanic area during the fruiting season of these species. The achenes were transported to the laboratory and cleaned from inert parts and plant residues; then the fruits were stored at 5 °C before each treatment.

Two destructive tests (Cut Test and T Z Test) were conducted for each species to determine the percentage of viable fruit. Prior to conducting these tests, visual inspection was carried out to evaluate the harvested materials' quality. Finally, germination tests were carried out for the two selected species and then, for both species, germination energy was determined following Maguire [52] assess the germination rate (GR) of the achenes:

$$GR = \frac{\sum(n1 * t1) + (n2 * t2) + (n3 * t3)}{N} \quad (1)$$

where:

N = number of achenes analyzed;

n = number of germinated achenes (in different time intervals);

t = time in which they germinated.

3.1 Cut Test

One hundred fruits of each species that appeared uniform and morphologically good to the eye were opened longitudinally to assess the quality of the endosperm, in accordance with Gosling [53]. Once opened, they were examined under the microscope and divided into three categories: viable, non-viable and vain.

Regarding *C. aspromontana*, the results showed 77% viable fruit, 19% non-viable fruit and 4% vain fruit, while for *P. anisoides* the 50% of the fruits were viable, 40% non-viable and 10% vain.

3.2 T Z Test

One hundred achenes were soaked for 24 h in a dark place. The following day, they were dissected to reveal the endosperm containing the embryo. Subsequently, a 100 mL solution containing 1% 2,3,5,5-Triphenyl-2H-tetrazolium chloride was prepared. The fruits were then incubated in a climatic chamber at 30 °C in the dark for a period of 6 h. After the incubation period, achenes appearing red indicated viable endosperm, while achene with uneven or no color indicated unviability. This procedure is in accordance with ISTA [54].

The results of this test showed that *C. aspromontana* confirmed the earlier test results with 63% viable, 29% non-viable and 8% viable fruits, while for *P. anisoides* showed a much higher percentage of viable fruits (70%) and lower percentages of non-viable (18%) and vain (12%) fruits.

3.3 Germination Test

In vivo germination tests were carried out on *C. aspromontana*. Three hundred and sixty achenes were selected and planted in polystyrene seed pots containing 120 cavities, each with a diameter of 55 mm. Three achenes were planted in each alveolus. The seed pots were then placed in climatic cells set at two different temperatures (15–25 °C), with constant humidity at 50% and a 12-h day/night photoperiod.

Germination tests revealed a higher growth percentage at 15 °C than at 25 °C. The germination energy at 15 °C is higher than at other temperatures. Germination was low at 27%, indicating that this plant has difficulty germinating due to its long dormancy of about 20 days.

Once the selected temperature was established, the plants were transferred to larger pots to enable growth at the optimal temperature. The growth tendencies of twenty plants were measured over a period of 40 days, assessing specific morphometric characteristics such as rosette diameter and number of leaves (Figs. 1 and 2).

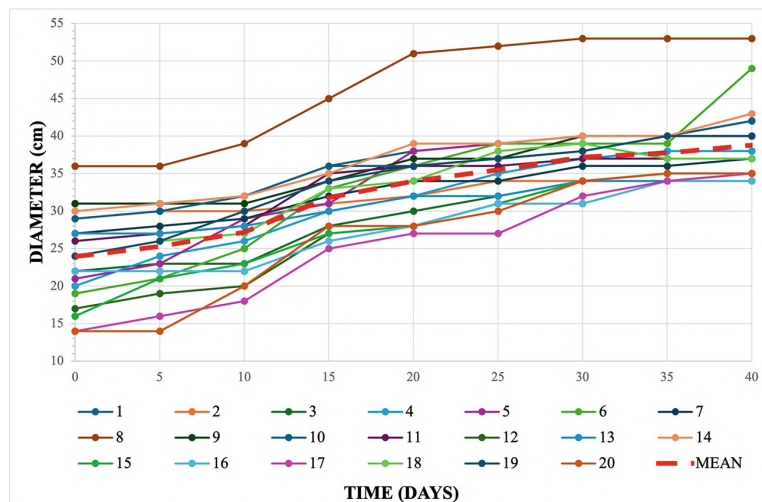


Fig. 1. Growth trends of *Crepis aspromontana* Brullo, Scelsi & Spamp.: on the left: rosettes diameter. The red dashed line shows the average growth trends of the 20 samples analyzed

The growth trends indicate that, in general, the twenty samples analyzed have the same growth rate, with a few special cases.

In vitro germination tests were conducted on *P. anisoides* to ascertain the optimal temperature for this species. The fruits were pre-treated with 100 mL of NaClO:H₂O 1:10 solution and then placed in 60x8 mm Petri dishes (10 per dish) on 2 sheets of absorbent paper with 10 mL of deionized water. The experiment utilized three replicates for each temperature. The selected temperatures were 15, 20 and 25 °C. Daily observations across a 15-day period were undertaken to evaluate the germination rates of the achenes (Fig. 3).

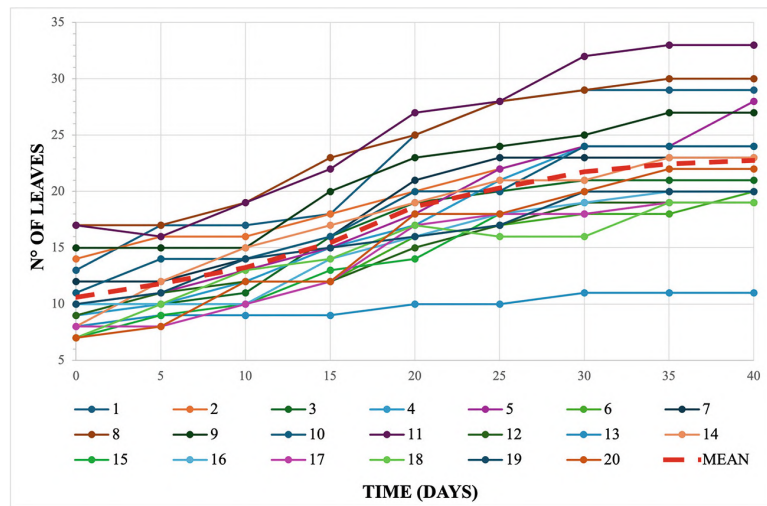


Fig. 2. Growth trends of *Crepis aspromontana* Brullo, Scelsi & Spamp.: on the left: number of leaves. The red dashed line shows the average growth trends of the 20 samples analyzed

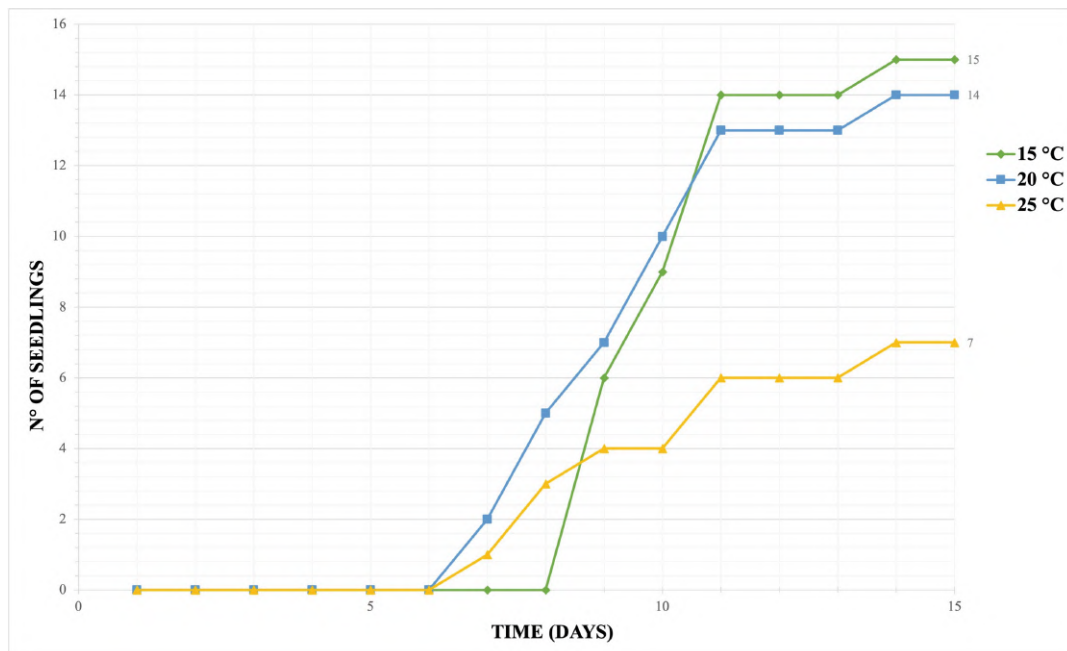


Fig. 3. Germination trend of *Pimpinella anisoides* V. Brig. at three different temperatures: 15, 20 and 25 °C

The growth trends in Fig. 3 show that the highest germination percentages were obtained at 15 °C and 20 °C. In addition, the first emergences appeared at both temperatures after seven days. The germination energy at the three different temperatures showed that the temperature at which seeds first germinated was 20 °C (9.50 days).

After 15 days, emergences were measured using ImageJ program to compare germination rates, percentage of emergence at each temperature and length of emergences. The 35 Seedling were distinguished into three parts: roots, hypocotyls and cotyledons, and measurements were taken accordingly (Figs. 4 and 5).

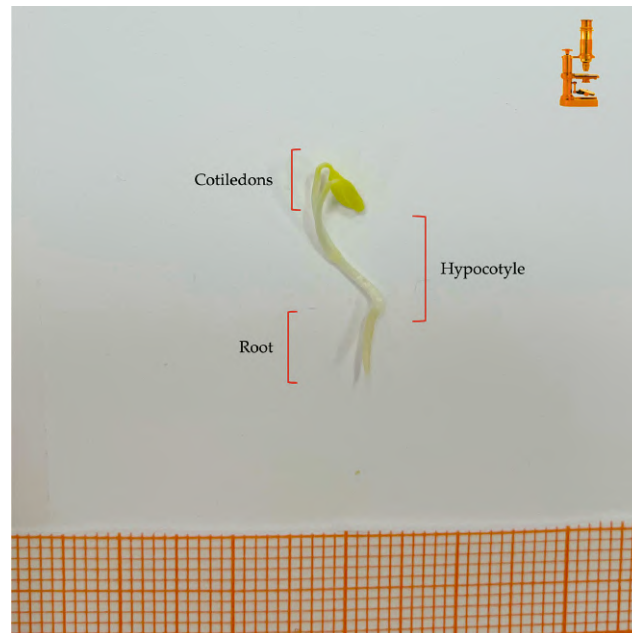


Fig. 4. Seedling of *Pimpinella anisoides* V. Brig. with root, hypocotyle and cotyledons

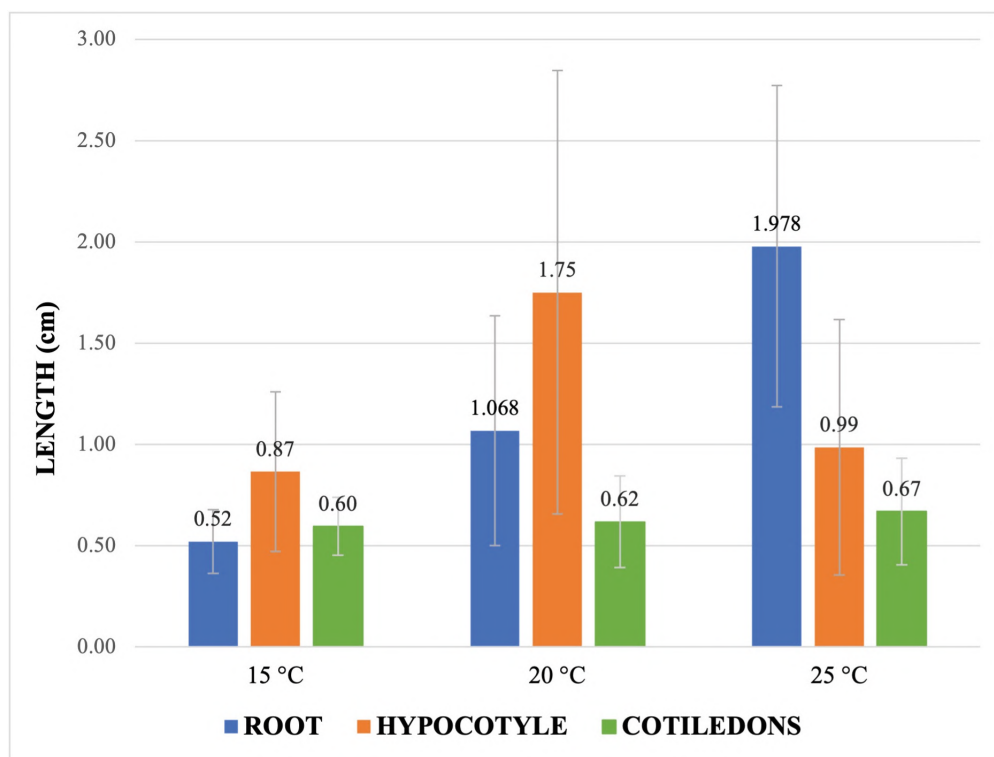


Fig. 5. Medium length of three parts of the seedlings of *Pimpinella anisoides* V. Brig. grown at three different temperatures (15, 20 and 25 °C). The grey lines indicate the standard deviation (σ) for each length mean

As shown in Fig. 5, the length of the three parts of the emergences is longer at temperatures of 20 °C and 25 °C. Specifically, the average root length is longer at a

temperature of 25 °C than at 20 °C, the hypocotyl length is higher in seedlings at 20 °C, while the length of the cotyledons shows no difference.

4 Conclusions

This work aimed to contribute to filling an ethnobotanical knowledge gap in the Graecanic area of Reggio Calabria Metropolitan City. This represents a territory rich in wild plants that are still widely used today, both for food and for other purposes. Additionally, there are numerous endemic plants frequently consumed by the local community: These present an opportunity for the area's expansion through the cultivation and sale of these plants with distinct features. Both *Crepis Aspromontana* and *Pimpinella Anisoides* were investigated in the laboratory and found to have positive responses to viability tests, as well as *in Vivo* and *in Vitro* germination tests, fundamental prerequisite for their domestication in the field.

Ethnobotany is confirmed to be a useful method for making the most of the rich heritage still preserved by rural populations, and it is also a tool for exploiting potential resources that occur spontaneously in nature.

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CHAPTER 7. A Comparative Morphometric and Phytochemical Analysis of the Calabrian Endemic Treasure *Crepis aspromontana* with Alimentary Potential

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A Comparative Morphometric and Phytochemical Analysis of the Calabrian Endemic Treasure *Crepis aspromontana* with Alimentary Potential

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Abstract

Crepis aspromontana, a Calabrian endemic species, has been the subject of interest about its potential applications as a nutritional source within the ethnobotanical tradition of the Graecanic area of southern Calabria. This study presents a comprehensive comparative analysis of the morphometric and chemical properties of wild and cultivated specimens of *C. aspromontana*. Morphometric parameters, including the number of leaves and rosette's diameter, were measured with great precision and subjected to comparison. The phytochemical analysis was conducted with a focus on chemical plant components, including colour, polyphenol content, chlorophyll and antioxidant activity. The results indicated significant differences between the wild and cultivated populations in both morphometric traits and phytochemical compositions. Cultivated plants exhibited superior morphometric growth characteristics, with larger rosettes and a greater number of leaves, while wild specimens showed higher concentrations of beneficial phytochemicals, including polyphenols and flavonoids, and exhibited enhanced antioxidant activity. Wild samples contained an average of 100.68 mg GAE/100 g of polyphenols compared to 79.26 mg GAE/100 g in cultivated samples, and their antioxidant activity, measured by ABTS and DPPH assays, reached 19.51% inhibition, significantly higher than the 11.01% inhibition observed in cultivated samples. Additionally, heat-stressed cultivated plants exhibited up to 438.72 mg GAE/100 g of polyphenols, demonstrating a remarkable increase in response to stress. This

research underscores the importance of wild species that can be domesticated to optimise their potential use and highlights the value of *C. aspromontana* as a new nutrient-rich food source belonging to the Calabrian flora.

Keywords: Asteraceae, ethnobotany, food plant, morphometric analyses, southern Italy, wild plant domestication.

Declarations

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Ethics and consent to participate We declare that there are no guidelines and/or regional laws prohibiting the harvesting of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) used for the present research. It is included in the Italian Red List and classified according with the IUCN's criteria as Least Concern (LC), indicating that this species is not currently at risk of extinction. Additionally, we confirm that the germplasm collection was conducted without uprooting the plants and from a large population. Lastly, we assert that this activity can be considered as an *ex-situ* conservation tool, having tested the species' domestication for conservation purposes.

Competing interests The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability Data will be made available on request to miriam.patti@unirc.it.

Code availability Not applicable.

Authors' contributions Conceptualization: Miriam Patti, Angelo Maria Giuffrè, Carmelo Maria Musarella, Giovanni Spampinato; Methodology: Miriam Patti, Angelo Maria Giuffrè; Formal analysis and investigation: Miriam Patti, Angelo Maria Giuffrè, Carmelo Maria Musarella, Giovanni Spampinato; Software: Miriam Patti, Angelo Maria Giuffrè; Writing—original draft: Miriam Patti; Writing—review and editing: Miriam Patti, Angelo Maria Giuffrè, Carmelo Maria Musarella, Giovanni Spampinato; Resources: Giovanni Spampinato; Supervision: Giovanni Spampinato; Funding acquisition: Giovanni Spampinato. All authors have read and agreed to the published version of the manuscript.

1. Introduction

Vegetables are a key component of a balanced human diet, being characterised by low fat and low-calorie intake [1]. In addition, they are rich in carbohydrates and fibre and provide significant amounts of several essential micronutrients [2]. Nowadays, consumers are increasingly aware of the importance of including a variety of fresh vegetables in their diet for comprehensive antioxidant support [3]. This is especially true in regions that follow the Mediterranean diet, recognised worldwide for its health benefits [4]. The Mediterranean diet, rich in fruit, vegetables, whole grains, legumes and olive oil has been shown to reduce the risk of cardiovascular diseases and diabetes [5–7]. A noteworthy feature of the Mediterranean diet is its incorporation of wild plants, which enhance nutritional diversity and provide bioactive compounds [8]. The consumption of wild plants, which are often rich in antioxidants and other phytonutrients, is a tradition that is being rediscovered for its nutritional and cultural value [9,10]. Wild plants frequently disregarded, provide a wide array of nutrients and bioactive compounds that can enhance the human diet [11,12]. These plants not only enhance the nutritional value of the diet but are also vital for maintaining agricultural biodiversity and ensuring food security. Moreover, recent studies have demonstrated that the ingestion of wild plants can confer health benefits, including anti-inflammatory and anti-diabetic properties [13].

The Calabria region in southern Italy is known for its high biodiversity, including a high rate of endemism [14,15]. Many of these plants are also utilised in traditional cooking practices, such as side dishes or baked desserts [16,17]. Furthermore, the region has been the subject of extensive ethnobotanical study, reflecting its rich traditional knowledge base [18-20].

During ethnobotanical field investigations conducted in Calabria, the cultural and nutritional value of *Crepis aspromontana* Brullo, Scelsi & Spamp. was revealed. This endemic plant is known locally as “*pricomaruddha*” and belongs to the Asteraceae family [21,22].

The results of ethnobotanical surveys conducted in the Graecanic area of the Metropolitan City of Reggio Calabria indicate that the basal rosettes are

consumed as a side dish, either boiled or stir-fried with seasonings. Additionally, the leaves are employed in traditional medicine, with a decoction prepared from them being used to facilitate digestion [23]. However, *C. aspromontana* is a potentially threatened species. According to The International Union for Conservation of Nature (IUCN) criteria, this species falls into the Least Concern (LC) category of the Red List of the Italian Flora [24]: therefore, it is a species that does not meet the criteria for inclusion in any of the risk categories and is therefore not threatened with extinction in the wild. It is, however, important to protect this plant, not only to ensure the preservation of local biodiversity, but also to maintain the associated culinary traditions and ethnobotanical knowledge. One strategy for ensuring the protection of the species is domestication, which can reduce the risk of extinction due to indiscriminate harvesting and preserve biodiversity by integrating domesticated plants into agricultural systems and improving their characteristics for human use [25,26].

The nutritional use of *C. aspromontana* underscores the necessity for further investigation into its chemical and nutritional characteristics. Prior research conducted in the same region on plants belonging to the same family, such as *Hypochaeris laevigata* (L.) Ces., Pass. & Gibelli and *Hyoseris radiata* L., has demonstrated a high concentration of phenolic compounds and antioxidant activity, emphasizing the nutritional potential of the Asteraceae family [27]. Moreover, the genus *Crepis*, and, specifically, species such as *C. leontodontoides* All., and *C. vesicaria* L., has been the subject of nutraceutical studies, which have revealed excellent contents of compounds beneficial to human health [28]. Nevertheless, no specific investigations have ever been conducted on *C. aspromontana* that highlight its significance not only from a cultural perspective but also in terms of its nutritional value.

The present study aims to fill this gap by providing a detailed analysis of the morphometric and chemical properties of *C. aspromontana*, with a comparison between specimens grown in the wild and those cultivated. The study thus encompassed a comprehensive array of morphometric analysis, i.e. the measurement of rosettes diameter and number of leaves, and analytical

techniques including colorimetric analysis, determination of Relative Humidity (RH), Ash (%), Water Activity (a_w), pH, Total Soluble Solids Contents (TSS), Chlorophyll and Carotenoid contents, in accordance with established methodologies. Furthermore, the Total Phenolic content (TPC), Total Flavonoid content (TFC) and Antioxidant Activity were quantified using the percentage of inhibition for the used radical DPPH and ABTS.

These tests were also carried out on heat stressed (25 °C and 29 °C) *Crepis aspromontana* plants to assess the plant's response to a sudden climate change.

The overall objective of this work is to investigate the morphometric, chemical and phytochemical traits of this little-known species. In particular, we analysed how these traits differ (a) between wild and cultivated specimens, (b) fresh and frozen (low temperature stress) and (c) between different thermal stress conditions for cultivated specimens only. The final aim was to determine the influence of cultivation and stress conditions on these traits to support the enhancement and conservation of this endemic plant.

2. Materials and Methods

2.1. Plant material

The germplasm of *Crepis aspromontana* was collected from Pentidattilo (37°57'11.0" N 15°45'43.0" E) a district of Melito di Porto Salvo, a southern Calabrian municipality located in the Graecanic Area of the Metropolitan City of Reggio Calabria. The plant materials were identified by the authors G. Spampinato, C.M. Musarella, and M. Patti. Two samples were collected from the municipalities of Bova and Condofuri and stored at the herbarium of the Mediterranean University of Reggio Calabria (REGGIO) under IDs 8683 and 8684 (Online Resources 1 and 2). The acronym of the cited herbarium is in accordance with [29]. *Crepis aspromontana* grows on the Ionian slopes of the Aspromonte Massif range in Calabria, in rocky, calcareous habitats characterised by xeric conditions [21]. Indeed, this region is known as the most arid part of Calabria, with a Mediterranean climate featuring hot, dry summers and mild, wet winters. The species thrives in crevices among rocks, often alongside other drought-tolerant

plants, which indicates its adaptation to low water availability and high temperatures [21].

The germplasm, previously cleaned and selected, was used to perform *in vivo* germination within a climatic cell at 15 °C with 12 h photoperiod and at 50% Relative Humidity. In cultivation, the plants were grown in clayey soils with a neutral pH (6.8-7.2), enriched with organic compost to enhance nutrient availability and water retention, aiming to replicate the optimal natural conditions and promote the desired morphological traits.

A total of 70 plants were grown. After 3 months of growth, the leaves of the basal rosettes were randomly collected from several specimens both under controlled conditions (within the climate cell) and in the field in the habitat of the species, at the same location as the germplasm collection and at the same phenological stage; the leaves were collected in various shapes and sizes to obtain a true distribution of the plants.

All analyses were carried out for Cultivated Fresh (CFR) and Cultivated Frozen (CFZ) specimens, for Wild Fresh (WFR) and Wild Frozen (WFZ) specimens, and, in addition, for some of the plants grown in climate cell (Cultivated), two further heat stress tests (25 and 29 °C) were conducted for 20 days to assess the behaviour of the species in response to a possible abrupt climatic change (Cultivated Fresh stressed at 25 °C - CFRs25, Cultivated Fresh stressed at 29 °C - CFRs29 - and Cultivated Frozen stressed at 25 °C - CFZs25, stressed at 29 °C - CFZs29). Heat stress was conducted in two different climatic cells with artificial light with 12h photoperiod.

The different matrices with the various treatments are illustrated in the experimental plan in Figure 1.

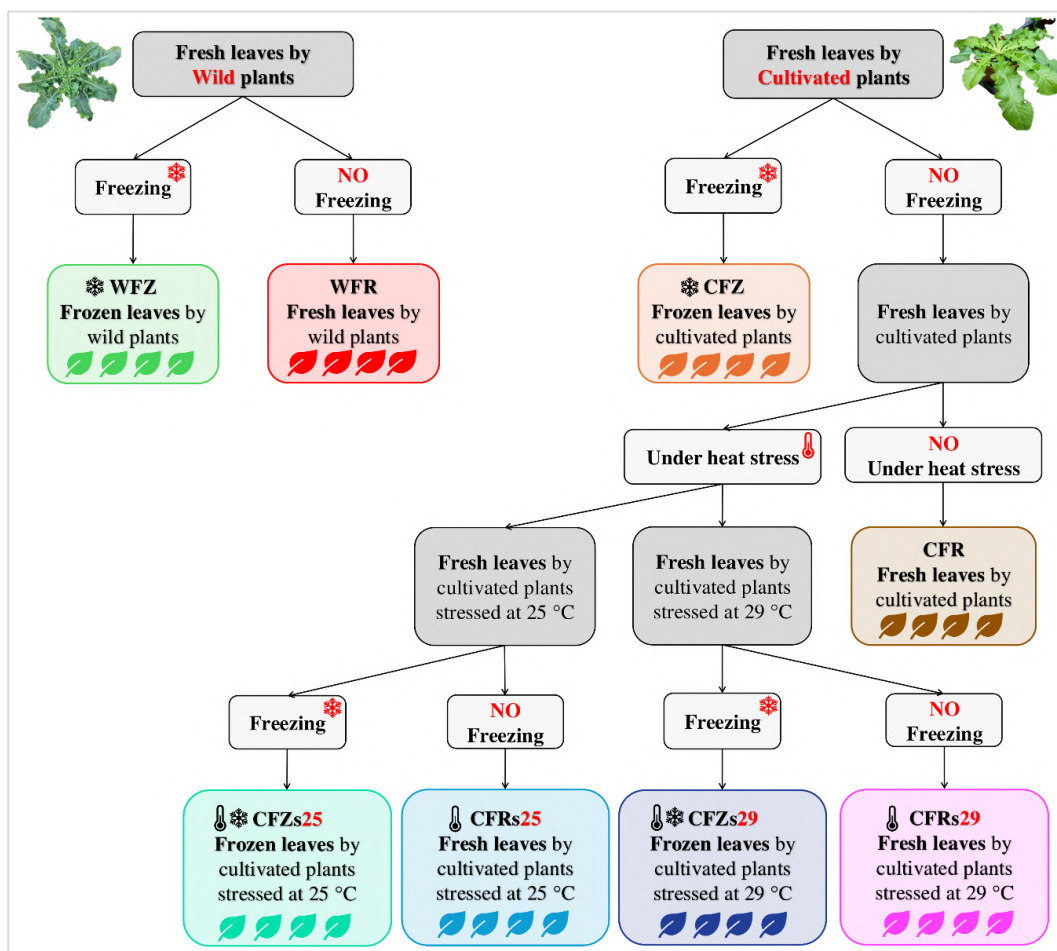


Figure 1. Experimental plan of the analysis on *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) on wild, cultivated and treated plants. Abbreviations: WFZ: Wild Frozen; WFR: Wild Fresh; CFZ: Cultivated Frozen; CFR: Cultivated Fresh; CFZs25: Cultivated Frozen stressed at 25 °C; CFRs25: Cultivated Fresh stressed at 25 °C; CFZs29: Cultivated Frozen stressed at 29 °C; CFRs29: Cultivated Fresh stressed at 29 °C.

2.2. Morphometric measurements

Before collecting the leaf samples, morphometric measurements were made on 20 plants under cultivated conditions (CFR) and 20 plants under wild conditions (WFR) regarding the diameter and number of leaves of the rosettes.

2.3. Colorimetric Analysis

Four leaves were analysed for each growth condition with different size and shape. Colorimetric analysis was carried out with a previously calibrated colorimeter (Tristimolo CR 300, Minolta). The CIE L a b system was used as

reference. Fifteen measurements were taken for each leaf surface (upper and lower front). Analyses were performed only on fresh leaves of wild and cultivated samples (CFR, WFR, CFRs25 and CFRs29) to obtain an overview of the characteristics of the species in wild and cultivated conditions without considering any stress [30].

2.4. Determination of chemical parameters: % Ash, pH, Relative Humidity (RH), Titratable Acidity (TA), Total Soluble Solids (TSS) and Water Activity (a_w)

To determine the Ash content, approximately 20 g of the fresh sample were weighed and placed in a quartz capsule. The capsule was then placed in a muffle furnace at 550 °C until a constant weight was reached. Analyses were conducted in duplicate on fresh leaves of wild and cultivated samples (CFR, WFR, CFRs25 and CFRs29). The ash percentage was calculated using the following formula, as outlined by Harris & Marshall [31]:

$$\% \text{ Ash} = \frac{\text{weight of ashes}}{\text{weight of fresh sample}} * 100 \quad (1)$$

For the determination of Relative Humidity (RH), approximately 5 g of fresh sample were broken up and placed in a thermobalance (MA160, Sartorius, California, US) to measure the Relative Humidity in %. The experiment was conducted in duplicate on fresh leaves of wild and cultivated samples (CFR, WFR, CFRs25 and CFRs29).

To measure Water Activity (a_w), a small amount of fresh sample was placed inside a hygrometer (Aqualab LITE Decagon). The analysis was conducted in duplicate on fresh leaves of wild and cultivated samples (CFR, WFR, CFRs25 and CFRs29).

For the determination of Titratable Acidity (TA), pH and Total Soluble Solids (TSS), the same extract was prepared on all fresh matrices (CFR, WFR, CFRs25 and CFRs29). Ten grams of leaf sample were taken, and 50 mL of distilled water

was added; the mixture was homogenised with Ultra-Turrax (T 25 digital, IKA, Staufen, Germany) for 30 seconds at medium speed and centrifuged (NF 1200R, Nüve, Ankara, Türkiye) for 5 min at 5000 rpm at 5 °C. The supernatant was filtered through qualitative filter paper (Whatman®, grade 4) into a 100 mL flask, and the solid residue was re-extracted with another 50 mL of water. A second centrifugation was performed, re-filtered and finally made up to volume.

For Titratable Acidity (TA), 10 mL of the extract was titrated with 0.05 N NaOH using 1% phenolphthalein as an indicator. All analyses were conducted in duplicate on the different samples. The results were expressed as % citric acid.

For the pH determination, a sample aliquot was subjected to pH measurement by immersing the electrode in the sample. All analyses were conducted in duplicate using a Crison basiC 20 pH meter, equipped with a 52-60 electrode.

For determination of Total Soluble Solids (TSS), a few drops of extract were placed on the prism of a digital refractometer (DBR 047 SALT, Giorgio Bormac s.r.l, Carpi (MO), Italy) and expressed in degrees Brix (°Bx). The test was carried out in duplicate. The TSS content was expressed in percent.

2.5. Phytochemical analysis: Chlorophylls and Carotenoids Content

In accordance with Nagata and Yamashita [32], 2 g of leaves with 10 mL acetone/hexane (2/3) were placed in a Falcon conical centrifuge tube and homogenised with Ultra-Turrax (T 25 digital, IKA, Staufen, Germany). Then centrifuged (NF 1200R, Nüve, Ankara, Türkiye) for 10 min at 6000 rpm at 5 °C. The supernatant was then filtered with qualitative filter paper (Whatman®, grade 4) and the absorbance was read on a spectrophotometer (UV-Vis k2, PerkinElmer Inc., Waltham, MA, USA) at 453, 505, 645 and 663 nm. The acetone/hexane solution (2/3) used for the extraction was used as a blank. The extract was prepared for all variables (CFR, CFZ, WFR, WFZ, CFRs25, CFZs25, CFRs29, CFZs29). The results are expressed in mg/100 mL of extract using the following formulae:

$$\text{Chlorophyll } a = 0.999A663 - 0.0989A645 \quad (2)$$

$$\text{Chlorophyll } b = -0.328A663 + 1.77A645 \quad (3)$$

$$\beta\text{-Carotene} = 0.216A663 - 1.22A645 - 0.304A505 + 0.452A453 \quad (4)$$

2.6. Phytochemical analysis: Total Polyphenol content (TPC), Total Flavonoid content (TFC) and Total Antioxidant Activity (TAA) (ABTS and DPPH)

2.6.1. Extract preparation

According to Sicari et al. [27], 10 g of sample are combined with 50 mL of ethanol/H₂O (80/20). The mixture was passed through the Ultra-Turrax for 30 seconds at medium speed and centrifuged in a refrigerated centrifuge at 5 °C for 10 min at 5,000 rpm. The supernatant was then removed and filtered with qualitative filter paper (Whatman ®, grade 4) before analysis. The extract was prepared for all variables (CFR, CFZ, WFR, WFZ, CFRs25, CFZs25, CFRs29, CFZs29).

2.6.2. Total Phenolic Content (TPC)

In accordance with Sepahpour et al. [33], 1/4 diluted extract (250 µL extract and 750 µL H₂O) and 5 mL of Folin-Ciocalteu (FCR) (1/10) were added to a 10 mL flask. After 5 minutes, 4 mL of Na₂CO₃ 7.5% was added. It was then vortexed for few seconds and incubated in the dark for 1 h. The absorbance was read at 765 nm using a spectrophotometer (UV-Vis k2, PerkinElmer Inc., Waltham, MA, USA). The blank was prepared in the same way, but the same amount of distilled water was added instead of the extract. The results were expressed as mg Gallic Acid Equivalent (GAE) per 100 g of fresh weight.

2.6.3. Total Flavonoid Content (TFC)

In accordance with Sepahpour et al. [33], 1/1 diluted extract (250 µL extract e 250 µL H₂O), 2.5 mL H₂O and 150 µL of NaNO₂ 5% were added to

a 5 mL flask. After a further 5 min 1 mL of 1 M NaOH was added and was made up to volume with H₂O (550 µL). Finally, it was vortexed for few seconds and incubated for 15 min. The blank was prepared in the same way, but the same amount of distilled water was added instead of the extract. The absorbance was read at 510 nm; results were expressed as mg Quercetin (QE) per 100g of fresh weight.

2.6.4. *Total Antioxidant Activity (TAA): ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) and DPPH (2,2-diphenyl-1-picrylhydrazyl)*

For the ABTS determination, 2980 µL of ABTS solution prepared by weighing 0.0192 g ABTS was added to a plastic cuvette. The absorbance at 734 nm was read. 20 µL of extract was then added and incubated in the dark under agitation for 6 min. After the 6 min, the absorbance was re-read. The blank was made with Ethanol. The results are expressed as % inhibition.

For the DPPH calculation, 2980 µL of DPPH solution (1×10^{-4}) was added to a cuvette and the absorbance was read at 517 nm. 20 µL of extract was then added and incubated in the dark under agitation for 30 min. After the 30 min, the absorbance was re-read. The blank was made with Methanol. The results are expressed as % inhibition.

The percentage of inhibition of DPPH and ABTS radical generation was calculated using the formula:

$$\text{Radical Scavenging Assay (RSA)\%} = \left[\frac{(A_0 - A_1)}{A_0} \right] * 100 \quad (5)$$

where A₀ represents the absorbance of the control, while A₁ denotes the absorbance of the sample at the designated time points (6 minutes for ABTS; 30 minutes for DPPH).

2.7. Statistical analysis

All experiments were conducted twice with the same methodologies and materials. For morphometric measurements, a Principal Component Analysis

(PCA) was carried out accompanied by visual box plot analyses. These analyses were performed using the software PAST version 4.15 [34]. The analytical data of all were reported as mean \pm standard deviation (SD) $n=3$. Analysis of variance (one-way ANOVA) was conducted by applying the Tukey post hoc test at $p < 0.01$ (SPSS software, version 29.0, Armonk, NY, USA). The following symbols were used to indicate significance: ** $p < 0.01$; * $p < 0.05$; n.s. (not significant) $p > 0.05$.

3. Results and discussion

3.1. Morphometric measurements

Morphometric analysis is a useful tool for distinguishing characters in the Asteraceae family [35]. For this purpose, we considered some morphometric characteristics and applied a principal component analysis (PCA) to compare them in *C. aspromontana* in wild and cultivated conditions, considering the number of leaves (X-axis) and the diameter of the rosettes (Y-axis) (Fig. 2).

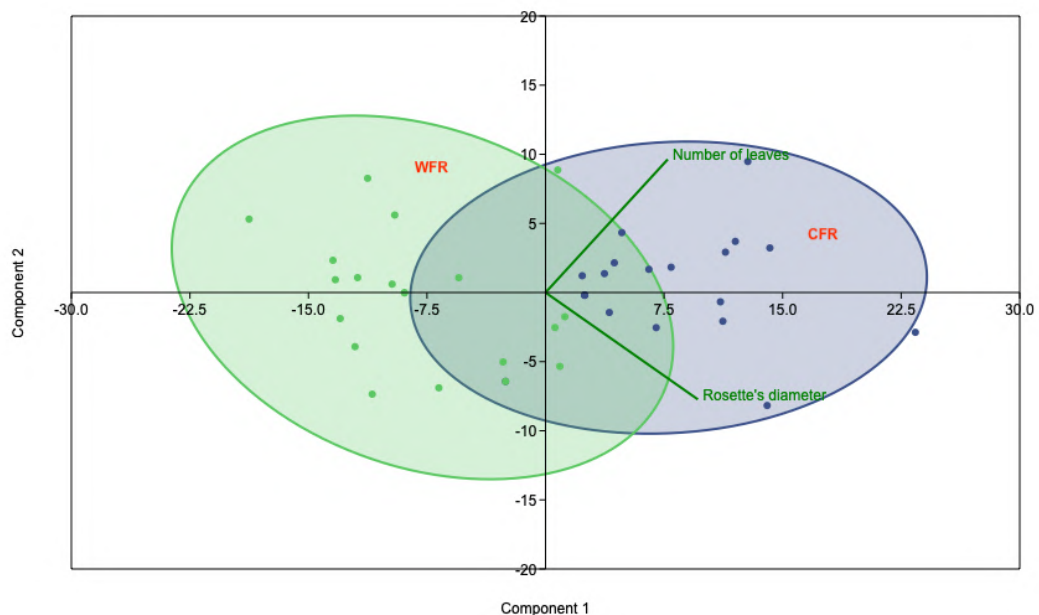


Figure 2. Principal Component Analysis (PCA) of the Wild (WFR) (in green) and Cultivated (CFR) (in blue) samples of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) performed on 20 plant samples for each of the two theses by measuring the number of leaves and the diameter of the rosettes.

As illustrated in Fig. 2, a distinct differentiation between wild (WFR) and cultivated (CFR) plant samples are evident. The results of the morphometric

analysis indicate that the cultivated plants exhibit notable differences in terms of higher leaf number and rosette diameter. Statistical significance was confirmed by the p value which, for both matrices, is very low and highly significant (Tab. 1).

Table 1. Measurements of rosettes diameter and number of leaves for Wild (WFR) and Cultivated (CWR) *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) plants.

Sample typology	Rosette's diameter	Number of leaves
CFR	38.8±5.08 ^a	22.75±4.96 ^a
WFR	27.1±6.06 ^b	12.45±4.45 ^b
sign.	**	**

*Abbreviations: CFR: Cultivated Fresh; WFR: Wild Fresh. Rosette diameter values are expressed in cm. Data are reported as mean ± standard deviation (SD) (n=3). **significance at $p < 0.01$. Results followed by different letters in the same row are significantly different according to Tukey's multiple interval test.

This distinction may be due to different growth conditions and domestication practices. Cultivated plants also show superior performance compared to their wild counterparts. Cultivation of *C. aspromontana* appears to favour improvement in both leaf number and rosette diameter, suggesting that cultivation practices may positively influence these traits. The clear differentiation between the groups, as evidenced by the box plots in Fig. 3, lends support to the hypothesis that cultivated plants exhibit greater vigour than their wild counterparts. Box plots were employed to evaluate the homogeneity and discrepancy between the variables "number of leaves" and "rosettes diameter" within the CFR (Cultivated Fresh) and WFR (Wild Fresh) groups.

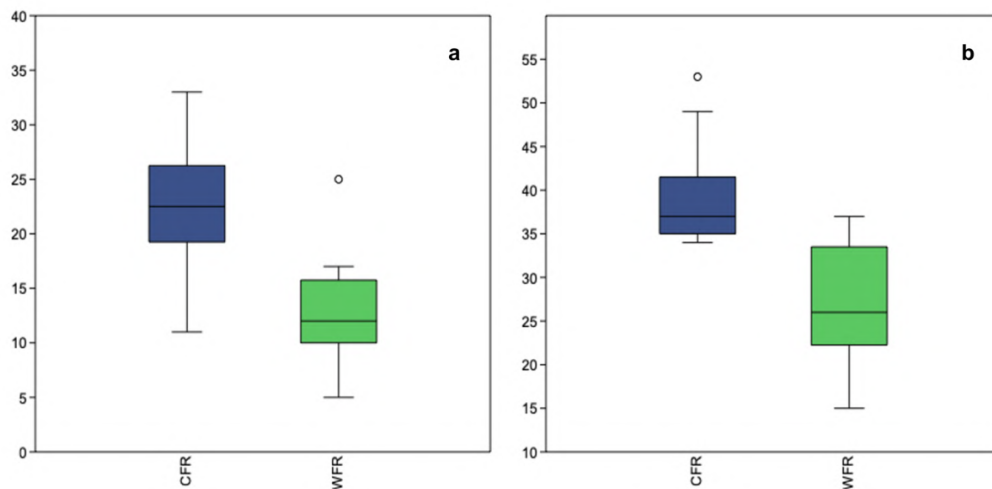


Figure 3a,b. Box plot of the variables “number of leaves” (a) and “rosettes diameter” (b) for the Cultivated Fresh (CFR) and Wild Fresh (WFR) groups of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) plants. Outliers were not excluded. These graphs were performed using the software PAST version 4.15 [34].

In the box plots relating to the number of leaves (left), the median of the CFR group is positioned in the centre of the box, indicating a relatively symmetrical distribution of the data. In contrast, the median of the WFR group is shifted downwards, indicating an asymmetric distribution. The whiskers of the CFR group are much longer than those of the WFR group, indicating a greater dispersion of the data in the CFR group. However, the WFR group has several outliers, whereas the CFR group has few or none, suggesting greater consistency of data in the CFR group. For rosette diameter (right), the median of the CFR group is shifted towards the bottom of the box, indicating a greater concentration of data towards higher values. The whiskers of the CFR group are asymmetrical, with one significantly longer than the other, but the box is much smaller than that of the WFR group, indicating less variability in the data of this group. In both cases, visual analysis of the box plots showed greater homogeneity in the data from the WFR group than the CFR group for rosette diameter, while for number of leaves the CFR group showed greater homogeneity than the WFR group. These results support the theory that there are statistically significant differences between the two matrices for leaf number and rosette diameter.

3.2. Colorimetric Analysis

Figure 4 shows the top and bottom of one of the leaves analysed for colorimetric analysis for each matrix (CFR, WFR, CFRs25 and CFRs29).



Figure 4. Colorimetric analysis on *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) to assess the colour differences of the different samples analysed: Cultivated Fresh (CFR), Wild Fresh (WFR), Cultivated Fresh stressed at 25 °C (CFRs25), Cultivated Fresh stressed at 29 °C (CFRs29).

Table 2 summarises the results of the colorimetric analysis carried out on the upper and lower front of leaves of *C. aspromontana* Cultivated (CFR), Wild (WFR), and grown under stress at 25 (CFRs25), and 29 °C (CFRs29). These measurements provide a complete overview of the colorimetric changes, allowing the impact of different growing, storage and heat treatment conditions to be compared.

Table 2. Mean chromatic values (L, a, b) of the upper and lower front of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) leaves under different growing conditions and heat stress.

Sample typology	Upper page of leaves			Lower page of leaves			
	L	a	b	L	a	b	
CFR	44.5±3.5 ^c	-9.5±1.4 ^d	18.5±4.5 ^b	CFR	50.2±3.4 ^c	-8.2±1.1 ^c	17.7±3.7 ^b
WFR	45.1±2.8 ^c	-5.3±1.3 ^a	10.2±3.1 ^c	WFR	49.1±3.1 ^c	-5.9±0.8 ^a	12.7±1.9 ^c
CFRs25	60.9±9.0 ^a	-7.2±2.3 ^b	28.2±5.8 ^a	CFRs25	64.1±8.5 ^a	-5.9±2.6 ^a	22.8±6.5 ^a
CFRs29	51±4.4 ^b	-8.2±1.4 ^c	19.3±5.0 ^b	CFRs29	56.8±3.7 ^b	-7.1±1.1 ^b	17.7±3.1 ^b
sign.	**	**	**	sign.	**	**	**

Abbreviations: CFR: Cultivated Fresh, WFR: Wild Fresh, CFRs25: Cultivated Fresh stressed at 25 °C, CFRs29: Cultivated Fresh stressed at 29 °C. L: brightness; a: red/green coordinate; b: yellow/blue coordinate. Data are reported as mean ± standard deviation (SD) (n=3). **significance at $p < 0.01$. Results followed by different letters in the same row are significantly different according to Tukey's multiple interval test.

Chromatic analysis of *Crepis aspromontana* leaves revealed significant variations in Lightness (L), red-green coordinate (a), and blue-yellow coordinate (b) across different growth conditions and heat stress treatments.

For the upper front of the leaves, the Lightness (L) values were similar between cultivated fresh (CFR) and wild fresh (WFR) leaves, at 44.5±3.5 and 45.1±2.8, respectively, with no significant differences. However, regarding the cultivated plant stressed with high temperature, CFRs25 (cultivated fresh stressed at 25 °C) exhibited the highest lightness (60.9±9.0), significantly differing from all other groups. CFRs29 (cultivated fresh stressed at 29 °C) presented an intermediate lightness (51.0±4.4), significantly different from CFR and CFRs25. For the red-green coordinate (a), CFR leaves had the most negative value (-9.5±1.4), indicating a stronger tendency towards green, and were significantly different from the other groups. WFR leaves showed the least negative value (-5.3±1.3), leaning more towards red and shows significant differences from the cultivated variant (CFR).

Regarding thermally stressed plants, CFRs25 and CFRs29 had intermediate values, yet still significantly distinct from plants grown at optimal temperatures (CFR). On the blue-yellow coordinate (b), CFR and CFRs29 leaves showed similar

values (18.5 ± 4.5 and 19.3 ± 5.0 , respectively), while WFR leaves had the lowest value (10.2 ± 3.1), indicating a stronger blue tendency. CFRs25 leaves exhibited the highest b value (28.2 ± 5.8), indicating a stronger yellow tendency, with significant differences compared to CFR and CFRs29.

For the lower front of the leaves, the Lightness (L) values for CFR and WFR were 50.2 ± 3.4 and 49.1 ± 3.1 , respectively, with no significant differences. CFRs25 displayed the highest lightness (64.1 ± 8.5), while CFRs29 had an intermediate value (56.8 ± 3.7), significantly different from CFRs25 and CFR. Regarding the red-green coordinate (a), CFR leaves had the most negative value (-8.2 ± 1.1), significantly different from the others. CFRs29 leaves presented intermediate values, with (-7.1 ± 1.1) significantly different from CFR and CFRs25.

Finally, for the blue-yellow coordinate (b), WFR leaves had the lowest value (12.7 ± 1.9), while CFRs25 showed the highest value (22.8 ± 6.5), both significantly different from the other groups.

3.3. Chemical parameters: % Ash, pH, Titratable Acidity (TA), Total Soluble Solids (TSS), Relative Humidity and Water Activity

The results of the chemical parameter analysis of *C. aspromontana* leaves collected under different conditions are presented. Fresh cultivated (CFR) and wild (WFR) samples, as well as fresh cultivated samples subjected to heat stress at 25 °C (CFRs25) and 29 °C (CFRs29), were analysed. The evaluated parameters include Ash content, pH, Relative Humidity (RH), Titratable Acidity (TA), Total Soluble Solids (TSS), and Water Activity (a_w). These measurements provide a comprehensive overview of the chemical characteristics of the leaves, allowing for a comparison of the impact of different cultivation and treatment conditions (Tab. 3).

Table 3. Analysis of chemical parameters of different leaf samples of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae).

Samples typology	Ash	pH	Relative Humidity (RH)	Titrateable Acidity (TA)	Total Soluble Solids (TSS)	Water activity (aW)
CFR	1.78±0.08 ^c	6.1±0.07 ^b	90.89±0.08 ^a	0.14±0.00 ^c	0.40±0.00 ^a	0.97±0.00 ^a
WFR	2.86±0.09 ^a	5.92±0.01 ^c	85.49±0.00 ^{b,c}	0.21±0.00 ^{b,c}	0.50±0.00 ^a	0.97±0.00 ^a
CFRs25	2.36±0.01 ^b	6.27±0.04 ^{a,b}	83.31±1.84 ^c	0.40±0.03 ^a	0.40±0.00 ^a	0.94±0.00 ^b
CFRs29	2.50±0.01 ^b	6.35±0.01 ^a	87.94±1.28 ^{a,b}	0.29±0.03 ^b	0.70±0.00 ^a	0.94±0.00 ^b
sign.	**	**	*	**	n.s.	**

Abbreviations: CFR: Cultivated Fresh, WFR: Wild Fresh, CFRs25: Cultivated Fresh stressed at 25 °C, CFRs29: Cultivated Fresh stressed at 29 °C. Values for Ash, Relative Humidity, Total Soluble Solids and Water Activity are given in percent (%). Titrateable acidity is expressed as a percentage of citric acid. Mean values are presented with the standard deviation (\pm) (n=3). **significance at $p < 0.01$, *significance at $p < 0.05$, n.s. (not significant) $p > 0.05$. Results followed by different letters in the same row are significantly different according to Tukey's multiple interval test.

From Table 3, it is evident that the chemical characteristics of *C. aspromontana* leaves are influenced by cultivation conditions and heat stress.

The chemical properties of *C. aspromontana* leaves varied significantly across different cultivation conditions and heat stress treatments. Ash content was notably higher in wild fresh (WFR) samples (2.86±0.09) compared to cultivated fresh (CFR) samples (1.78±0.08), suggesting a greater mineral content in wild plants, likely due to the less controlled, natural soil conditions in which they grow [36]. The increase in Ash content observed in heat-stressed samples (CFRs25 and CFRs29) compared to CFR could indicate a concentration of minerals resulting from moisture loss [37], aligning with typical Ash content ranges found in commercial vegetables (0.4-2.0%) [38].

The pH of the samples also differed, with CFR samples having a slightly higher pH (6.1±0.07) than WFR samples (5.92±0.01), reflecting potential differences in acid-base metabolism between cultivated and wild plants. Interestingly, heat-stressed samples, particularly CFRs29 (6.35±0.01) and CFRs25 (6.27±0.04), exhibited even higher pH values, indicating that heat stress may alter the plants' acid-base balance [39].

Relative Humidity (RH) was higher in CFR samples (90.89 ± 0.08) than in WFR samples (85.49 ± 0.00), possibly due to intrinsic water content differences between cultivated and wild plants. However, in heat-stressed samples (CFRs₂₅ and CFRs₂₉), Relative Humidity decreased, which is consistent with moisture loss at elevated temperatures [40].

Titrateable Acidity (TA) was higher in WFR samples (0.21 ± 0.00) compared to CFR (0.14 ± 0.00), suggesting a difference in organic acid content between wild and cultivated plants. This parameter increased significantly in heat-stressed samples (CFRs₂₅ and CFRs₂₉), indicating that heat stress could lead to alterations in the organic acid composition [39].

Total Soluble Solids (TSS) showed no significant differences between CFR and WFR samples or among the stressed samples (CFRs₂₅ and CFRs₂₉), suggesting that soluble solids remained stable across various conditions. Water Activity (a_w) was similar between CFR and WFR samples (0.97 ± 0.00), implying that the availability of water for biochemical reactions was consistent. In contrast, heat-stressed samples (CFRs₂₅ and CFRs₂₉) showed slightly lower Water Activity (0.94 ± 0.00), which may suggest reduced water availability under stress conditions [39].

3.4. Chlorophylls and Carotenoids Content

In Table 4, the results of the analysis for chlorophyll a, chlorophyll b, and β -carotene content are indicated. Fresh cultivated (CFR) and wild (WFR) samples were analysed, as well as frozen cultivated (CFZ) and wild samples (WFZ). Additionally, fresh cultivated samples subjected to heat stress at 25 °C (CFRs₂₅) and 29 °C (CFRs₂₉), and frozen cultivated samples subjected to heat stress at 25 °C (CFZs₂₅) and 29 °C (CFZs₂₉) were included. These measurements provide a comprehensive overview of the variations in the content of photosynthetic pigments, allowing for a comparison of the impact of different cultivation, storage, and heat treatment conditions.

Table 4. Contents of chlorophyll a, chlorophyll b and β -carotene in *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) leaves analysed under different conditions.

Sample typology	Chlorophyll a	Chlorophyll b	β -Carotene
CFR	1.2 \pm 0.56 ^a	3.54 \pm 0.09 ^a	not detection
CFZ	1.57 \pm 0.56 ^a	2.65 \pm 0.09 ^a	not detection
WFR	1.85 \pm 0.56 ^a	2.61 \pm 0.09 ^a	not detection
WFZ	1.52 \pm 0.56 ^a	3.33 \pm 0.09 ^a	not detection
CFRs25	1.1 \pm 0.01 ^a	0.43 \pm 0.06 ^d	0.27 \pm 0.03 ^a
CFZs25	2.04 \pm 0.25 ^a	2.19 \pm 0.21 ^b	not detection
CFRs29	1.78 \pm 0.21 ^a	2.55 \pm 0.07 ^{a,b}	not detection
CFZs29	2.11 \pm 0.02 ^a	1.47 \pm 0.04 ^c	not detection
sign.	n.s.	**	**

Abbreviations: CFR: Cultivated Fresh, CFZ: Cultivated Frozen, WFR: Wild Fresh, WFZ: Wild Frozen, CFRs25: Cultivated Fresh stressed at 25 °C, CFZs25: Cultivated Frozen stressed at 25 °C, CFRs29: Cultivated Fresh stressed at 29 °C, CFZs29: Cultivated Frozen stressed at 29 °C. All the values are expressed in mg/100 mL. Mean values are presented with the standard deviation (\pm) (n=3). **significance at $p < 0.01$, n.s. (not significant) $p > 0.05$. Results followed by different letters in the same row are significantly different according to Tukey's multiple interval test.

The analysis of photosynthetic pigments (chlorophyll a, chlorophyll b, and β -carotene) revealed significant differences in the content across the different treatment conditions. Chlorophyll b content showed significant variations between fresh and frozen matrices, both for cultivated and wild plants, but with no differences between these groups. Specifically, the fresh cultivated matrix (CFR) exhibited the highest chlorophyll b content (3.54 \pm 0.09), while in the matrix stressed at 25 °C (CFRs25-CFZs25), a significant increase in chlorophyll b content was observed in the frozen sample (2.19 \pm 0.21) compared to the fresh one (0.43 \pm 0.06). This increase may be due to the likely disruption of cell membranes during the freezing process, which releases some cellular contents that were not available in fresh samples [41].

Regarding chlorophyll a, no significant differences were observed among the groups. The variability found could be attributed to the different treatment conditions, but there were no evident trends suggesting a clear response to freezing or thermal stress.

Finally, β -carotene was absent in most samples, with a small amount (0.27 ± 0.03) detected only in the fresh matrix stressed at 25 °C, which was significantly different from the other samples. These results suggest that β -carotene is not significantly affected by freezing or high temperatures, at least in the analysed samples.

In summary, the results indicate that freezing and heat stress differently affect photosynthetic pigments in leaves, with noticeable differences between cultivated and wild plants, and between fresh and frozen leaves.

3.5. Total Phenolic content (TPC), Total Flavonoid content (TFC) and Total Antioxidant Activity (ABTS and DPPH)

In this section, the results of the analysis of total polyphenol content (TPC), flavonoid content (TFC), and antioxidant activities measured by ABTS and DPPH assays in *C. aspromontana* leaves collected under different conditions are presented. Fresh cultivated (CFR) and wild (WFR) samples, as well as frozen cultivated and wild samples (CFZ and WFZ), were analysed. Additionally, fresh cultivated samples subjected to heat stress at 25 °C (CFRs25) and 29 °C (CFRs29), and frozen cultivated samples subjected to heat stress at 25 °C (CFZs25) and 29 °C (CFZs29), were included. These analyses provide a detailed overview of the variations in phenolic compound content and antioxidant capacities, allowing for a comparison of the impact of different cultivation, storage, and heat treatment methods (Tab. 5).

Table 5. Mean contents of Total Polyphenols (TPC) (mg GAE/100 g), Total Flavonoids (TFC) (mg QE/100 g) and antioxidant activities (ABTS and DPPH) in different samples of fresh and frozen, cultivated and wild *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) leaves and heat stressed at 25 °C and 29 °C.

Sample typology	Total Phenolic content	Total Flavonoid content (TFC)	ABTS	DPPH
CFR	79.26±5.14 ^e	298.49±24.74 ^{d,e}	21.43±2.29 ^d	11.01±0.88 ^d
CFZ	95.31±8.60 ^{d,e}	357.34±25.75 ^{c,d}	22.81±1.75 ^{c,d}	17.67±0.05 ^c
WFR	100.68±9.35 ^d	413.12±24.70 ^{b,c}	27.25±0.64 ^c	19.51±2.15 ^c
WFZ	84.55±1.87 ^{d,e}	140.64±4.55 ^f	18.65±2.49 ^d	14.73±1.89 ^{c,d}
CFRs25	319.59±3.57 ^b	588.04±16.48 ^a	68.88±0.03 ^a	71.25±0.57 ^a
CFZs25	132.92±0.52 ^a	310.41±1.89 ^b	33.26±1.43 ^b	30.00±1.08 ^b
CFRs29	438.72±3.06 ^c	436.75±7.31 ^{d,e}	38.89±0.56 ^b	33.18±0.36 ^b
CFZs29	46.92±0.22 ^f	248.79±4.30 ^e	7.76±0.20 ^e	12.14±1.95 ^d
sign.	**	**	**	**

Abbreviations: CFR: Cultivated Fresh, CFZ: Cultivated Frozen, WFR: Wild Fresh, WFZ: Wild Frozen, CFRs25: Cultivated Fresh stressed at 25 °C, CFZs25: Cultivated Frozen stressed at 25 °C, CFRs29: Cultivated Fresh stressed at 29 °C, CFZs29: Cultivated Frozen stressed at 29 °C, ABTS: 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid), DPPH: 2,2-diphenyl-1-picrylhydrazyl; TPC values are expressed as mg GAE/100g of fresh weight, TFC values are expressed as mg QE/100g of fresh weight; ABTS and DPPH values are expressed as % inhibition. Mean values are presented with the standard deviation (\pm) (n=3). **significance at $p < 0.01$. Results followed by different letters in the same row are significantly different according to Tukey's multiple interval test.

The analysis of Total Polyphenol content (TPC), Total Flavonoid content (TFC), and antioxidant activity (ABTS and DPPH) in *Crepis aspromontana* leaves shows significant differences based on the treatment conditions, with notable distinctions between fresh cultivated (CFR) and fresh wild (WFR) samples, as well as the effects of freezing and heat stress. Fresh wild samples (WFR) generally exhibited higher levels of bioactive compounds compared to fresh cultivated samples (CFR). WFR had a significantly higher Total Flavonoid content (413.12±24.70) compared to CFR (298.49±24.74), indicating that wild plants are more capable of synthesizing flavonoids. This could be attributed to the more stressful environmental conditions in which they grow [42,43]. Moreover, frozen cultivated samples (CFZ) showed an increase in TFC (357.34±25.75) compared to fresh cultivated leaves (CFR), likely due to the damage to cell membranes caused by freezing, which releases previously inaccessible cellular contents [44].

Regarding Total Polyphenol content, WFR exhibited higher values (100.68 ± 9.35) than CFR (79.26 ± 5.14), suggesting that wild plants accumulate more polyphenols. This is consistent with the fact that plants often increase the synthesis of secondary metabolites in response to environmental stressors such as water, nutrient, and temperature stress [45,46]. Wild plants tend to experience higher levels of stress compared to cultivated plants, which may trigger enhanced polyphenol production [47].

Antioxidant activities, measured by ABTS and DPPH assays, were also higher in wild samples, with WFR showing ABTS activity of $27.25 \pm 0.64\%$ and DPPH activity of $19.51 \pm 2.15\%$, while CFR had lower values (ABTS $21.43 \pm 2.29\%$, DPPH $11.01 \pm 0.88\%$). These results suggest that wild plants possess stronger antioxidant properties, possibly because of their exposure to more variable and stressful environments.

Heat stress treatment significantly increased bioactive compound content and antioxidant activity in both fresh and frozen samples. Specifically, the fresh cultivated samples subjected to stress at $25\text{ }^{\circ}\text{C}$ (CFRs₂₅) and $29\text{ }^{\circ}\text{C}$ (CFRs₂₉) exhibited the highest levels of total polyphenols (CFRs₂₉: 438.72 ± 3.06 , CFRs₂₅: 319.59 ± 3.57) and flavonoids (CFRs₂₉: 436.75 ± 7.31 , CFRs₂₅: 588.04 ± 16.48). The antioxidant activities in these samples were also substantially higher (CFRs₂₉ ABTS: $38.89 \pm 0.56\%$, DPPH: $33.18 \pm 0.36\%$; CFRs₂₅ ABTS: $68.88 \pm 0.03\%$, DPPH: $71.25 \pm 0.57\%$), indicating that heat stress enhances the production of bioactive compounds and boosts antioxidant properties [48].

An interesting trend was observed in the frozen cultivated leaves (CFZ), which had higher total polyphenol (95.31 ± 8.60), and flavonoid content (357.34 ± 25.75) compared to fresh cultivated samples (CFR). This increase could be due to the freezing process, which might induce cell rupture through ice crystal formation, facilitating the release of phenolic compounds. Furthermore, freezing may stimulate the biosynthesis of these secondary metabolites as part of a protective response to the oxidative stress caused by the freezing process [49,50].

4. Conclusions

This study provides a thorough analysis of the morphometric and phytochemical characteristics of *Crepis aspromontana*, an endemic species from Calabria with notable ethnobotanical and nutritional potential. The results showed that cultivation significantly improved the plant's vigour, leading to a higher number of leaves and larger rosettes, traits that could make the species more appealing for commercial purposes. Conversely, wild plants exhibited superior phytochemical qualities, with higher concentrations of polyphenols, flavonoids, and antioxidant activity, emphasizing their rich bioactive composition and potential health benefits.

In the heat stress experiments, cultivated plants displayed a marked increase in bioactive compound synthesis, particularly polyphenols and flavonoids, which corresponded to enhanced antioxidant activity. However, these conditions also had a negative impact on photosynthetic efficiency, reducing chlorophyll b content, while stimulating β -carotene synthesis, possibly as a defensive response to heat stress. Furthermore, the study revealed important differences in chemical traits such as ash content, pH, and titratable acidity between wild and cultivated plants, further highlighting the influence of environmental factors and cultivation practices on the overall quality of the species.

These findings underscore the importance of integrating domestication strategies to optimize the potential of *C. aspromontana* as a nutrient-rich food source, while also ensuring the preservation of its biodiversity. The results also suggest a need for additional research aimed at improving the species' adaptability to various environmental stresses, which would enhance its sustainability and role in addressing challenges related to food security and climate change resilience.

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General Conclusions and Future Perspectives

This research highlights the importance of ethnobotany as a key discipline for the conservation and valorization of plant biodiversity, with particular focus on the Calabria region and, specifically, the Graecanic Area. This territory, deeply tied to cultural and linguistic traditions of Greek origin, preserves an invaluable heritage of traditional knowledge regarding the use of wild plants. These plants are not only a food resource but also a fundamental part of the cultural identity of the local population. However, these traditions are increasingly at risk due to factors such as population aging, rural abandonment, and modernization.

Through a multidisciplinary approach integrating anthropological, botanical, phytochemical, and agronomic methods, this thesis analyzed the traditional use of wild species in the Graecanic Area, selecting some of them to test their potential domestication. Ethnobotanical surveys allowed the collection and analysis of knowledge related to the use of over 150 plant taxa employed for food, medicinal, artisanal, and symbolic purposes. The most used species belong to the families Asteraceae, Lamiaceae, and Apiaceae, reflecting the deep connection between local flora and the traditional Mediterranean diet and medicine. Among these, *Crepis aspromontana* and *Pimpinella anisoides* emerged as two endemic species of particular interest, not only for their traditional use but also for their alimentary and commercial potential. In addition to these two species, other commonly consumed species were selected for domestication trials: *Asparagus acutifolius*, *A. albus*, and *Hypochaeris radicata*.

The selection of these species led to the implementation of domestication trials in the field (for *A. albus*, *A. acutifolius*, and *H. radicata*) and in the laboratory (for *C. aspromontana* and *P. anisoides*), contributing to their conservation and valorization through integration into controlled agricultural systems. Germination tests conducted in the laboratory for *Crepis aspromontana* and *Pimpinella anisoides* demonstrated their ability to adapt to controlled conditions, showing potential for the development of broader domestication protocols. This approach represents an important step not only for the conservation of these

species but also for their potential integration into local agricultural supply chains, thus promoting sustainable economic development in the region.

Comparisons between cultivated and wild plants of *Crepis aspromontana*, based on morphometric and phytochemical studies, revealed significant differences, particularly in leaf number and rosette diameter, suggesting that domestication can enhance the performance of cultivated plants. Additionally, thermal stress response tests provided valuable insights into the species' ability to adapt to sudden climatic changes, a crucial aspect in the context of accelerated climate change.

Another significant outcome of this research is the importance of the phytochemical compounds present in the studied species. Analyses revealed high levels of total phenolic content (TPC) and antioxidant activity in both wild and cultivated plants. These findings confirm the nutraceutical potential of *Crepis aspromontana*, potentially paving the way for the development of functional foods or dietary supplements based on this species, with potential health benefits. Valorizing this species could represent an economic opportunity not only for local communities but also for a broader market seeking high-quality, natural, and organic products.

The future directions of this work span several areas. First, it will be crucial to continue domestication trials in open field conditions, expanding experiments to include a larger number of specimens and evaluating the impact of various agronomic factors on plant yield. Additionally, phytochemical studies should be broadened to include new analyses of bioactive compounds in *Crepis aspromontana* and *Pimpinella anisoides* to fully explore their potential as food and medicinal resources.

Parallel to these efforts, engaging local communities will be vital to ensuring the success of projects aimed at promoting wild plants. Integrating traditional knowledge with modern agronomic technologies offers a promising path to preserving the cultural and botanical biodiversity of Calabria. In this context, creating networks among farmers, researchers, and local entrepreneurs

could foster the development of short supply chains based on products derived from endemic species, generating positive environmental and economic impacts.

Finally, climate change poses a significant challenge to biodiversity conservation, particularly in Mediterranean areas, which are already vulnerable to desertification and habitat loss. The knowledge gained from this research could contribute to the development of adaptive strategies based on the selection of resilient plant species and the implementation of sustainable agricultural practices. Ethnobotany thus proves to be a fundamental discipline not only for understanding the past but also for shaping a more sustainable future, attentive to the preservation of natural and cultural resources.

In conclusion, this doctoral research has made an important contribution to the valorization and conservation of Calabria's ethnobotanical resources, demonstrating how the integration of scientific research and traditional knowledge can be a winning strategy for promoting sustainable development and biodiversity conservation.

List of figures

CHAPTER 1

Figure 1. The Graecanic area of the Metropolitan City of Reggio Calabria (Calabria, Southern Italy), with municipal borders highlighted in red. The included municipalities are Africo, Bagaladi, Bova, Bova Marina, Brancaleone, Bruzzano Zeffirio, Cardeto, Condofuri, Ferruzzano, Melito di Porto Salvo, Montebello Jonico, Motta San Giovanni, Palizzi, Roccaforte del Greco, Roghudi, San Lorenzo, and Staiti (adapted from Google© 2024).....**13**

CHAPTER 2

Figure 1. Calabria region (Southern Italy). In red are the boundaries of the five provinces of the region: Catanzaro, Cosenza, Croton, Reggio Calabria and Vibo Valentia (adapted from Google© 2024).....**46**

Figure 2. Distribution of ethnobotanical knowledge documented in the literature across the five Calabrian provinces (adapted from Google© 2024).....**49**

Figure 3. Life spectrum of ethnobotanical taxa detected in Calabria (Southern Italy). Ch- Chamaephytes; G- Geophytes; H- Hemicryptophytes; NP- Nanophanerophytes; P- Phanerophytes; T- Therophytes [49].....**52**

Figure 4. Chorological spectrum of ethnobotanical taxa use detected in Calabria (Southern Italy) according to [50].....**53**

Figure 5. Origin of ethnobotanical taxa detected in Calabria (Southern Italy) in accordance with [48]. Acult. – Alien cultivated; Awild – Alien wild; Ccult. – Cryptogenic cultivated; Cwild – Cryptogenic wild; Ncult. – Native cultivated; Nwild – Native wild.....**53**

Figure 6. Plant parts most used for ethnobotanical purposes in Calabria (Southern Italy).....**54**

Figure 7. Types of ethnobotanical use of taxa detected in Calabria (Southern Italy), sorted according to the number of records and taxa for each use.....	55
Figure 8. Composition of the bibliographic sources analyzed, categorized by the number of records for each type of use of the taxa surveyed in Calabria (Southern Italy).....	56
Figure 9. Number of records and taxa divided categorized by to medicinal purposes. The medicinal categories follow the classification by Cook [51].....	58
Figure 10. Food purposes ordered by decreasing number of records and number of taxa.....	59

CHAPTER 3

Figure 1. Calabria region. In red are highlighted the provinces of Catanzaro, Cosenza, Crotona, Vibo Valentia and the Metropolitan City of Reggio Calabria..	67
Figure 2. Life forms spectrum of recorded taxa. Ch Chamaephytes, G Geophytes, H Hemicryptophytes, NP Nanophanerophytes, P Phanerophytes, T Therophytes.....	68
Figure 3. Chorological spectrum of recorded taxa.....	69
Figure 4. The most relevant part of plants used for food purposes.....	69
Figure 5. Food purposes with the number of citations and number of taxa for each, ordered by number of citations.....	70
Figure 6. Most recurrent taxa used as a side dish sorted by number of citations..	70
Figure 7. Most recurrent taxa for snack purpose ordered by number of citations.....	71

Figure 8. Most common taxa recorded with the "salads" purpose sorted by number of citations.....72

Figure 9. Taxa most used for the "omelettes" purpose in order of number of citations.....73

CHAPTER 4

Figure 1. Highlight in green are the borders of the municipalities belonging to the Graecanic area of the Metropolitan City of Reggio Calabria (Calabria, Southern Italy): Africo, Bagaladi, Bova, Bova Marina, Brancaleone, Bruzzano Zeffirio, Cardeto, Condofuri, Ferruzzano, Melito di Porto Salvo, Montebello Jonico, Motta San Giovanni, Palizzi, Roccaforte del Greco, Roghudi, San Lorenzo, Staiti.....81

Figure 2. Distribution of the informants and their ethnobotanical knowledge in three age groups: 21-40, 41-60 and 61-82. The relationship between age and ethnobotanical knowledge was established through the number of interviews and the number of taxa..84

Figure 3. Life forms spectrum of the taxa recorded during the interviews detected the Graecanic Area of Reggio Calabria (Southern Italy) according to Raunkiaer [78].....86

Figure 4. Chorological spectrum of the taxa recorded from the interviews detected the Graecanic Area of Reggio Calabria (Southern Italy) according to Pignatti [79].....86

Figure 5. Origin of ethnobotanical taxa detected within the Graecanic Area of Reggio Calabria (Southern Italy). The origin is in accordance with Galasso et al. [77].....87

Figure 6. Plant parts most used for ethnobotanical purposes within the Graecanic Area of Reggio Calabria (Southern Italy).....87

Figure 7. Types of ethnobotanical use of taxa detected within the Graecanic area of Reggio Calabria (Southern Italy), sorted by the number of records and taxa for each use.....88

Figure 8. Food purposes detected within the Graecanic area of Reggio Calabria (Southern Italy) sorted by number of interviews.....91

Figure 9. Some species belonging to the Asteraceae family eaten as food: *Cynara cardunculus* L. subsp. *cardunculus* (a), *Scolymus hispanicus* L. (b), *Hypochaeris radicata* L. (c), and *Crepis vesicaria* L. (d) (Ph. Miriam Patti and Valentina Lucia Astrid Laface).....92

Figure 10. On the left, a cladode of *Opuntia ficus-indica* L. (Cactaceae) with fruits; on the right, *O. ficus-indica* fruits cleaned from the spiny epicarp with a knife and eaten during an ethnobotanical interview in the Graecanic Area (Ph: Valentina Lucia Astrid Laface).....92

Figure 11. “Scaddateddhe”, typical Calabrian baked products prepared with the fruits of *Pimpinella anisoides* V.Br. (Apiaceae) (Ph. Miriam Patti).....93

Figure 12. Medicinal purposes and taxa used detected within the Graecanic area of Reggio Calabria (Southern Italy) sorted by number of interviews. The disease groups follow the classification of Cook [81].....94

Figure 13. Chord diagram showing all medicinal taxa identified during the interviews within the Graecanic area of Reggio Calabria (Southern Italy), categorized into nine medicinal use groups. The diagram was processed using R software (version 2024.04.2+764) and the ‘ethnobotany’ package. The medicinal use groups follow the classification of Cook [81].....95

Figure 14a,b. On the left (a) goat collars made from *Morus nigra* L. (Moraceae) wood. On the right (b) spoon and fork for *ricotta* cheese made from *Erica arborea* L. (Ericaceae) wood (Ph. Valentina Lucia Astrid Laface).....96

Figure 15. *Verbascum thapsus* L. subsp. *thapsus* (Scrophulariaceae) used as a nursery rhyme by an informant within the Graecanic Area of Reggio Calabria (Ph. Valentina Lucia Astrid Laface).....**97**

Figure 16. *Quercus pubescens* Willd. subsp. *pubescens* (Fagaceae) acorn used to make a toy pipe (Ph. Miriam Patti).....**97**

CHAPTER 5

Figure 1a,b. Wild plants of *Asparagus acutifolius* L. (a) (Ph. Giovanni Lento) and *Asparagus albus* L. (b) (Ph. Miriam Patti).....**111**

Figure 2. Plants of *Hypochaeris radicata* L. (Ph. Miriam Patti).....**112**

Figure 3a,b. Plant of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) in wild habitat (a) (Ph. Valentina Lucia Astrid Laface) and flower bracts of *Crepis aspromontana* with typical blackish bristles (Ph. Miriam Patti; image obtained with a stereoscope at 2x magnification).....**113**

Figure 4. Plants of *Pimpinella anisoides* V.Brig. (Ph. Valentina Lucia Astrid Laface).....**114**

Figures 5a,b. Figures 5a,b. Collection of morphometric measurements (a) and measurement of *Asparagus albus* L. specimen (b) according to the protocol of Bacchetta et al. [35] (Ph. Miriam Patti).....**115**

Figure 6a,b. Specimens of *Asparagus albus* L. (a) and *Hypochaeris radicata* L. (b) domesticated in pots (Ph. Miriam Patti).....**116**

Figure 7. Row of *Asparagus acutifolius* L. on the left and *Asparagus albus* L. on the right planted 90 cm apart in each furrow (Ph. Miriam Patti).....**117**

Figure 8a,b,c. Division of plots of *Hypochaeris radicata* L. plants into *Controlled* (a), *Semi-controlled* (b) and *Wild* (c) conditions (Ph. Miriam Patti).....**118**

Figure 9. Growth comparison of *Asparagus acutifolius* L. and *Asparagus albus* L.'s plants in wild and cultivated conditions.....**119**

Figure 10. Growth comparison of *Hypochaeris radicata* L.'s plants in different conditions.....**120**

CHAPTER 6

Figure 1. Growth trends of *Crepis aspromontana* Brullo, Scelsi & Spamp. rosettes diameter. The red dashed line shows the average growth trends of the 20 samples analyzed.....**131**

Figure 2. Growth trends of *Crepis aspromontana* Brullo, Scelsi & Spamp. leaves number. The red dashed line shows the average growth trends of the 20 samples analyzed.....**132**

Figure 3. Germination trend of *Pimpinella anisoides* V.Brig. at three different temperatures: 15, 20 and 25 °C.....**132**

Figure 4. Seedling of *Pimpinella anisoides* V.Brig. With root, hypocotyle and cotyledons.....**133**

Figure 5. Medium length of three parts of the seedlings of *Pimpinella anisoides* V.Brig. Grown at three different temperatures (15, 20 and 25 °C). The grey lines indicate the standard deviation (σ) for each length mean.....**133**

CHAPTER 7

Figure 1. Experimental plan of the analysis on *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) on wild, cultivated and treated plants. Abbreviations: WFZ: Wild Frozen; WFR: Wild Fresh; CFZ: Cultivated Frozen; CFR: Cultivated Fresh; CFZs25: Cultivated Frozen stressed at 25 °C; CFRs25: Cultivated Fresh stressed at 25 °C; CFZs29: Cultivated Frozen stressed at 29 °C; CFRs29: Cultivated Fresh stressed at 29 °C.....**146**

Figure 2. Principal Component Analysis (PCA) of the Wild (WFR) (in green) and Cultivated (CFR) (in blue) samples of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) performed on 20 plant samples for each of the two theses by measuring the number of leaves and the diameter of the rosettes.....**151**

Figure 3a,b. Box plot of the variables “number of leaves” (a) and “rosettes diameter” (b) for the Cultivated Fresh (CFR) and Wild Fresh (WFR) groups of *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) plants. Outliers were not excluded. These graphs were performed using the software PAST version 4.15 [34].....**153**

Figure 4. Colour analysis on *Crepis aspromontana* Brullo, Scelsi & Spamp. (Asteraceae) to assess the colour differences of the different samples analysed: Cultivated Fresh (CFR), Wild Fresh (WFR), Cultivated Fresh stressed at 25 °C (CFRs25), Cultivated Fresh stressed at 29 °C (CFRs29).....**154**

List of tables

CHAPTER 2

Table 1. List of all the bibliographic source with the year of publication, the Calabrian provinces (according to the Figure 1) and the types of use documented.....**48**

Table 2. Comprehensive list of recorded families in alphabetical order, including the number of taxa in each family, the number of records, the FC index (family) and the FIV index (%)......**51**

Table 3. Most frequently used plant parts for ethnobotanical purposes in Calabria (Southern Italy) ranked by Plant Part Value (PPV) index.....**54**

Table 4. The most relevant taxa of ethnobotanical use in Calabria sorted according to Cultural Value (CV) index.....**57**

Table 5. List of the most used taxa within the medicinal category, ordered by number of records.....**68**

CHAPTER 4

Table 1. Number of interviews and informants by municipality within the Graecanic Area of Reggio Calabria (Southern Italy).....**84**

Table 2. List of the all the botanical families sorted in alphabetical order. For each family, the following information is provided: the number of interviews (out of a total of 632), the number of taxa (out of a total of 157), the Frequency of Citation (FC), and the Family Importance Value (FIV).....**84**

Table 3. Plant parts most used for ethnobotanical purposes within the Graecanic Area of Reggio Calabria (Southern Italy) ordered by Plant Part Value (PPV) index.....**88**

Table 4. The most relevant taxa of ethnobotanical use within the Graecanic Area of Reggio Calabria sorted according to the descending Cultural Value (CV) index.....	89
---	-----------

CHAPTER 7

Table 1. Measurements of rosettes diameter and number of leaves for Wild (WFR) and Cultivated (CWR) <i>Crepis aspromontana</i> Brullo, Scelsi & Spamp. (Asteraceae) plants.....	152
--	------------

Table 2. Mean chromatic values (L, a, b) of the upper and lower front of <i>Crepis aspromontana</i> Brullo, Scelsi & Spamp. (Asteraceae) leaves under different growing conditions and heat stress.....	155
--	------------

Table 3. Analysis of chemical parameters of different leaf samples of <i>Crepis aspromontana</i> Brullo, Scelsi & Spamp. (Asteraceae).....	157
---	------------

Table 4. Contents of chlorophyll a, chlorophyll b and β -carotene in <i>Crepis aspromontana</i> Brullo, Scelsi & Spamp. (Asteraceae) leaves analysed under different conditions.....	159
---	------------

Table 5. Mean contents of Total Polyphenols (TPC) (mg GAE/100 g), Total Flavonoids (TFC) (mg QE/100 g) and antioxidant activities (ABTS and DPPH) in different samples of fresh and frozen, cultivated and wild <i>Crepis aspromontana</i> Brullo, Scelsi & Spamp. (Asteraceae) leaves and heat stressed at 25 °C and 29 °C.....	161
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ADDITIONAL ARTICLES

APPENDIX 1. The Use of Plants for Building Purposes in the Popular Tradition

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The use of plants for building purposes in the popular tradition

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Abstract. Designing, building and operating a “green” building means that it considerably reduces the negative impacts and increase the positive ones on the climate and the natural environment. Thanks to green buildings it is possible to preserve natural resources and improve the quality of people’s life.

Ethnobotany is a science that describes the relationships between humans and plants, in particular by describing and analyzing the traditional uses that are made of them. In addition to the most common food, medicinal and religious uses, there are artisanal ones and in particular for building purposes.

The main goal of this work is to present a synthesis of the traditional uses of plants as a building material, useful for constructing ecologically sustainable buildings.

Among the most common species for this last purpose are two species belonging to the Poaceae family: *Ampelodesmos mauritanicus* (Mauritania grass) and *Arundo donax* (giant reed). These species have very strong fibres and a high potential in carbon sequestration too: therefore, in addition to representing a valid natural resource that can be re-evaluated in modern and more technological terms, they could guarantee a valid aid for the abatement of greenhouse gases.

Even ethnobotany, therefore, can actively contribute to determining environmental policy choices that guarantee an effective fight against climate change.

Keywords: Ethnobotany, Green Buildings, Green Districts, Post-Carbon City, Natural Products.

1. Introduction

1.1 For a Green Planet: from the past to the future

“Green” is a word that is used a lot nowadays to mean anything or action that is environmentally friendly [1]. The issue of “Green buildings” is very topical and has been dealt with in various scientific contributions about both their ecological retrofitting and valuation [2-5] and price market premium [6-12]. In order to be able to deal with these issues in a broader and more integrated way, the concept of “Green district” is increasingly affirming itself [13-17], as a generalization of the “Green Buildings” strategy, up to the creation of the “post-carbon city”, thanks to the consolidated naturalistic characterization of energy efficiency obtained with natural materials which come from plant species very useful for carbon sequestration [18-23]. Furthermore, a city can be considered sustainable if it is built with materials whose extraction and processing do not have a strong impact on the environment and whose ecological footprint can be easily mitigated [24].

For this purpose, there are numerous examples of building interventions carried out with panels of granulated cork: they are very useful to prevent mould, provide insulation from the cold and the warm (reducing at the same time energetic costs and CO₂ emissions) and act as agro-regulators [3,4,14,17,25]. Furthermore, it has been demonstrated that “healthier”, “greener” and with better energy performance buildings can be sold at higher prices [9-11; 26-27].

This model today followed is the same of the past, according to which peoples have always resorted to natural resources to meet their primary needs, including housing: all this knowledge is studied by Ethnobotany.

1.2 What is Ethnobotany?

Ethnobotany is the scientific study of the complex and dynamic relationships between peoples and the plant heritage that characterizes their natural environment [28]. People established a relationship with plants by looking first and foremost those with which to feed himself, cure himself of diseases, manufacture tools, tools for daily use in the fields and at home, create artifacts, toys and hobbies [29-34].

This work aims to review the traditional uses of plants as a building material, with a low environmental impact and the ability to reduce the concentration of CO₂ in the atmosphere, in order to demonstrate how it is possible to plan modern buildings using “green” materials.

2. Traditional uses of plants in buildings

There are many traditional uses of plants that have been found for different building purposes. Among them, we consider here two species belonging to the Poaceae family: *Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz (Mauritania grass) and *Arundo donax* L. (giant reed). *Ampelodesmos mauritanicus* is very common throughout the Mediterranean basin, from the Iberian Peninsula to Greece, including Northern Africa, growing from the coastal to the hilly areas (up to 1,200 m.a.s.l.) [35]. *Arundo donax* is a perennial grass growing spontaneously in temperate and tropical zones almost all over the world and can act as an invasive species [36].

There are very few building uses found for *A. mauritanicus*. Once dried, the stems of *A. mauritanicus* were mowed and cleaned of the leaves, cut to size and used to build domestic shutters [37]. Its stems were used until the 1950s to make roller shutters [38]. In general, its fibers were used in the construction of the roofs of the huts due to their durability, strong resistance to water and heat insulation [39].

The roofs of the rural houses were also made with the stems of *A. donax*: after cutting the stems to the appropriate extent and cleaned from the leaves, they were tied together with thin iron wire in order to obtain large mats. The stems were placed laterally on the skeleton of the roof which was made up of load-bearing wooden beams. A mixture of plaster was spread on the cane mats and finally the tiles were laid in an imbrice [39,40]. The barrel roofs of town houses were also made with the reeds [40]. In southern Iraq, “Mudhif”, an imposing building used as a meeting place for ceremonies and for the reception of foreign guests, were built with large and thick columns realized with *A. donax* stems folded up to arches. This building system creates a pre-stressing of the arches that are initially inserted into the soil at opposing angles [41,42]. In Calabria, after the earthquake of 1783, a reconstruction plan of the collapsed buildings was initiated by providing a load-bearing structure framed in wood and a sheath which, in the “poorer” solution, adopted above all in rural areas, consisted of two layers of *A. donax* covered by a plaster layer: this building system is still evident in some abandoned house [43]. In the XIX century, *A. donax* was introduced from the Mediterranean area into North America for roof thatching [44]. In Sicily, some ethnobotanical studies reported, through interviews carried out to the rural population, that the stems of *A. donax* were used for the construction of raftered ceilings: from the ridge of the roof, some beams were putted on the perimeter walls. Above them were applied bundles of reeds which previously had been well cleaned of the residues of the leaves and cut to size and, then, were arranged tying them together with string or wire. A layer of lime was spread over this roof and the tiles rested on it [45-49]. However, *A. donax* is native to western or southern Asia, cultivated for millennia in the Mediterranean regions and in others with similar climate, where it is now completely naturalized and sometimes invasive: this allowed it to out-compete native plant species, dramatically altering riparian habitats [50]. It is considered as one of the 100 world’s worst invasive alien species [51]. Its widespread use is due to its robustness which has also been demonstrated experimentally by various authors: in fact, the *A. donax* fiber has a very high tensile strength [52]. The production of panels made with particles obtained from the grinding of stems and rhizomes of *A. donax* with low thermal conductivity and excellent mechanical properties is demonstrated [53].

3. Conclusions

Numerous scientific evidences confirm that natural resources increasingly represent a precious source of useful resources for various purposes, including construction. Thanks to these works, with our review we can confirm: a) the technical efficiency of different materials of plant origin for the energy efficiency of buildings; b) the considerably reduced environmental impact they have; c) Ethnobotany can be considered as an useful tool for investigating the traditional uses of plants for building purposes. Therefore, we can again affirm that man must move more and more convinced towards a sustainable use of natural resources. Only in this way will we be able to obtain both significant energy savings in economic and ecological terms, and respect for nature that will allow us to slow down the ongoing process of climate change, which is already causing irreversible damage to our planet, including habitat and biodiversity erosion [54-58].

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APPENDIX 2. Contribution to the Ethnobotanical Knowledge of Serre Calabre (Southern Italy)

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Article

Contribution to the Ethnobotanical Knowledge of Serre Calabre (Southern Italy)

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Abstract: This work presents the results of an ethnobotanical research carried out in the territory of Serre Calabre, province of Vibo Valentia (Calabria, southern Italy). In this territory, the bond between the residents and the rural environment is still strong, because the small urban centers are placed in a predominantly agricultural and forestry environment still managed in a traditional way. The survey took place between January 2019 and July 2021. Data were collected through semi-structured interviews with locals. As many as 17 informants were interviewed and a total of 185 interviews were recorded. Plant specimens were collected under the indication of the informants and then deposited at the herbarium of the Mediterranean University of Reggio Calabria (REGGIO). The data were stored on a digital database and then statistically analyzed some synthetic indexes have also been calculated, such as Relative Frequency of Citation (RFC) and the Cultural Importance Index (CI). The investigation allowed to identify 84 taxa belonging to 39 different families, among which the most represented are Lamiaceae (23 interviews, 9 taxa), Asteraceae (22 interviews, 12 taxa). The identified taxa were prevalently cited for alimentary (46 interviews, 32 taxa) and healing (55, 27) uses. The results obtained show how the traditional knowledge about plants in the Serre Calabre area is still alive, however it is exclusive heritage of elderly people and often only in one or just a few informants. In fact, many practices are no longer in use and will not be transferred to the new generations.

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Keywords: Biodiversity, Calabria, Cultural Heritage, Ethnobotany, Medicinal Plants, Edible Plants, Plant Conservation

1. Introduction

Ethnobotany is the science that studies the relationships between human beings and the plant world [1]. It deals with collecting and processing all the information about the traditional uses of plants, often related to the culture of a specific geographical area or ethnic group [2-5]. These traditions still survive mainly thanks to oral testimonies [6], handed down from one generation to another, and deserve to be fully recognized as Intangible Cultural Heritage as enshrined in the 2003 UNESCO Paris Convention [7]. Ethnobotany, with its interdisciplinary nature, makes it possible to study the same aspect from different technical and scientific perspectives and to examine complex interactions between human and natural systems [8]. All ethnobotanical knowledge is limited to a small number of people and linked to the perception that the inhabitants of a community have of the environment in which they live: hence, it represents a heritage indispensable for the survival of human societies, but also constantly threatened by the rapid socio-economic changes that accompany the disappearance of rural societies [9]. In Italy, plant and cultural diversity is high, along with the presence of many minor ethnic-linguistic groups such as Frank-Provençals, Occitans, Ladins, Arbërësh and Graecanics [10]

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contributing to the great overall richness of the national ethnobotanical knowledge [11,12]. Moreover, the “Mediterranean diet”, including legumes, cereals, and various vegetables, in addition to fish and other foods, has also been declared by UNESCO as an “Intangible Cultural Heritage of Humanity” [13]. The health aspect of the Mediterranean diet applies also to dishes made with wild herbs that are often mixed with typical local products, in diverse recipes and preparations [12,14,15]. Calabria region can be considered an “ecological and social edge” because of the encounter of so many different people in the past (Greeks, Romans, Byzantines, Arabs, Normans, etc.). It is not by chance that the places with the greatest linguistic diversity are also those hosting the greatest biological diversity; consequently, there is also an association between linguistic loss and Traditional Environmental Knowledge (TEK) loss [16]. Moreover, from a socio-economic point of view, Calabria is a region where the rural communities persist, the culture of “subsistence” resists and some archaic customs have been maintained [17]. In recent years, there has been an increase in botanical studies [18,19] and in those ethnobotanical [9,20-23], although the province of Vibo Valentia (central-southern Calabria) is very little investigated [6]. Within this province, the territory of the Serre Calabre was selected as the study area of this research. This is an area where the bond between the residents and the rural environment is still strong and the small urban centers are placed in a predominantly agricultural and forestry environment, still managed in a traditional, extensive way.

The aim of this work is to document the plant lore in the territory of Serre Calabre (Southern Italy), to identify the most frequently used taxa and analyze them quantitatively, in order to contribute to the ethnobotanical knowledge of Southern Italy and guarantee the conservation of this important cultural heritage.

2. Materials and Methods

2.1. Study area

The Serre Calabre Massif is located in the southern Apennines, between Sila and Aspromonte. The territory begins at the Limina Pass and ends up at the isthmus of Marcellinara, the narrowest point of the Italian Peninsula, where 35 kilometers separate the Ionian Sea from the Tyrrhenian Sea. The surveys concerned various municipalities, all falling within the administrative province of Vibo Valentia: Vallelonga, Simbario, Brognaturo, Capistrano, Maierato and Nardo di Pace Vecchio. The altitude of the study area ranges between 350 and 900 m a.s.l. (Figure 1).

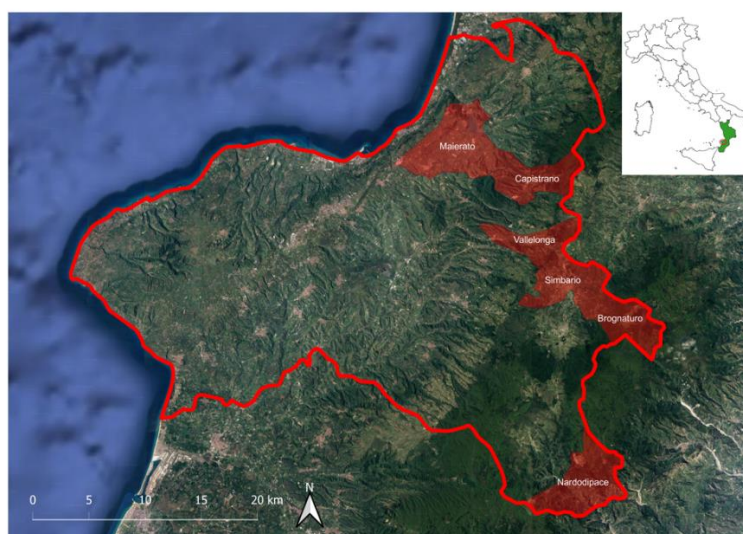


Figure 1. Calabria region in the Italian territory and a zoom of the province of Vibo Valentia in which the investigated municipalities (marked in red) fall (Google© 2022).

2.2. Ethnobotanical surveys and data collection

The investigation was carried out respecting the principles of the Code of Ethics of the International Society of Ethnobiology [24]. The survey took place between January 2019 and July 2021, for an amount of 185 interviews. The data were collected through semi-structured interviews with locals, according to Musarella *et al.* [6]. The information was collected through an emic approach, always considering the point of view of the respondents and therefore the possibility of an unforeseen answer. The interviews have been integrated with samples of plants collected under the indication of the informants, in order to identify the distinctive morphological characteristics of each taxon. As the vernacular name often corresponds to several taxa, similar in the morphological characteristics (at least in the vegetative stage in which they are utilized), it is important to correlate the collected information with the samples object of the interviews. Each interviewed provided information on many taxa and contributed to the compilation of various interviews, and on each taxon often provided information on different uses. Information has been collected on traditional uses of both spontaneous and cultivated plants. Spontaneous plants include those introduced by man for agricultural or forestry purposes. The collected samples were pressed into newspaper sheets and dried up, each with an appropriate label to produce herbarium samples. Subsequently, the samples were identified; for the identification and for the systematic ordering of the taxa, reference was made to the Flora of Italy [25]; the nomenclature of the plant taxa cited in the text is according to The World Flora Online website [26]. Several additional data, such as family, life forms, chorotype, and origin were collected for each taxon during the species list compilation. The life forms and the chorotypes are reported according to Pignatti [27]. To the 9 chorological types proposed by this author, a tenth has been added to bring together the exotic taxa: 10. Alien - Exotic or non-native taxa.

To facilitate further elaborations, based on their origin, the taxa have been grouped into 3 different groups: Native, Alien, and Cryptogenic, according to the Portal of the Flora of Italy [28].

The samples identified, reporting labels with the scientific name, the location, the date, and the habitat of collection, collector and determinator, were deposited at the herbarium of the Mediterranean University of Reggio Calabria (REGGIO, acronym according to [29]). The information collected with the interviews was stored on an electronic database that takes the structure of the interview sheet, using the software "Microsoft Office Access"®. The information was then analyzed and processed statistically with the software "Microsoft Office Excel"®.

The standard interview sheet used for the interviews is divided into 5 sections which are detailed below, according to [6]:

1. The first section regards the informant's personal details (name, surname, age, current and/or past job, location of the interview).
2. The second section regards the names (scientific, Italian common and vernacular) of the plant, the family to which it belongs, the reference number of the herbarium sample and the photos taken, moreover location and period of collection. The vernacular name was provided by the informants during the interviews. The Italian common name was obtained from the Portal of the Flora of Italy [28], while the scientific one from The World Flora Online website [26]: both were found after the interviews.
3. The third section regards the uses and purposes specified in relation to the type of use. Category of use is defined as one of the following general typologies of use: Agro-pastoral, Alimentary, Aromatic, Cosmetic, Domestic, Forage, Handicraft, Ludic, Magical, Medicinal, Ornamental, Religious, Veterinary, Other Uses. It also highlights the used part of the plant (leaves, flowers, etc.), the method of use or administration (e.g.,

infusion, decoction), the techniques and timing of conservation, as well as the origin of the information on the use of the plant, i.e., if it derived from a direct use made by the informants in the present or in the past or learned from other people. This section also deals with the frequency of use of the plant as usual (one or more than one times a week), recurring (one or more than one times a month), casual (few times a year) and rarely (one time a year or more rarely).

4. The fourth section is filled in only if the harvested plant is spontaneous, indicating the habitat in which it grows, its frequency and whether the harvest is for personal use or for business.
5. The fifth section is filled in only if the plant is cultivated, indicating the type of use (personal or for business) and the cultivation technique.

The most anthropological part of the ethnobotanical study also includes eventual place names with botanical references (phytotoponyms or plant place names), the occurrence of plants in myths, legends, rituals, songs, idioms, various cultural practices, etc.

One important aspect of ethnobotanical analysis is the use of quantitative techniques to highlight the importance of traditional uses in the study area. In the present study the following indexes have been calculated:

Relative Frequency of Citation (RFC): it represents how many times each taxon is mentioned by informants. The formula follows the system described by [30]:

$$\frac{FC}{N} \quad (1)$$

where FC is the number of informants who cited a certain taxon and N is the total number of the informants of this study. RFC ranges from zero (when nobody attributes a use for that taxon), to one (when all the informants use that taxon) ($0 < RFC \leq 1$)

Family Importance Value (FIV): it represents how many times each botanical family is cited by informants, and it is calculated as follows [31]:

$$\frac{FC (family)}{N} \times 100 \quad (2)$$

where FC (family) is the number of informants mentioning the family and N is the total number of the informants that took part in this study.

Cultural Importance Index (CI): it is calculated by using the formula suggested in [30]:

$$\frac{UR}{N} \quad (3)$$

where UR is the total number of use citations for each taxon (each interviewed could have done more than one interview for each taxon) and N is the total number of informants.

3. Results and Discussion

Seventeen informants were interviewed, 8 men and 9 women, ranging in between 42 and 98 years of age; 7 of them are aged between 40-65 and 10 are aged between 66-99. Most of them are retired and housewives. Elderly women are the main keepers of traditional knowledge in the domain of local food and medicinal plants, while men that mostly worked as farmers and forestry workmen, play an important role in gathering plants for agro-pastoral and handicraft uses. A total of 185 interviews were recorded.

The surveys led to the identification of 84 plant taxa belonging to 39 different families. The complete list with Family, Taxon, Status, Local Vernacular Name, Life forms, Part used, Category of Use, Purpose, FC, RFC, UR, and CI can be found in the Table S1.

Regarding the reported families, were highlighted the most cited (i.e., those with a higher number of interviews) and the most represented, with a higher number of taxa (Table 1).

The most cited and represented families are Lamiaceae (23 interviews, 9 taxa), Asteraceae (22 interviews, 12 taxa), Fabaceae (13 interviews, 7 taxa) and Rosaceae (12 interviews, 6 taxa). The other families recorded less than 10 interviews and less than 4 taxa (Table 1).

Table 1. Botanical families reported in alphabetical order with the number of interviews (over a total of 185 interviews) and number of taxa (over a total of 84 taxa) for each.

Family	Interviews	Taxa
Adoxaceae	9	2
Anacardiaceae	2	1
Apiaceae	9	2
Apocynaceae	1	1
Araliaceae	2	1
Asparagaceae	2	2
Asteraceae	22	12
Boraginaceae	5	3
Brassicaceae	1	1
Cactaceae	1	1
Caprifoliaceae	2	1
Caryophyllaceae	1	1
Convolvulaceae	3	2
Crassulaceae	7	3
Dennstaedtiaceae	1	1
Dryopteridaceae	2	1
Equisetaceae	4	1
Ericaceae	8	2
Euphorbiaceae	1	1
Fabaceae	13	7
Fagaceae	3	1
Hypericaceae	2	1
Juglandaceae	2	1
Juncaceae	2	1
Lamiaceae	23	9
Lauraceae	4	1
Lythraceae	2	1
Malvaceae	6	1
Myrtaceae	3	1
Oleaceae	1	1
Papaveraceae	2	2
Plantaginaceae	6	3
Poaceae	9	3
Ranunculaceae	2	1
Rosaceae	12	6
Scrophulariaceae	1	1
Thymelaeaceae	1	1
Urticaceae	6	2
Verbenaceae	2	1

The most common botanical family, based on the calculated FIV index is Asteraceae with 52.9%, followed by Lamiaceae with 35.3% (Table 2).

Table 2. Botanical families reported with the Family Importance Value (FIV) index that represents how many times each botanical family is cited by the informants and FC (Family) is the number of informants mentioning the family.

Family	FC (Family)	FIV
Asteraceae	9	52.9
Lamiaceae	6	35.3
Adoxaceae	5	29.4
Fabaceae	5	29.4
Apiaceae	4	23.5
Ericaceae	4	23.5
Malvaceae	4	23.5
Poaceae	4	23.5
Rosaceae	4	23.5
Boraginaceae	3	17.6
Crassulaceae	3	17.6
Urticaceae	3	17.6
Anacardiaceae	2	11.8
Asparagaceae	2	11.8
Convolvulaceae	2	11.8
Hypericaceae	2	11.8
Myrtaceae	2	11.8
Oleaceae	2	11.8
Plantaginaceae	2	11.8
Ranunculaceae	2	11.8
Apocynaceae	1	5.9
Araliaceae	1	5.9
Brassicaceae	1	5.9
Cactaceae	1	5.9
Caprifoliaceae	1	5.9
Caryophyllaceae	1	5.9
Dennstaedtiaceae	1	5.9
Dryopteridaceae	1	5.9
Equisetaceae	1	5.9
Euphorbiaceae	1	5.9
Fagaceae	1	5.9
Juglandaceae	1	5.9
Juncaceae	1	5.9
Lauraceae	1	5.9
Lythraceae	1	5.9
Papaveraceae	1	5.9
Scrophulariaceae	1	5.9
Thymelaeaceae	1	5.9
Verbenaceae	1	5.9

Regarding the taxa surveyed, the corresponding life form spectrum (Figure 2) shows the prevalence of Hemicryptophytes (32.5%), followed by Phanerophytes (21.7%).

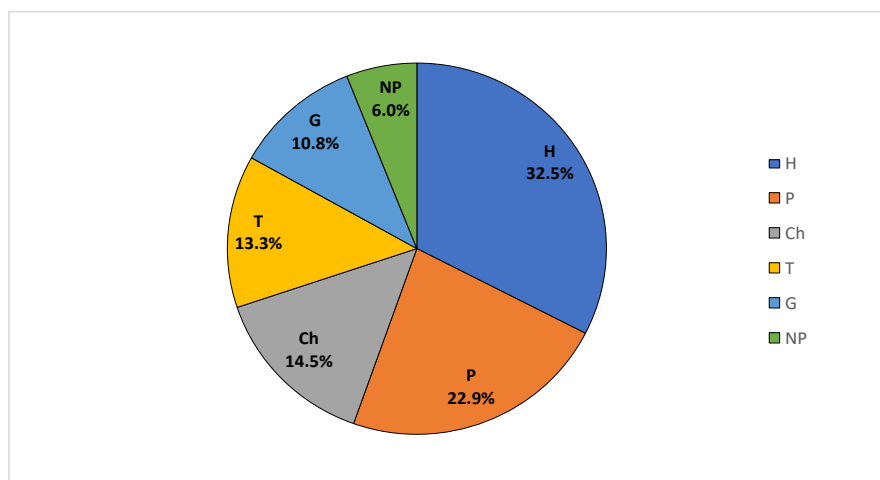


Figure 2. Life form spectrum of the taxa recorded from the interviews. H- Hemicryptophytes; P- Pharenophytes; Ch- Chamaephytes; T- Therophytes; G- Geophytes; NP- Nanopharenophytes.

The chorological spectrum (Figure 3) shows that the Mediterranean plants are the most represented, on an average, the Mediterranean taxa are about the half of the recorded taxa. In particular, the Stenomediterranean chorotype, represent 28.9% of the total. Also, Eurasian species are highly represented (27.7%) and are more abundant than Euro-Mediterranean ones: this is justified by the fact that the study area has a wetter microclimate in which there are cold, wet winters and hot but not dry summers.

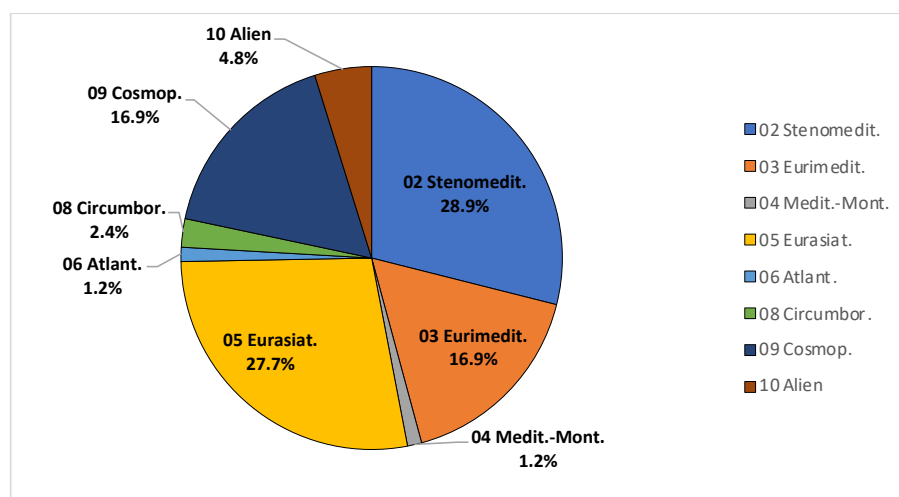


Figure 3. Chorological spectrum of the taxa recorded from the interviews. 02 Stenomediterranean - Taxa distributed along the coasts of the Mediterranean; 03 Eurimediterranean - Taxa distributed along the coasts of the Mediterranean but with ample inland irradiations; 04 Mediterranean-Mountain - Taxa of the circum-Mediterranean mountains; 05 Eurasiatic - Eurasian taxa; 06 Atlantic - Taxa found on the Atlantic coasts of Europe; 08 Circumboreal - Taxa found in the cold and temperate-cold areas of Eurasia and North America; 09 Cosmopolitan - Taxa widespread in almost all areas of the world and cultivated; 10 Alien - Exotic or non-native taxa.

Concerning the origin, most of the taxa (92.4%) are native, while the alien ones are just 6.5%. In addition to these ones, we identified a very small percentage of cryptogenic (1.1%).

Plants of ethnobotanical interest were collected in 8 different habitats (Figure 4). The following graph shows in which habitat the taxa of ethnobotanical interest are mostly found during the interviews. The taxa of the uncultivated lands, meaning ruderal taxa from marginal areas, courtyards, and roadsides, formed the largest portion (39.1%); in fact, eighty-one out of the 84 taxa grow wild and only three are cultivated, followed by the typical taxa of the Mediterranean scrub (19.0%) and the taxa growing in cultivated and pastures (10.6% each).

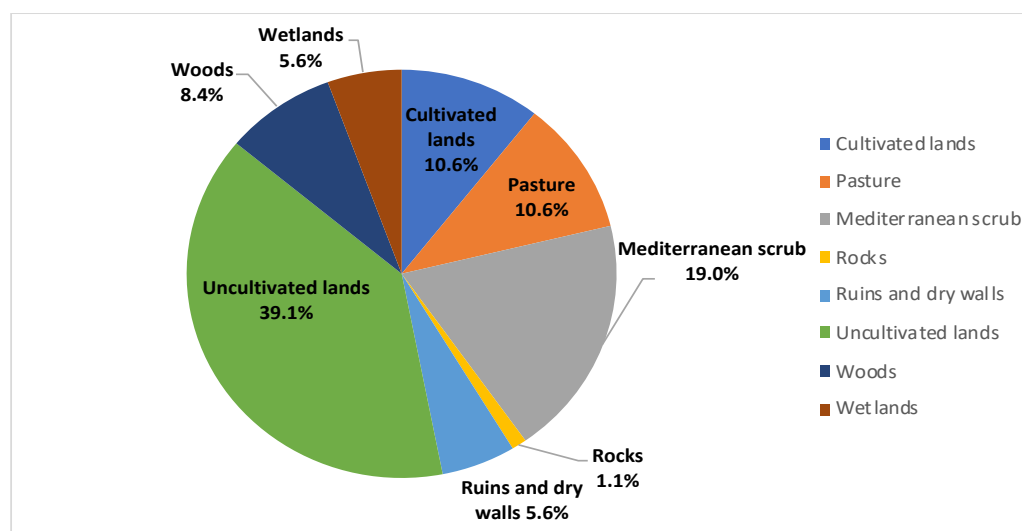


Figure 4. Habitats of the taxa recorded from the interviews.

Regarding the used parts of the plants, in general categories of use, the most common parts were leaves (36.4%), followed by flowers (25.0%) (Figure 5).

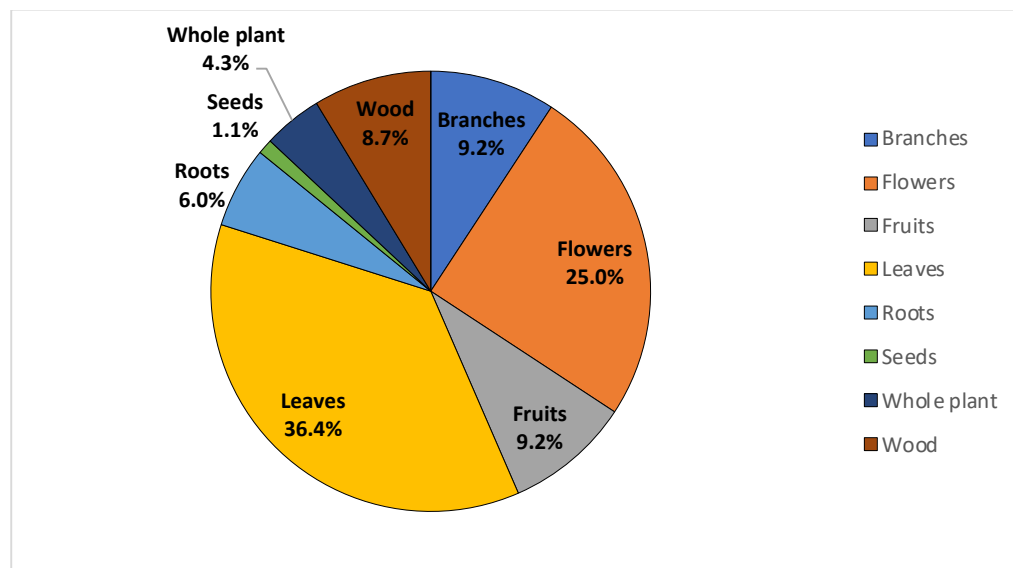


Figure 5. Used part(s) of the plants.

The gathering of wild greens is seasonal and therefore the frequency of use of the taxa is reduced to a few times a year (casual e.g., few times a year). Among the identified taxa, the prevalent uses are the alimentary one (46 interviews, 32 taxa), the medicinal one (55, 27); also, the religious (13, 12) and the aromatic ones (15, 8) proved to be remarkably frequent, while the other uses play a minor role (Figure 6). With the term “Other uses” we

intend the ones that do not fall within the general “Category of use” like repellent use and tobacco substitute use.

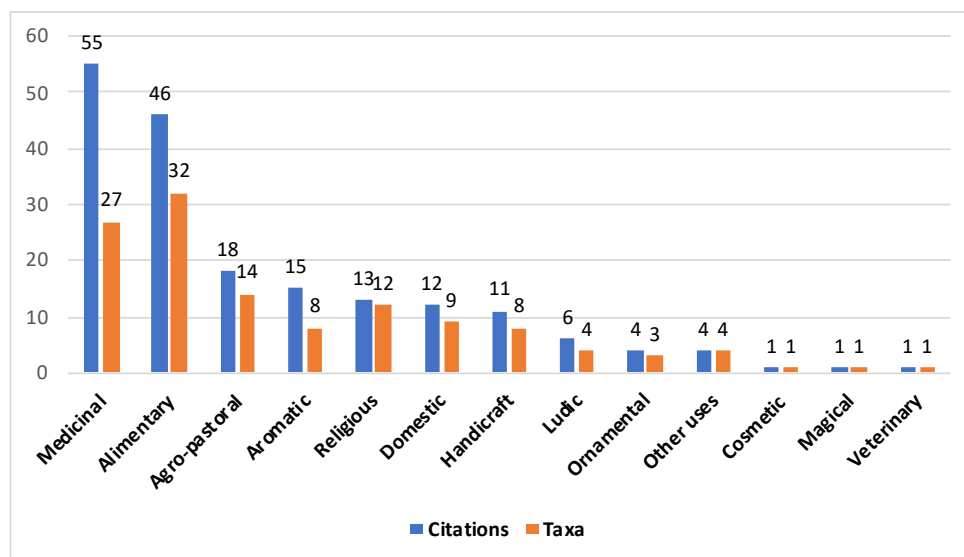


Figure 6. Number of citations and taxa for each category of use.

The knowledge on traditional uses of plants was heterogeneous and only 6 taxa were mentioned by three or more informants and only 13 were mentioned by 2 informants (Table 3). This result reflects the unevenness, hence the high risk of disappearance, of specific traditional knowledge in the whole investigated area.

Table 3. The knowledge distribution on traditional uses of plants shows the number of taxa known by one or more informants.

Taxa	Informants mentioning the taxa
<i>Malva sylvestris</i> L.	4
<i>Sambucus nigra</i> L.	4
<i>Ampelodesmos mauritanicus</i> (Poir.) T. Durand & Schinz	3
<i>Erica arborea</i> L.	3
<i>Matricaria chamomilla</i> L.	3
<i>Spartium junceum</i> L.	3
<i>Anethum foeniculum</i> L.	2
<i>Calystegia silvatica</i> Griseb.	2
<i>Clematis vitalba</i> L.	2
<i>Daucus carota</i> L.	2
<i>Genista monspessulana</i> (L.) L.A.S.Johnson	2
<i>Hypericum perforatum</i> L.	2
<i>Myrtus communis</i> L.	2
<i>Picris hieracioides</i> L.	2
<i>Pistacia lentiscus</i> L.	2
<i>Prunus spinosa</i> L.	2

<i>Sedum cepaea</i> L.	2
<i>Thymus longicaulis</i> C.Presl	2
<i>Urtica dioica</i> L.	2

The most mentioned taxa were *Malva sylvestris* L. and *Sambucus nigra* L. (4 informants each), as shown in the Table 5 (Basic value FC), that reports the results of quantitative analysis for the 20 most relevant and useful taxa in the area, as cited by the informants. While FC represents the number of informants mentioning the taxon, UR considers the number of interviews or citations. Indeed, rating UR, besides *M. sylvestris* and *S. nigra*, also *Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz, *Erica arborea* L. and *Matricaria chamomilla* L. had the highest number of interviews. *Malva sylvestris* was cited 6 times for the same medicinal use that will be discussed later. The taxa with a higher number of completely different uses (U) are: *Urtica dioica* L. (4), *A. mauritanicus* (4) [32], *S. nigra* (4), *Lavandula angustifolia* Mill. (3), *Laurus nobilis* L. (3), *Robinia pseudoacacia* L. (3), *Myrtus communis* L. (3) and *Spartium junceum* L. (3) (Table 4).

Table 4. Most recurrent taxa sorted by Relative Frequency of Citation (RFC).

Taxa	Basic value				Indices	
	UR	U	NC	FC	CI	RFC
<i>Sambucus nigra</i> L.	7	4	5	4	0.41	0.24
<i>Malva sylvestris</i> L.	6	1	4	4	0.35	0.24
<i>Erica arborea</i> L.	7	2	6	3	0.41	0.18
<i>Ampelodesmos mauritanicus</i> (Poir.) T. Durand & Schinz	6	4	5	3	0.35	0.18
<i>Matricaria chamomilla</i> L.	6	2	4	3	0.35	0.18
<i>Spartium junceum</i> L.	3	3	3	3	0.18	0.18
<i>Urtica dioica</i> L.	5	4	4	2	0.29	0.12
<i>Anethum foeniculum</i> L.	5	2	5	2	0.29	0.12
<i>Daucus carota</i> L.	4	2	4	2	0.24	0.12
<i>Lavandula angustifolia</i> Mill.	5	3	5	1	0.29	0.06
<i>Equisetum telmateia</i> Ehrh.	4	2	3	1	0.24	0.06
<i>Umbilicus rupestris</i> (Salisb.) Dandy	4	1	3	1	0.24	0.06
<i>Laurus nobilis</i> L.	4	3	4	1	0.24	0.06
<i>Robinia pseudoacacia</i> L.	3	3	3	1	0.18	0.06
<i>Hypochaeris radicata</i> L.	3	1	3	1	0.18	0.06
<i>Mentha pulegium</i> L.	3	1	3	1	0.18	0.06
<i>Plantago major</i> L.	3	2	3	1	0.18	0.06
<i>Quercus ilex</i> L.	3	2	3	1	0.18	0.06
<i>Rosa sempervirens</i> L.	3	2	3	1	0.18	0.06
<i>Salvia officinalis</i> L.	3	2	3	1	0.18	0.06

¹ Basic values: UR = Number of interviews ('citations'); U = Number of different categories of use. NC = Number of different purposes; FC = Number of informants mentioning the taxon. Indexes: CI = Cultural Importance Index.

Highest RFC was obtained for *S. nigra* and *M. sylvestris* (RFC=0.24) that result to be the most used taxa; also, *S. nigra*, together with *E. arborea*, are the most culturally significant (CI=0.41). *Erica arborea* is also the taxon with the highest number of completely different uses, considering the purposes of each use (NC=6). When considering the purposes of each use, the medicinal category is the one that have the greatest number of different purposes (24), followed by the handicraft and aromatic ones (10) (Figure 7).

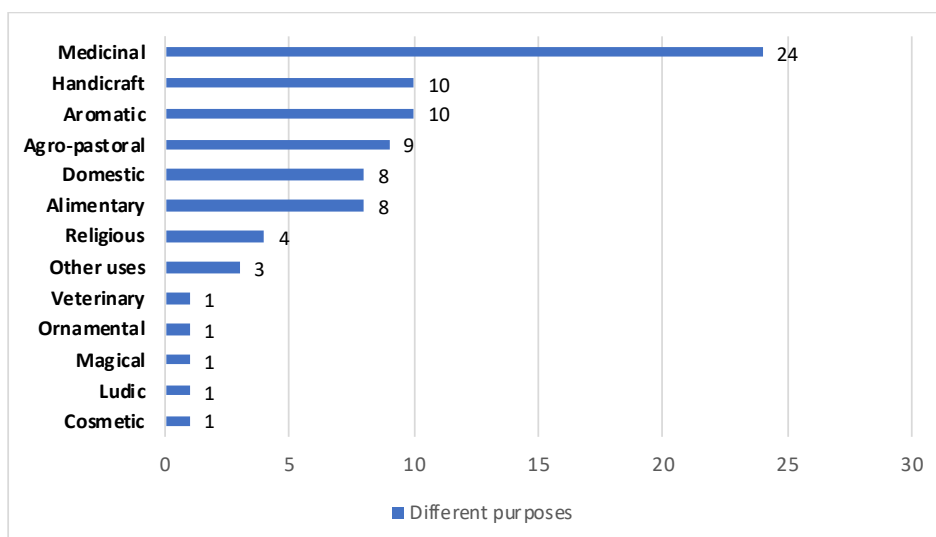


Figure 7. Number of purposes for each category of use.

3.1. Medicinal plants

Within the medicinal category, among the 27 taxa identified, the most cited are *M. sylvestris*, *M. chamomilla*, *S. nigra* and *Umbilicus rupestris* (Salisb.) Dandy (Figure 8). Seven taxa were cited to treat pain and 6 were cited as anti-inflammatory, purifying and calming purposes: most of them were boiled in infusion or decoction (Figure 9). The flowers of *M. chamomilla* were the most used to treat general pain, in infusion with the leaves of *L. nobilis* to treat abdominal ailments; this practice survives and is still used today. The roots of *M. sylvestris*, with dry figs added to sweeten, were used in decoction with anti-inflammatory purposes both for gastric problems and inflammation of the teeth and mouth; regarding this use, it was found a popular proverb that recites: “*eppe la bronchita e mi guarivi cu li malohj guggghjuti, mi dozzeru li denti e mi passaru cu la malohjia; quandu mi vene la cimorra mi pigghju nu tazzoni de maluohj; chi borrhissi de chju?*” (English version: “I had bronchitis, and I was cured with cooked mallow, my teeth ached, and I was cured with mallow, when I have a cold, I drink a cup of mallow; what else do you want?”).

Dry flowers of *S. nigra* were infused and applied to soothe red eyes or in case of conjunctivitis and in decoction to purify the kidneys; these uses, and plants are commonly shared in the traditional medicine of Calabria and Sicily (see [9,33] for Calabria; [34-35] for Sicily). Fresh leaves of *U. rupestris* were used to heal cyst, pimples, calluses and the locally so-called “giraditu”. i.e., an inflammation of the fingers; the same use is also reported for the Reventino Massif area (Central Calabria) [9]. Another taxon whose fresh leaves are used for the same topical purpose, is *Cotyledon orbiculata* L.: the leaves are heated and peeled, i.e., deprived of the superficial epidermis and used to heal cyst. Until today, this use was unknown for Calabria: in fact, no other information was found in regional literature; the same use was found in the work of Camangi & Tomei [36] that investigated the province of Livorno (Tuscany, Northern Italy). Among the 55 interviews, 35 reported boiling as preparation method; on the contrary, according to Hadjichambis et al. [37], the species perceived as healthy were consumed raw more often than cooked. The

same plant taxa might be consumed cooked in one season and raw in another season (e.g., tender shoots vs. old leaves) [12].

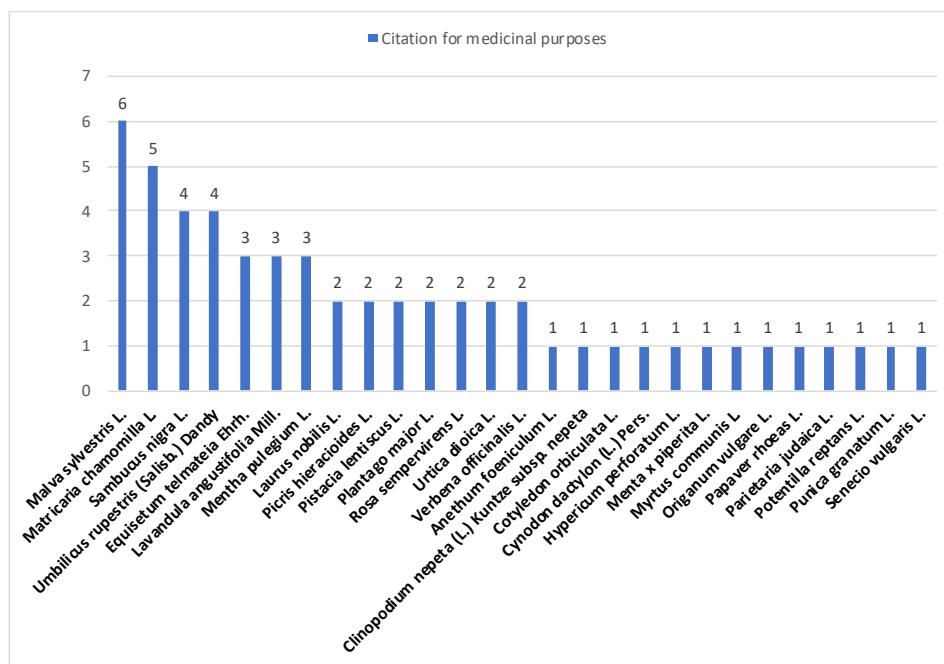


Figure 8. Most cited taxa for medicinal purposes.

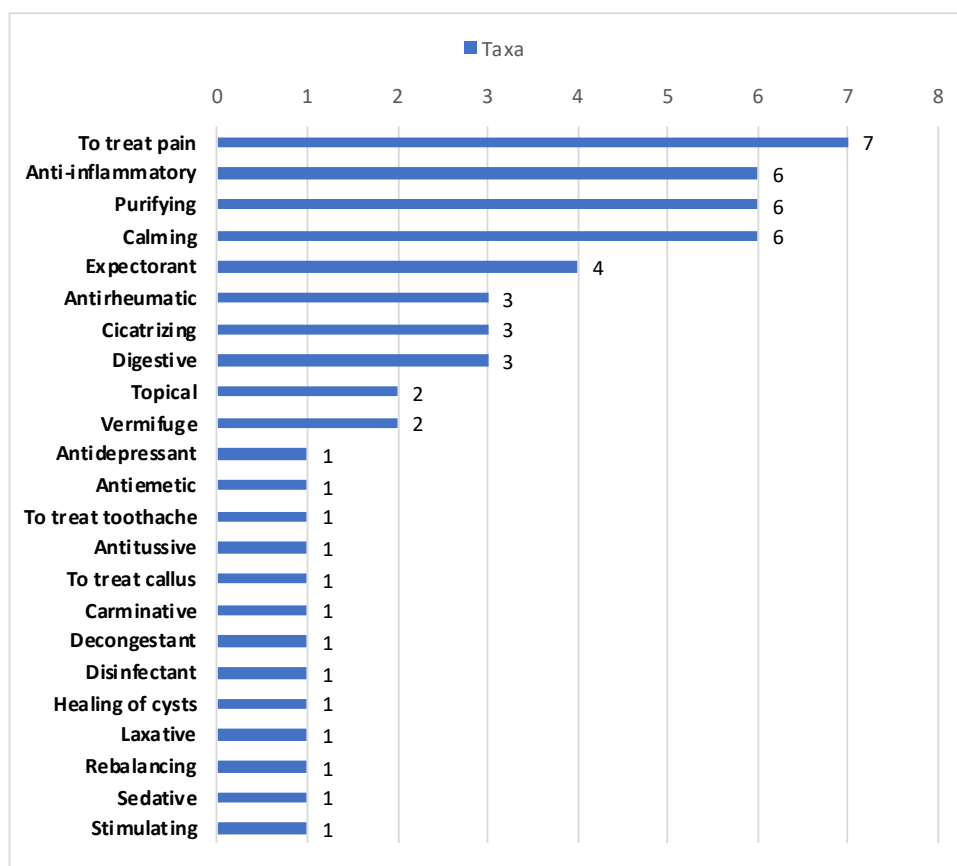


Figure 9. Number of medicinal taxa used to treat various ailments.

3.2. Alimentary plants

Among the alimentary use, most of the informants use the taxa for side dishes and rural snacks (Figure 10).

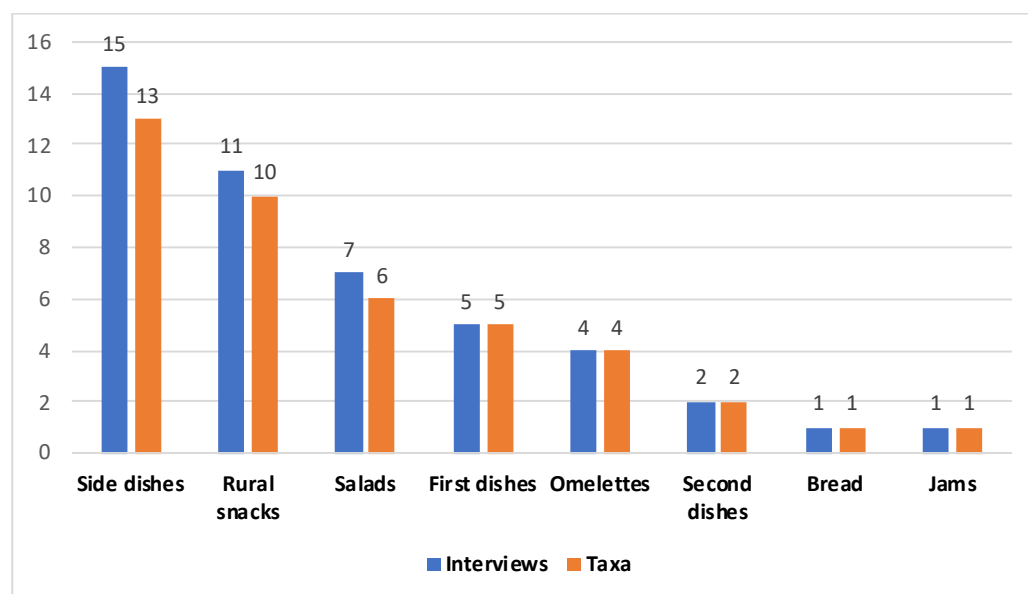


Figure 10. Number of interviews and taxa for each purpose of the alimentary category of use.

The most mentioned alimentary taxa were: *Borago officinalis* L., *Daucus carota* L., *Galactites tomentosus* Moench, *Hypochaeris radicata* L. (3 mentions each). The leaves that, usually, are harvested in spring and consumed at the juvenile stage, are mostly boiled, or consumed raw, alone or in association with other vegetables, as side dishes. *Borago officinalis* is according to Ghirardini et al. [38] the most quoted taxa in both the Southern and the Northern Italian sites. Also, Tavilla et al. [39] report numerous food uses of *B. officinalis*. Moreover, in the present study were also reported alimentary uses for *Asparagus acutifolius* L. and *Cichorium intybus* L., that are the most quoted wild food taxa in Southern Italy along with *Anethum foeniculum* L. (= *Foeniculum vulgare* Mill. subsp. *vulgare*), *Reichardia picroides* (L.) Roth and *Sonchus* spp., according to Ghirardini et al. [38]. Regarding our study, *A. foeniculum* appears only in the aromatic category of use, in which it is the most cited taxon. *Anethum foeniculum* was cited between the most common 16 taxa in Italy concerning the aromatic use, due to its phytochemical profile (the ability to stimulate the excretion of digestive enzymes, carminative properties) [40]. *Sonchus asper* (L.) Hill and *Crepis biennis* L. are both referred with the same vernacular name as “Jùncu”, and were cooked the same way (boiled) as well as *C. intybus*, *H. radicata*, and *Hypochaeris laevigata* L. Many taxa of the Asteraceae family are referred to by the vernacular name “Cicuori” as well as “Jùncu”; all of them are more or less bitter herbs, consumed as cooked vegetables, collected at the stage of basal rosette, and often found in different types of agricultural and marginal environments. *Cichorium intybus*, *S. asper* and *Picris hieracioides* L. are widely used all over Calabria as edible but also as medicinal plants according to Marrelli et al. [41], who studied the phytochemical content of these taxa. In the present work, *P. hieracioides*, was mentioned only in the medicinal category of use: the leaves reduced to mush were applied to wounds to cicatrize. Also, *H. radicata* and *H. laevigata* are known to be used traditionally both in the alimentary and in the medicinal category of use in Southern Italy [9,12,42]; their phytochemical content and bioactivity, together with *Hyoseris radiata* L., and *Hyoseris lucida* subsp. *taurina* (Pamp.) Peruzzi & Vangelisti, was studied and compared to fresh plant materials and residual blanching water by Sicari et al. [43]. The results of this study demonstrated the healthy effect of these wild plants, and that the blanching water should be repurposed in food preparation. In fact, because it is a

good source of bioactive compounds, its consumption should be recommended to increase the absorption of micronutrients.

Among the 46 interviews, 24 reported cooking (boiled) as preparation method. In a study carried out in seven countries over the Mediterranean area [37], the predominant preparation method for leafy vegetables greens is cooking (54%) [10]. Ten taxa have been pointed out as “rural snacks”, probably because most of the informants worked closely to the natural environment and picked up the fruits directly from the plant, for example *Arbutus unedo* L., *Prunus spinosa* L. and *Rubus ulmifolius* Schott. The same use has also been found in the Peloritani Mounts (NE Sicily) [39]. Many vegetable food products contain a high concentration of polyphenols (e.g., [44,45]), but also flavonoids (e.g., [46,47]) and omega3 fatty acids [12,48]. It is the case of *A. foeniculum*, *U. dioica*, *B. officinalis*, *H. radicata*, *A. acutifolius*.

According to Jordana [49], to be traditional, a product must be linked to a territory, and it must also be part of a set of traditions, which will necessarily ensure its continuity over time. Many wild edible plants reported in this study can be defined as food–medicine due to the presence of different classes of natural products (e.g., [50–52]) or active compounds (e.g., [53–55]). Since several of these molecules have antioxidant properties and are contained in large quantities in vegetables, the role of these plants in the diet has been reevaluated [12]. Moreover, wild food species contribute to local food systems and to the local gastronomy, playing an important role in the economy of small communities [40].

3.3. Religious plants

The informants have reported 10 taxa as being used for various religious rituals, like to decorate the villages’ streets during religious processions like *Anchusella cretica* (Mill.) Bigazzi, E. Nardi & Selvi, or like torches (*Verbascum thapsus* L.) or small candle floating on water (*Pseudodictamnus mediterraneus* Salmaki & Siadati) (Figure 11), especially during the Easter period. *Hypericum perforatum* L. was reported for a specific religious use: on June 24, St. John’s Day, it was customary to collect it as a gift to friends in order to establish or reinforce fraternal bonds.



Figure 11. *Pseudodictamnus mediterraneus* Salmaki & Siadati. The calyx of flowers was used as small candle floating on water.

3.4. Agro-pastoral plants

Fourteen interviews contained information concerning agro-pastoral use: among them, there are 7 different purposes. A very peculiar use concerns *Euphorbia lathyris* L. (Figure 12): in the past it was a very common plant species, used for several purposes in southern Italy and Sicily [56]. In the territory of the Serre Calabre, *E. lathyris* is still used as a mole (“surici uòrvu” = blind rat) repellent by planting it in their burrows: it was noted that during seeds production, moles leave them.



Figure 12. *Euphorbia lathyris* L. with fruits used as mole repellent.

Another interesting purpose among agro-pastoral uses regards *Daphne gnidium* L.: the roots were used in the past for the illegal fishing of eels (“angide”). Similar uses were found in numerous papers regarding Sardinia, Sicily, and other Italian regions [57-60].

A typical agro-pastoral use is to make ropes, ties, and cattle collars with the stems of *A. mauritanicus* (Figures 13 a,b); the same use has been found in several works concerning the southern Italian area [39,61-63].



Figure 13. (a) Rope and (b) tie for *Vitis vinifera* L. made with stems of *Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz.

3.5. Most culturally significant taxa

3.5.1. *Sambucus nigra* L.

As already illustrated, in addition of being the most used taxon, the elder is also the most culturally significant: indeed, the informants provided 4 different categories of use for it: medicinal, aromatic, domestic and handicraft. The medicinal category of use was cited 4 times and as already described in the previous paragraphs, it concerned the flowers, also used to flavor the bread in a typical preparation of the area, called "Pitta de fiuri" or "Pitta china". The bread is filled with hot pepper, anchovies, olives, and onion. The fruits were used to extract ink and to color the homemade soap.

3.5.2. *Erica arborea* L.

This taxon registered the highest number of different purposes (6) within two different categories of use: domestic and handicraft. The roots, collected and cleaned, are still used today to make jewelry and pipes by local artisans. During the study it emerged that this is the only taxon collected for commercial purposes and not only for personal and family uses. The artisanal creation of pipes with the briar root of *E. arborea* is a traditional peculiarity of Serre Calabre area, which over time has become a real commercial activity aimed at a market niche that refers to fans of this way of smoking. To make pipes the briar is boiled and left aside for 20 years and then it is carved. The tree heath produces lignotubers that are highly valued for making smoking pipes also in the Peloritani Mountains of northeastern Sicily as reported by La Mantia *et al.* [64]. The wood is also used to make traditional musical instruments. With this aim, it is dried for 10 years and then carved to make the melody reeds of the bagpipe known in Calabria as "zampogna". A very similar use was found in [39] where *E. arborea* wood is used to make the different parts of the "ciaramedda" (bagpipe). Regarding this taxon, it was found a popular proverb that recites: "Quandu hjiure la bruvera, arrivau la vera primavera" (english version: "When the tree heat blooms, the true spring has arrived"). Moreover, the branches were used to make kitchen tools and like a rudimentary broom to clean the outside yard and as firewood for the oven to prepare homemade bread together with

Fraxinus ornus L. (vernacular name: *mijriu*), *Pistacia lentiscus* L. (*scinu*) and *Quercus ilex* L. (*ilici*) A popular proverb about the firewood use was reported by informants: “*Io su lu scinu e fazzu lu luci finu, io su lu mijriu e cchiu finu lu fazzu io, io su l’ilici gravu pe tridici e ajrumu pe quattuardici*” (English version: I am the mastic tree and I make the fire weak, I am the manna tree and I make it weakest, I am the evergreen oak and I weigh for thirteen and I heat for fourteen”).

4. Conclusions

The results obtained show how the traditional knowledge about plants in the Serre Calabre area is still alive, both in terms of uses and in terms of vernacular names, rhymes, proverbs, and rituals. However, it is exclusive heritage of elderly people who have grown up following the rhythm of nature and in close contact with their land, where they have learned to take advantage of all the resources it can offer. They saw nature not only as the main survival source, but also as a stimulus for creativity, from simple games for children up to handcrafted works. This information is often reported only by one or few informants, as suggested by the large number of plants cited by fewer than 3 informants. Moreover, many practices are no longer in use and survive only as memories or in the form of family lexicon and small daily habits. The change in lifestyle has meant that, even in small countries and rural environments such as those studied, this information is no longer transmitted to the new generations, and the people interviewed are not aware of the huge patrimony of which they are the last holders. Concerning the traditional phytotherapeutic remedies, they were more popular and widespread in the past when medicines were not easily available. On the contrary, in addition to being the most cited category of use, the alimentary use is still popular, with several edible wild plants used both as delicacies and as the ingredients of local specialties.

This work involved a few municipalities in the study area: deepening the work could be the beginning of a larger research in this territory which is still very little investigated from this point of view. In agreement with Gracia et al. [65], the diversification of production using such resources could be a socio-economically sustainable activity in areas with non-optimal farming conditions by contributing to population stabilization in rural areas.

In conclusion, this study has the purpose to preserve this knowledge as a cultural heritage that characterizes the identity of the territory, and make sure it will not be lost; highlighting, where possible, taxa of value and suggesting scientific insights for little-known taxa in relation to their use.

Supplementary Materials: The following are available online at <https://www.scipublications.com/Supplementary-Materials/389/tables1.xlsx>, Table S1: List of the taxa of ethnobotanical interest recorded in the Serre Calabre territory. Status: C (cultivated), W (wild). FC: number of informants who cited a certain taxon; RFC: Relative Frequency of Citation; UR: total number of use citations for each taxon; CI: Cultural Importance Index.

Author Contributions: Conceptualization, C.M.M. and G.S.; methodology, C.M.M. and G.S.; validation, C.M.M. and G.S.; formal analysis, C.G., M.P. and V.L.A.L.; investigation, C.G., C.M.M., V.L.A.L. and G.S.; resources, C.G., G.S. and C.M.M.; data curation, C.G., G.S., M.P., V.L.A.L. and C.M.M.; writing—original draft preparation, C.G., G.S., M.P., V.L.A.L. and C.M.M.; writing—review and editing, C.G., G.S., M.P., V.L.A.L. and C.M.M.; visualization, C.G., M.P. and C.M.M.; supervision, G.S. and C.M.M.; project administration, G.S. and C.M.M. All authors have read and agreed to the published version of the manuscript.

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

Human and animal rights: This research involved human participants who gave a verbal informed consent prior to the interview.

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APPENDIX 3. Ethnobotanical studies on the Tyrrhenian side of the Aspromonte Massif (Calabria, Southern Italy)

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ABSTRACT

A great deal of ethnobotanical knowledge, passed down from generation to generation by oral tradition, is still preserved in the Mediterranean basin. Over the years, efforts have been made to collect this information to avoid losing this heritage. This work is a contribution towards the ethnobotanical knowledge of Calabria (southern Italy) through a survey on the Tyrrhenian side of the Aspromonte Massif in the metropolitan city of Reggio Calabria, an area that has been little studied from the ethnobotanical point of view. For this purpose, several semi-structured interviews were conducted with informants on the current and past use of spontaneous and cultivated plants in this study area; the data were collected in a Microsoft Excel[®] spreadsheet and then processed. Fifty-nine people were interviewed. Results show that the most frequently used plant family is Asteraceae, the most mentioned taxon is *Anethum piperitum* (22 interviews), and the most recurrent use is use is culinary, for the preparation of side-dishes. This work highlights the presence of cultures that have used plants in the past and represents a further contribution to the ethnobotanical knowledge of this region.

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1. Introduction

Ethnobotanical studies play a pivotal role in understanding the complex relationships between humans and the plant kingdom, providing invaluable insights into the traditional knowledge and sustainable utilisation of plant resources within diverse cultural contexts (Harshberger 1896; Zocchi et al. 2022). Since ancient times, humans have used a considerable diversity of wild plants for food, medicine, toolmaking, hunting, and improving domestic life (Tardío et al. 2006; Bhat et al. 2021), although some authors prefer to call them “non-crop plants” (Pieroni et al. 2005) or “non-crop food” (Bonet and Vallès 2002). Recent studies have also highlighted the importance of wild species closely related to crops (crop wild relatives): they often possess useful traits, such as disease resistance, and can have several benefits on human health and on environmental protection (Abenavoli et al. 2021; Perrino and Wagensommer 2021; Perrino 2022).

Wild plants often play a central role in the Mediterranean diet, according to Naska and Trichopoulou (2014), who defined it as a diet characterised by an abundance of plant foods, fruits, olive oil, and fish, and in smaller amounts of meat and wine.

Despite the evidence of the importance of plant species, several studies (Rivera et al. 2005, 2006; de Cortes

Sánchez-Mata and Tardío 2016; Tsioutsou et al. 2017; La Rosa et al. 2021) and the consideration that the Mediterranean diet is an Intangible Cultural Heritage of Humanity by UNESCO (2013), the extent to which wild plants are consumed by most people living in the Mediterranean basin is largely unknown. This is largely due to the sudden change in lifestyle in recent decades related to globalisation, which has resulted in the loss of ethnobotanical heritage handed down by our ancestors (Nebel et al. 2006; Musarella et al. 2019; Mattalia, Sôukand, et al. 2020).

Another important aspect of ethnobotany is the medicinal use of wild plants. Despite the advent of new technologies and new pharmaceutical products, people prefer the use of less invasive, naturally derived compounds, in fact, plant biodiversity has numerous bioactive compounds that can be the basis of many medicines that are more effective and safer than modern synthetic products (Shin et al. 2019; Costa et al. 2022). In addition, to prevent or treat SARS-CoV-2 infection, populations have been preparing to seek alternative solutions, and the use of medicinal plants has emerged as a promising alternative resource to boost immunity and counter COVID-19 (Benkhaira et al. 2021; Brahmi et al. 2023; Chebaibi et al. 2022; Odebunmi et al. 2022).

Other ethnobotanical uses related to crafts, magic, and cosmetics are also important and have been highlighted in

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many studies (Leporatti and Pavesi 1989; Arcidiacono et al. 2007; Costa et al. 2022).

The Mediterranean basin has a very diverse cultural history; its complexity is due to the many influences that have occurred over the centuries (Hammer et al. 1987). Hadjichambis et al. (2008) pointed out that in some rural areas of the Mediterranean, ancient ethnobotanical traditions are maintained, and wild plants play an essential role in daily nutrition. This important heritage has been passed on from generation to generation through oral testimonies (Singh et al. 2014; Verma 2014; Nyero et al. 2021). Today, knowledge about the use of wild plants is mostly held by older people who live in rural areas and have maintained a traditional way of life, while people who have adapted to urban contexts by following the rhythms of modern life tend not to be interested in this knowledge, which is often considered obsolete; therefore, ethnobotanical knowledge is gradually disappearing (Luczaj et al. 2012; Maruca et al. 2019; Zarbà et al. 2019). Not only are traditions related to plant use lost, but so is the use of ancestral languages, mainly derived from Greek, Latin, and Arabic influences. Indeed, there is a correlation between the loss of language, traditional culture, and Traditional Ecological Knowledge (TEK) (Mühlhäusler 2001; Pieroni et al. 2002).

One of the regions that maintains these traditions is Calabria, located in southern Italy, which is renowned for its rich biodiversity (Brullo et al. 2001; Musarella and Tripodi 2004; Bernardo et al. 2011, 2012; Spampinato 2014; Musarella 2020; Caruso 2022; Caruso et al. 2022; Spampinato et al. 2022; Capuano and Caruso 2023; Laface et al. 2023; Morabito et al. 2023) and a long history of human settlement, making it an intriguing area for ethnobotanical exploration (Spampinato et al. 2017, 2022). Over the years, several scientific publications have contributed to unravelling the ethnobotanical knowledge of Calabria's inhabitants, shedding light on their traditional practices, beliefs, and the wide array of plant species used for various purposes (Barone 1963; Leporatti and Pavesi 1989; Iuliano et al. 2002; Nebel et al. 2006; Passalacqua et al. 2006; Leporatti and Impieri 2007; Tagarelli et al. 2010; Guarrera and Savo 2013; Maruca et al. 2019; Musarella et al. 2019; Mattalia, Söukand, et al. 2020; Motti 2021; Sicari et al. 2021; Gentile et al. 2022; Patti et al. 2022a, 2022b).

The aim of this study was to investigate one of the least ethnobotanically studied areas of Calabria, specifically the Tyrrhenian side of the Aspromonte Massif, in the metropolitan city of Reggio Calabria, to increase knowledge of the traditional uses of plants in this area and ensure that its ethnobotanical heritage is not lost.

2. Materials and methods

2.1. Study area

The study area is the Tyrrhenian side of the Aspromonte Massif in the metropolitan city of Reggio Calabria (Calabria, southern Italy). This area includes several municipalities, eight of which were considered in the present study: Delianuova, Polistena, San Ferdinando, Sant'Eufemia d'Aspromonte, Santa Cristina, Santo Stefano in Aspromonte, Scilla, and Villa San Giovanni (Figure 1). The altitude of the study area is between 0 and 1300m a.s.l.

According to the classification of Pesaresi et al. (2017), the bioclimate is Mediterranean pluvioseasonal oceanic with thermo-types ranging from Lower and Upper ThermoMediterranean in the coastal zone, Lower and Upper Mesomediterranean in the hilly and lower submountain belts, while only a small area in the mountain belts is Lower Supramediterranean.

2.2. Ethnobotanical surveys and data collection

To gather information, we conducted semi-structured interviews in the field with different people living in the study area. We selected people who live in rural areas far from the effects of globalization, who still have as their custom the use of wild plants, and who are not influenced by personal studies or books but based solely on their cultural tradition. In addition, using the word-of-mouth system, starting with the informants, we obtained other possible informants. Interviews took place at different times of the year, between 2012 and 2022.

The interviews were conducted in accordance with the Code of Ethics of the International Society of Ethnobiology (ISE), which aims to promote ethical practice and equitable relationships (ISE 2006).

The interviews were done following the model of Musarella et al. (2019) in Italian and in the local dialect so that the informants could answer the questions freely and not feel judged.

During the field surveys, we collected numerous samples and took several photographs of the reported plants to ensure the correct identification of the species.

In the laboratory, we dried the plant samples collected during the interviews by pressing them between newspaper sheets and placing them in an aerated environment at 42°C. Once dried, we made an herbarium, and species identification was carried out through the use of dichotomous keys found within the Flora of Italy (Pignatti, 2017a, 2017b, 2018, 2019). The nomenclature used was in accordance with the Portal to the Flora of Italy (2023).

The biological form was determined according to the model of Raunkiaer (1934), whereas the chorological type followed Pignatti (1982). The chorological types "Cryptogenic" and "Alien" follow the glossary of Pyšek et al. (2009). For the plants that were considered "cultivated", information was taken objectively during the interviews.

The collected plant samples were deposited in the Herbarium of the Mediterranean University of Reggio Calabria (REGGIO, acronym according to Thiers 2023).

The information from the ethnobotanical surveys was stored in a database using Microsoft Access® software, in which a digital copy showing all the fields of the ethnobotanical form used in the area was created, and the results were exported to Microsoft Excel® software for qualitative statistical processing.

The data on medicinal uses was classified, according to Cook (1995), into nine different groups based on the diseases and the type of genetic disorder. Quantitative indexes were calculated to statistically analyze the weight of each taxon or family in the total data collection to better highlight their ethnobotanical value.



Figure 1. Study area. Tyrrhenian side of Aspromonte Massif in the metropolitan city of Reggio Calabria. In red are the boundaries of the eight municipalities where the ethnobotanical interviews were conducted: Delianuova, Polistena, San Ferdinando, Sant'Eufemia d'Aspromonte, Santa Cristina, Santo Stefano in Aspromonte, Scilla and Villa San Giovanni (Google© 2023).

The indexes were calculated as follows:

- Cultural Importance Index (CI), in accordance with Tardío and Pardo-de-Santayana (2008) and Whitney et al. (2018), which calculates the cultural importance of plants.
- Family Importance Value (FIV), according to Vitalini et al. (2013), which represents the number of times a botanical family is mentioned by informants.
- Frequency of Citation (FC), according to Prance et al. (1987), was used to calculate the frequency with which a taxon is cited by informants.
- Relative Frequency of Citation (RFC), according to Tardío and Pardo-de-Santayana (2008), which has the same function as the FC index but is related to the total number of informants and is a value between 0 and 1.
- Relative Importance index (RI), according to Tardío and Pardo-de-Santayana (2008), was used to calculate the relative importance of each species.
- Use Value (UV), according to Tardío and Pardo-de-Santayana (2008), was used to calculate the use value of each species.

These indexes were calculated using R software, version 4.3.1 (R Core Team 2022), with the EthnobotanyR package, version 0.1.9, that was produced by Whitney (2022) following

the indications of Tardío and Pardo-de-Santayana (2008); the FIV index, instead, was calculated by Microsoft Excel®.

In addition, within the "ethnobotanyR" package, the "EthnoChord" function was used to create chord diagrams, whose function was to display the totality of the information collected, highlighting which of them were the most relevant (Whitney et al. 2018; Haq et al. 2022). The purpose of the diagram is not only to show which species are used for each purpose (a detailed description of the different uses is provided in the following sections) but also to show which species are most widely used for various purposes and, therefore, carry more weight than others at the ethnobotanical level.

3. Results and discussions

Fifty-nine informants were interviewed, 38 women (64%) and 21 men (36%), who were aged between 21 and 102 years; the age of the informants was divided into three groups to assess the number of people interviewed in each age group (Figure 2): most informants were between 51 and 80 years old (59%), 24% were between 20 and 50 years old, and 17% were over 81 years old.

Overall, 381 interviews were conducted within the study area. A total of 126 taxa, belonging to 47 families, were identified. The complete database with family, taxon, Italian

common name, local dialect name, biological form and growth mode, chorological type, part used, use, purpose, and the U, UR, FC, RFC, CI, RI, and UV indices are given in Table S1.

In addition, the relationship between the age of the informants and their level of ethnobotanical knowledge was assessed using the number of interviews conducted and the number of taxa cited during the interviews (Figure 3).

From Figure 3, it can be seen that the range 51–80 has more informants (35) and also more ethnobotanical knowledge (corresponding to the number of interviews, 268); the

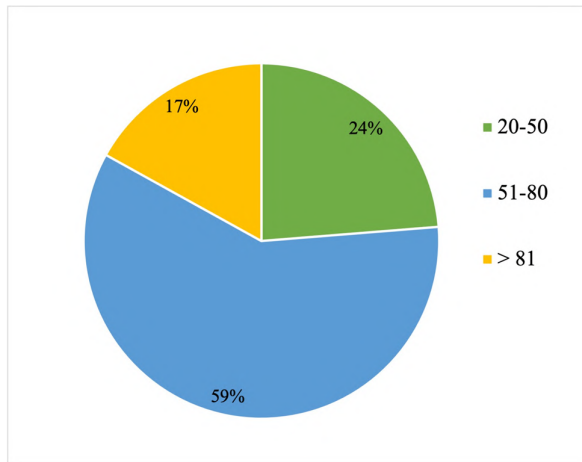


Figure 2. Age of informants divided into three range: 20–50, 51–80, and >81 years old.

ratio between these two values is 1:7. If we compare the ratios of the other two age groups (21–50 equal to 1:4; >81 equal to 1:5), we can see that the ratio of the age group 51–80 is significantly higher from the point of view of ethnobotanical knowledge. These results were also confirmed by the higher presence of taxa recorded in the age range 51–80 (106).

The informants interviewed and the number of interviews were categorized by municipality considered (Table 1). As can be seen, the number of people interviewed was greater in the municipalities of Scilla (19) and San Ferdinando (16); consequently, the number of interviews recorded was greater in these two municipalities.

Table 2 shows the list of families with the number of interviews and the number of taxa for each. The most frequently mentioned families were Asteraceae (52 interviews and 21 taxa), Lamiaceae (37, 11), and Apiaceae (34, 7).

According to the FIV index, the most common botanical families were Asteraceae (44.68%), Apiaceae (34.04%), and Lamiaceae (31.91%) (Table 2).

The biological spectrum (Figure 4) shows that Therophytes (T) were the most common life forms (28%), followed by Phanerophytes (P) (25%), and Hemicryptophytes (H) (25%).

The chorological analysis (Figure 5) showed that the most common species had a Mediterranean chorotype *sensu lato* (37%), subdivided into Stenomediterranean (24%) and Eurimediterranean (13%), followed by cultivated plants (21%), Eurasian (16%), and Cosmopolitan (12%). Other chorological types were less widespread.

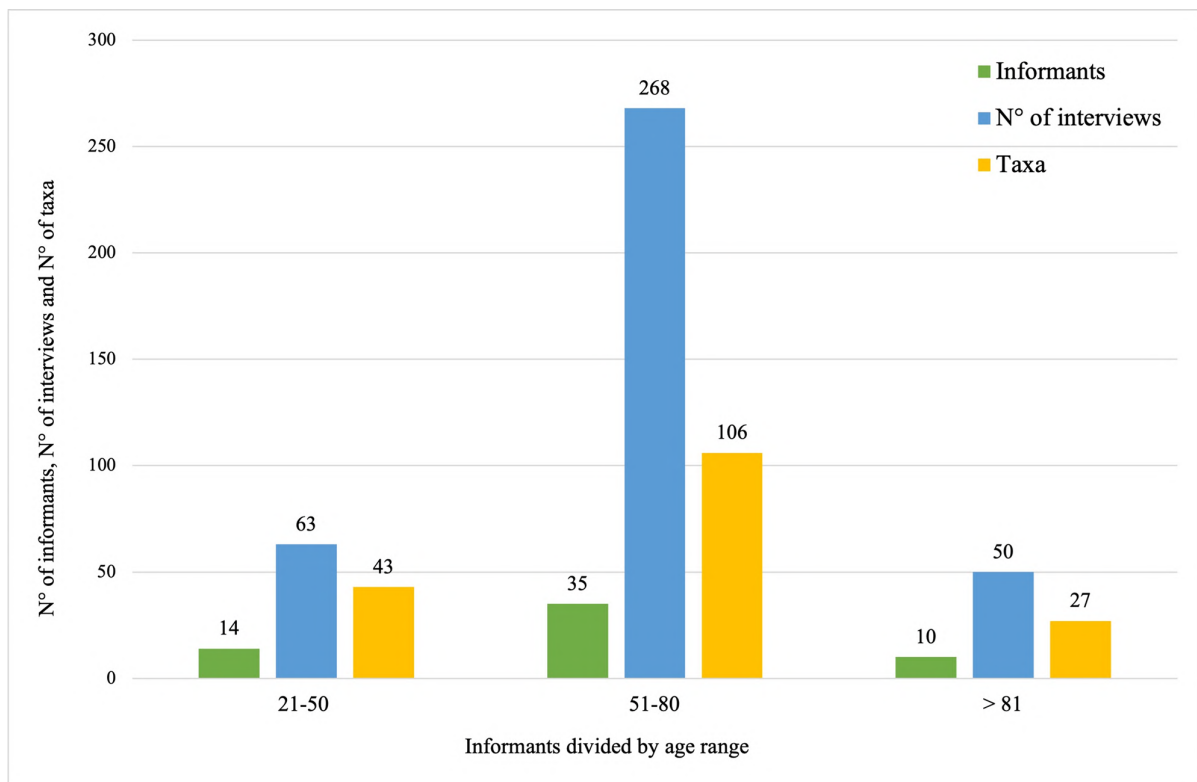


Figure 3. Relationship between the age of informants and their level of ethnobotanical knowledge (number of interviews and number of cited taxa).

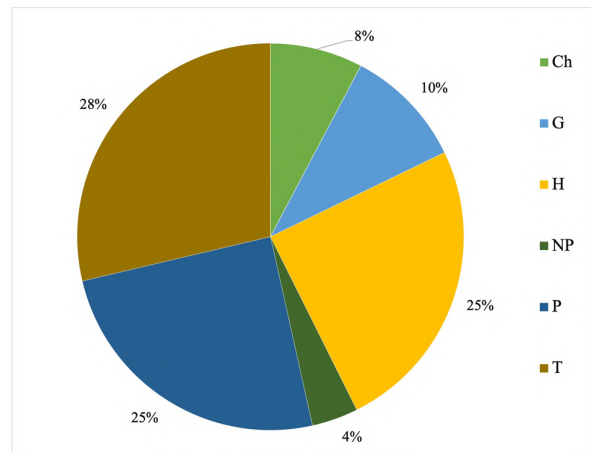
Table 1. Number of interviews and informants by municipality.

Municipalities	N° of interviews	N° of informants
Delianuova	28	9
Polistena	3	2
San Ferdinando	161	16
Sant'Eufemia d'Aspromonte	10	1
Santa Cristina	2	2
Santo Stefano in Aspromonte	18	9
Scilla	154	19
Villa San Giovanni	7	1

Table 2. The botanical families are listed in alphabetical order with the number of interviews (out of a total of 381 interviews), the number of taxa (out of a total of 129 taxa) for each, the FC value (the number of informants mentioning the family) and the family index value (FIV) which indicates the frequency of mention of the families.

Family	Interviews	Taxa	FC (family)	FIV %
Aizoaceae	2	2	2	4.26
Amaranthaceae	2	2	2	4.26
Amaryllidaceae	9	4	5	10.64
Apiaceae	34	6	16	34.04
Asparagaceae	8	4	5	10.64
Asphodelaceae	8	2	8	17.02
Aspleniaceae	1	1	1	2.13
Asteraceae	52	20	21	44.68
Boraginaceae	7	1	5	10.64
Brassicaceae	13	7	10	21.28
Cactaceae	11	1	6	12.77
Caryophyllaceae	1	1	1	2.13
Convolvulaceae	1	1	1	2.13
Cucurbitaceae	4	4	4	8.51
Equisetaceae	2	1	2	4.26
Ericaceae	2	1	2	4.26
Euphorbiaceae	3	1	1	2.13
Fabaceae	19	7	12	25.53
Fagaceae	7	3	6	12.77
Juglandaceae	3	1	3	6.38
Lamiaceae	37	10	15	31.91
Lauraceae	21	1	13	27.66
Lythraceae	1	1	1	2.13
Malvaceae	5	1	4	8.51
Moraceae	12	1	9	19.15
Myrtaceae	3	2	2	4.26
Oleaceae	2	1	2	4.26
Oxalidaceae	3	1	3	6.38
Papaveraceae	3	2	3	6.38
Phytolaccaceae	1	1	1	2.13
Plantaginaceae	2	2	2	4.26
Poaceae	16	5	11	23.40
Polypodiaceae	1	1	1	2.13
Portulacaceae	2	1	2	4.26
Ranunculaceae	1	1	1	2.13
Rhamnaceae	1	1	1	2.13
Rosaceae	22	5	11	23.40
Rubiaceae	2	2	2	4.26
Rutaceae	4	2	2	4.26
Salicaceae	1	1	1	2.13
Scrophulariaceae	2	1	1	2.13
Solanaceae	21	6	15	31.91
Tamaricaceae	1	1	1	2.13
Urticaceae	13	3	8	17.02
Viburnaceae	2	1	4	8.51
Violaceae	2	1	1	2.13
Vitaceae	4	1	3	6.38

Taxa were also classified according to exoticity as native, alien, or cryptogenic (Figure 6). Most of the recorded species were native (69%), followed by alien (29%), and to a small extent cryptogenic (2%). Of all the alien taxa, 65% were cultivated species. The use of various alien species is not surprising, since their presence in the Calabrian territory has been established for centuries and has been increasing in recent


Figure 4. Biological spectrum of the species recorded during the interviews. Ch: Chamaephytes; G: Geophytes; H: Hemicryptophytes; NP: Nanophanerophytes; P: Phanerophytes; T: Therophytes.

years, and some of them have spread to other habitats from cultivated fields (Laface et al. 2020; Musarella et al. 2020; Spampinato et al. 2022; Musarella et al. 2024).

In the interviews, the most used plant parts were the leaves (36%), fruits (21%), and aerial parts (17%); all other parts were used by <10% (Figure 7).

During the interviews, many different uses of the plants were recorded: food, medicinal, domestic (uses for cleaning and home care), handicraft, agro-pastoral, cosmetic, ornamental, magical, forage, religious, and ludic (Figure 8). The most common uses were alimentary (182 interviews and 81 taxa) and medicinal (126 interviews and 47 taxa). Other uses are less common, but still interesting, and are discussed in detail below.

According to the FC index, which calculates the number of informants mentioning the same species, only a few taxa were mentioned by more than one informant: *Laurus nobilis* L. was the most mentioned taxon with 13 informants, *Anethum piperitum* Ucria was mentioned by 11 different informants but was the most cited taxon (highest number of interviews, UR = 22), and *Ficus carica* L. was mentioned by nine informants (Table 3). Two taxa were mentioned by seven people and five taxa by five people. Most of the species were mentioned by only one person (70 taxa). Other indices were calculated to show the frequency of mention of the different species (RFC), cultural importance of the plants (CI, RI), and their utility value (UV). Based on the RFC index, the most frequently mentioned species were *L. nobilis* (RFC = 0.22), *A. piperitum* (RFC = 0.19), and *F. carica* (RFC = 0.15). The remaining indices also confirm that these are the most common taxa during the interviews: CI (0.37; 0.37; 0.20), RI (0.80; 0.72; 0.65), and UV (0.31; 0.25; 0.15).

Opuntia ficus-indica (L.) Mill. Has an RFC value of 0.10 but is the species with the highest variability of use; it is used for five different use categories (U), as shown by the high RI value of 0.73. The other species with high U were *Robinia pseudoacacia* L. (U=4; RFC = 0.08) and *Urtica dioica* L. (U=4; RFC = 0.08).

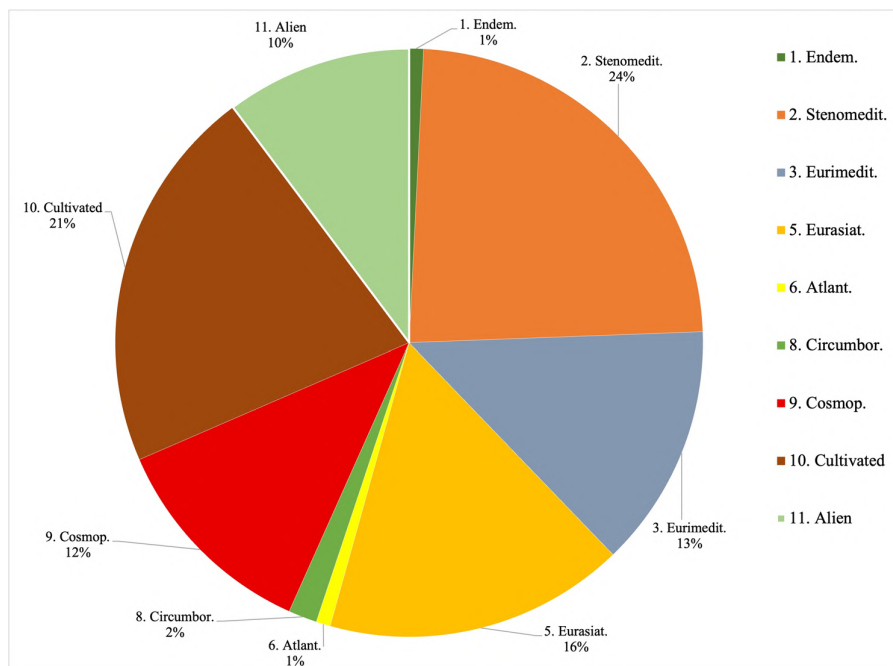


Figure 5. Chorological spectrum of the taxa recorded from the interviews.

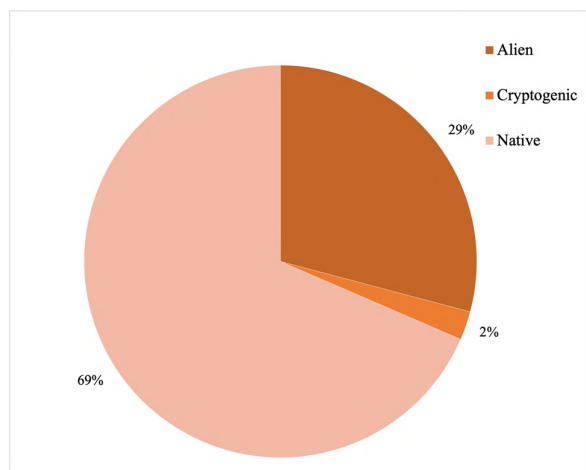


Figure 6. Origin of the taxa divided in alien, cryptogenic, and native.

Owing to the high heterogeneity of the data obtained, a method was used to assess the taxa that are more important than others in terms of use and the diversity of their potential. To do this, a chord diagram (ethnoChord, R software, version 0.1.9) was created to show the relationships between the matrices (taxa) and use categories (Figure 9). This diagram is a graphical representation of the indexes listed in Table 3. The most used category is alimentary (almost all species are used for this purpose), followed by medicine, and handicrafts.

As can be seen, the most relevant species are highlighted more prominently (they are thicker than the others), such as *Anetum piperitum*, *Laurus nobilis*, *Rubus ulmifolius* Schott, *Sambucus nigra* L., and *Opuntia ficus-indica*. The graph also

shows that the different species have multiple uses; for example, *A. piperitum*, is used for both food and medicinal purposes; *O. ficus-indica*, on the other hand, has a more diversified use; in fact, the categories of use associated with it are agro-pastoral, alimentary, handicraft, cosmetic, and medicinal.

3.1. Alimentary use

For the food category, 182 interviews were conducted, involving 81 different taxa (Figure 8). The category includes various types of plant use, such as those used for food (omelettes, first courses, side dishes) and those used for flavoring, seasoning, or preparing liquors (Figure 10). Most of the food species surveyed are already documented in the ethnobotanical literature of Calabria. However, the use of *Reichardia crassifolia* (Willk.) Guarino and Pignatti, a native species previously reported only in Sicily (Pignatti et al. 2019), is a new finding for the Italian peninsula.

One of the most common uses of the harvested plants in the study area is as a side dish (60 citations). The leaves are typically fried in a pan with oil, salt, and garlic, or simply boiled. The most commonly used species for this purpose are *Hypochaeris radicata* L. (Hadjichambis et al. 2008; Cornara et al. 2009; Guarrera 2009; Geraci et al. 2018; Gentile et al. 2022) and *Borago officinalis* L. (Scherrer et al. 2005; Passalacqua et al. 2006; Lentini and Venza 2007; Passalacqua et al. 2007; Guarino et al. 2008; Hadjichambis et al. 2008; Signorini et al. 2008, 2009; Arcidiacono et al. 2010; Aleo et al. 2013; Cornara et al. 2014; Bellusci 2017; Musarella et al. 2019; Mattalia, Sökand, et al. 2020).

The leaves of many other species are still used as a side dish, such as *Amaranthus retroflexus* L. (Salerno and Guarrera 2008), *Helminthotheca echioides* (L.) Holub (Cornara et al.

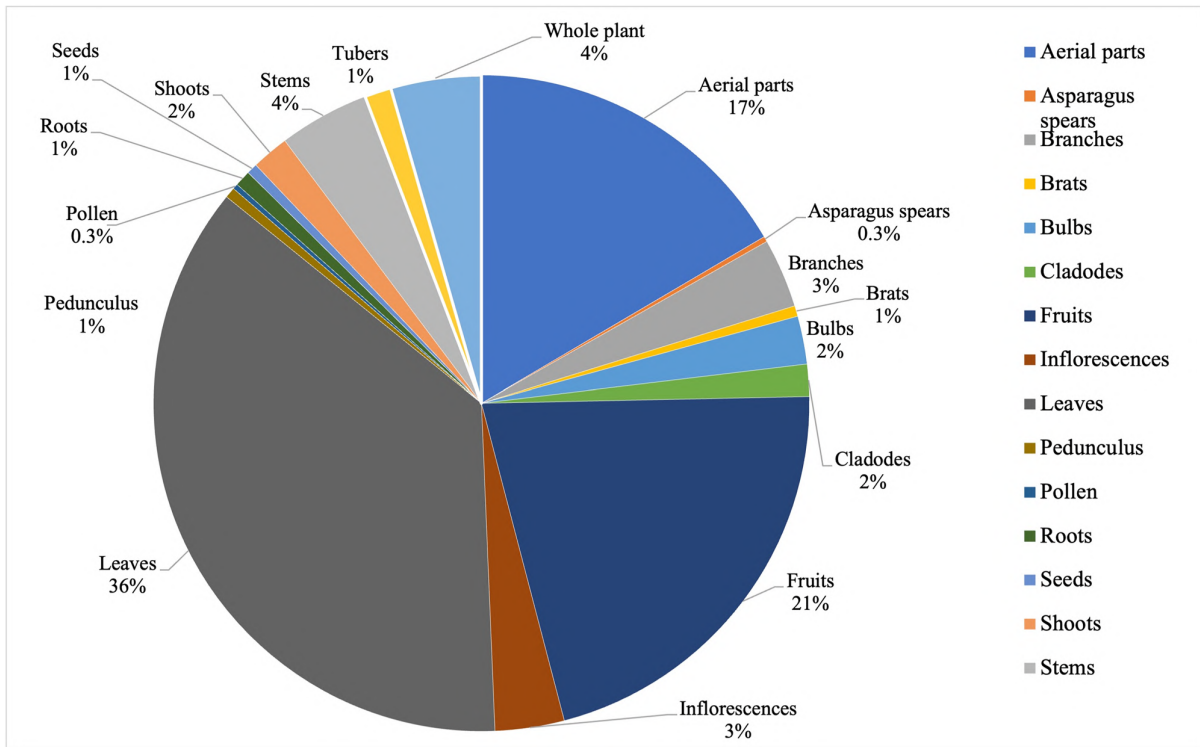


Figure 7. Parts of plants used by informants.

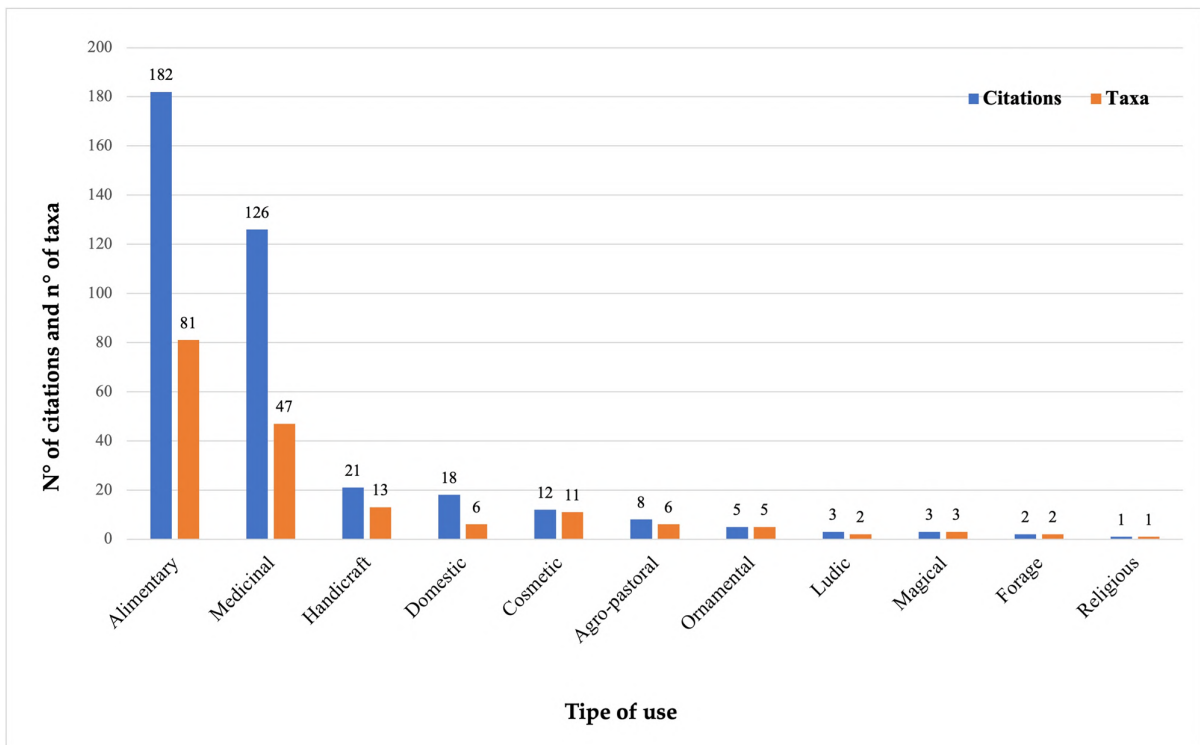


Figure 8. Number of interviews and taxa by category of use, sorted by number of interviews.

2009; Mattalia, Sōukand, et al. 2020), *Portulaca oleracea* L. (Montesano et al. 2012), *Reichardia crassifolia*, *Reichardia picroides* (L.) Roth (Pieroni 1999; Lentini 2000; Lentini and Venza 2007; Signorini et al. 2008; Cornara et al. 2009; Savo 2009; Arcidiacono et al. 2010; Idolo et al. 2010; Vanzani et al. 2011; Cornara et al. 2014), *Scolymus hispanicus* L. (Guarrera

Table 3. Most recurrent taxa sorted according to RFC index.

Taxa	Basic value			Indexes			
	UR	U	FC	RFC	CI	RI	UV
<i>Laurus nobilis</i> L.	21	3	13	0.22	0.37	0.80	0.31
<i>Anethum piperitum</i> Ucria	22	2	11	0.19	0.37	0.72	0.25
<i>Ficus carica</i> L.	12	3	9	0.15	0.20	0.65	0.15
<i>Clinopodium nepeta</i> (L.) Kuntze subsp. <i>Nepeta</i>	7	1	7	0.12	0.10	0.33	0.10
<i>Solanum tuberosum</i> L.	7	1	7	0.12	0.12	0.37	0.12
<i>Hypochaeris radicata</i> L.	7	1	6	0.10	0.12	0.33	0.10
<i>Opuntia ficus-indica</i> (L.) Mill.	11	5	6	0.10	0.19	0.73	0.12
<i>Rubus ulmifolius</i> Schott	13	3	6	0.10	0.20	0.53	0.15
<i>Zea mays</i> L. subsp. <i>mays</i>	6	3	6	0.10	0.07	0.45	0.07
<i>Borago officinalis</i> L.	7	1	5	0.08	0.02	0.14	0.02
<i>Robinia pseudoacacia</i> L.	6	4	5	0.08	0.10	0.59	0.09
<i>Sambucus nigra</i> L.	9	3	5	0.08	0.17	0.59	0.14
<i>Urtica dioica</i> L.	8	4	5	0.08	0.14	0.59	0.10
<i>Aloë vera</i> (L.) Burm.f.	4	1	4	0.07	0.07	0.25	0.07
<i>Asphodeline lutea</i> (L.) Rchb.	4	1	4	0.07	0.02	0.14	0.02
<i>Capsicum annuum</i> L.	4	3	4	0.07	0.02	0.14	0.02
<i>Castanea sativa</i> Mill.	5	2	4	0.07	0.05	0.28	0.05
<i>Malva sylvestris</i> L.	5	1	4	0.07	0.09	0.25	0.07
<i>Mentha</i> × <i>piperita</i> L.	8	2	4	0.07	0.02	0.14	0.02
<i>Solanum lycopersicum</i> L.	7	2	4	0.07	0.07	0.45	0.07
<i>Sonchus oleraceus</i> L.	4	2	4	0.07	0.07	0.35	0.07

Basic value: UR: number of interviews ('citations'); U: number of different categories of use; FC: frequency of citation. Indexes: RFC: relative frequency of citation; CI: cultural importance index; RI: relative importance index; UV: use value. Several statistical indices were calculated to highlight the weight of each taxon.

and Leporatti 2007; Leporatti and Guarrera 2007) and *Sonchus asper* (L.) Hill (Pieroni 1999; Nebel et al. 2006; Lentini and Venza 2007; Savo 2009; Biscotti et al. 2018). *Raphanus raphanistrum* L. subsp. *landra* is today eaten as a side dish. This use was reported in the nineteenth century by some authors for the area of Pavia and its surroundings (Moretti and Chiolini 1828; Gambini 1850), and until now it seemed to be an abandoned use, as reported by Ardenghi et al. (2017); therefore, it can be considered as a traditional use recovered over time and new in southern Italy.

For the preparation of salads, the leaves of *B. officinalis* (Passalacqua et al. 2006; Lancioni et al. 2007; Passalacqua et al. 2007 Leporatti and Guarrera 2007; Arcidiacono et al. 2010; Montesano et al. 2012; Bellusci 2017; Musarella et al. 2019; Mattalia, Sökand, et al. 2020; Tavilla et al. 2022), *H. echinoides* (Biscotti et al. 2018), *P. oleracea* (Scherrer et al. 2005; Nebel et al. 2006; Lentini and Venza 2007; Guarino et al. 2008; Salerno and Guarrera 2008; Signorini et al. 2008; Savo 2009; Arcidiacono et al. 2010; Idolo et al. 2010; Aleo et al. 2013; Bellusci 2017; Biscotti et al. 2018; Maruca et al. 2019; Musarella et al. 2019; Mattalia, Sökand, et al. 2020), *R. crassifolia*, *R. picroides* (Corsi et al. 1980; Pieroni 1999; Lancioni et al. 2007; Signorini et al. 2008; Savo 2009; Signorini et al. 2009; Arcidiacono et al. 2010; Idolo et al. 2010; Vanzani et al. 2011; Cornara et al. 2014; Biscotti et al. 2018), *S. hispanicus* (Lentini and Venza 2007) and *S. asper* (cleaned of thorny parts) (Pieroni 1999; Lentini and Venza 2007; Savo 2009) are also used; in the past, the flowers of *Papaver rhoeas* L. were utilized for the same purpose.

The fruits of *Vicia pseudocracca* Bertol. are used for another food purpose, the preparation of tasty first courses. This is the first recorded mention of this species in the ethnobotany literature, although it has been studied nutritionally (Pastor-Cavada et al. 2013). Snack use is another common purpose (17 interviews). The fruits are usually picked and eaten directly in the field, such as *Ceratonía siliqua* L., *Solanum*

villosum Mill., and *Ficus carica* L. Although *S. villosum* is considered toxic due to the presence of a toxic alkaloid (Zepigi 2023), scientific studies have shown that the fruits of this species have been consumed in the past (Maundu et al. 1999; Schippers 2002; Zahara et al. 2019). In the past, the apical parts of the stems of *Chondrilla juncea* L. were also consumed raw, as they are generally more tender. This practice was already known in Italy (Nebel et al. 2006; Signorini et al. 2009). Additionally, the fresh flowers of some species, such as *Cichorium intybus* L., were commonly consumed and still are today. The use of *Oxalis latifolia* Kunth is noteworthy. The bulbs are collected and cooked over the fire, like roast chestnuts. This same use was found in Sicily for *Oxalis pes-caprae* L. (Arcidiacono et al. 2010). In the study area, this species is also used as an after-dinner snack. The stem with the flowers is chewed after meals to remove the taste left in the mouth, thanks to its bitter taste, as previously reported in Sicily (Arcidiacono et al. 2010).

Opuntia ficus-indica (L.) Mill is still used to prepare two types of appetizers. The first involves grilling the cleaned cladodes, a method previously documented in other studies (Gouws et al. 2019; Sinicropi et al. 2022). The second involves frying the cleaned peels of the fruit, a method already known in the Campania region of southern Italy (Salerno and Guarrera 2008). The flower petals of this species have also been used in the past to prepare a fresh drink, obtained by filtering a decoction of the petals.

The preparation of liqueurs is a widespread practice (15 citations), and many taxa are used for this purpose, including *Sambucus nigra* L., *Anethum piperitum*, *Juglans regia* L., *Myrtus communis* L., and *Fragaria vesca* L. subsp. *vesca*. These liqueur solutions are commonly consumed as an after-dinner drink and as a digestive aid. In Calabria, *Fragaria vesca* subsp. *vesca* is a popular choice for this purpose (Mattalia, Paolo, et al. 2020). A traditional drink with a moderate alcoholic content, called "rosoli", can be made using the petals of *Rosa* cultivars.

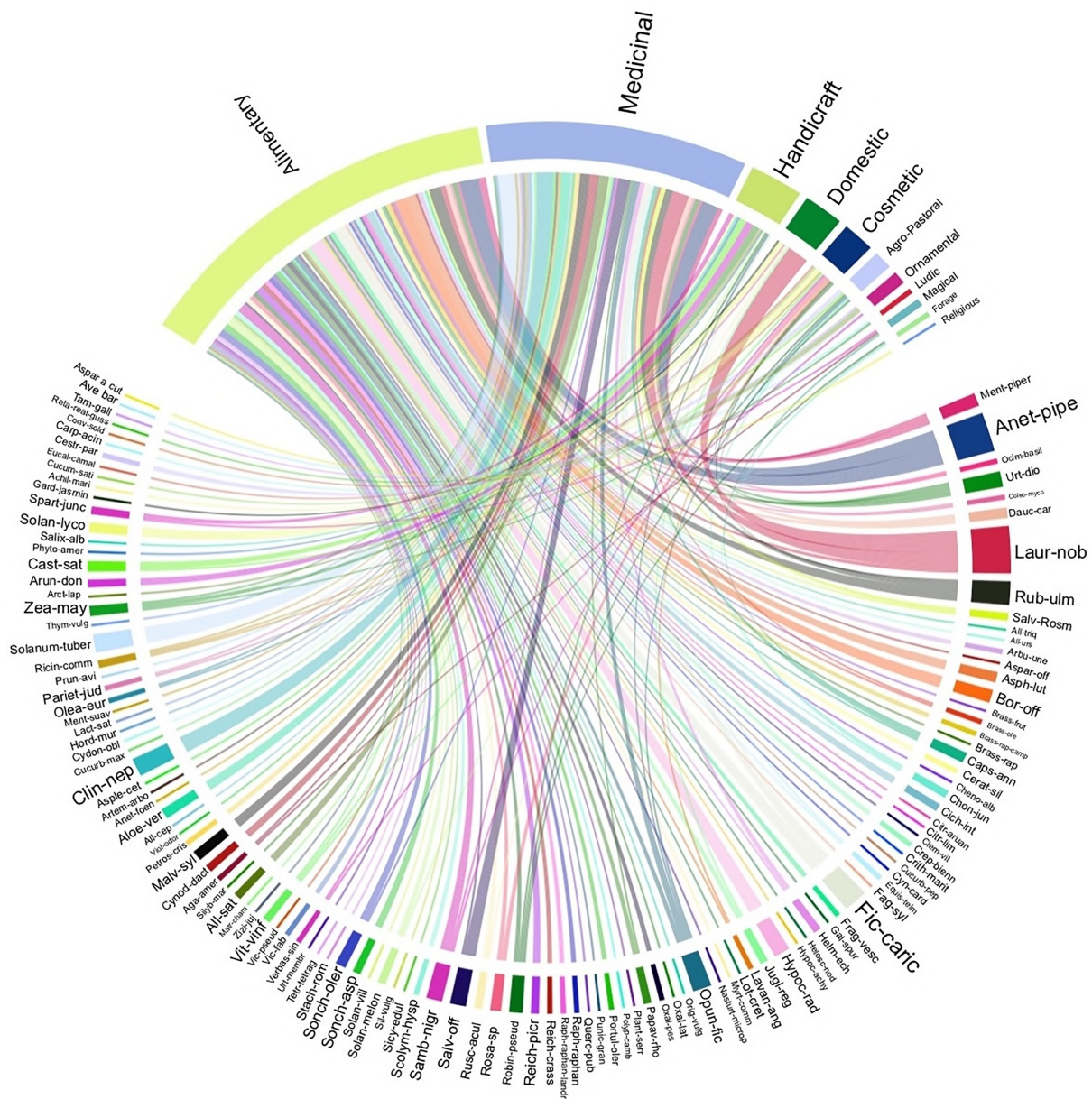


Figure 9. Chord diagram relating all taxa mentioned during the interviews to the category of use, processed with R software version 2023.06.0+421 +“ethnobotanyR” package.

Two very particular uses linked to ancient traditions are the use of plants to prepare bread and coffee substitutes: centuries ago, not everyone could afford coffee or bread; therefore, plants were used to prepare products that resembled them (substitutes), as also reported by Zocchi et al. (2022).

In the past, the ripe fruits of *Ceratonia siliqua* L. were used to make bread; de Castro and Rivera Núñez (1991) confirm the same use in the Murcia region of Spain. In Spain, this type of bread is known as “famine bread” (Luczaj et al. 2012). The acorns of *Quercus pubescens* Willd. subsp. *pubescens*, on the other hand, were used to make coffee substitutes: in summer they were harvested, peeled, roasted, and ground; the coffee was then brewed in a pot with water. The same use is reported by Mattalia, Paolo, et al. (2020).

3.2. Medicinal use

For medicinal use, 126 interviews were conducted with 47 taxa (Figure 8). Medicinal purposes were divided into nine categories of disease groups (Cook 1995), and a chord diagram (ethnoChord, R software, version 0.1.9) was produced to show the distribution of taxa in the different categories (Figure 11).

The most relevant taxon for this purpose in the study area is *Anethum piperitum*, which is used more frequently in the group of digestive disorders (1- digestive disorders). Fruits are often used in herbal infusions and decoctions as a digestive aid or for the treatment of abdominal pain. The leaves, boiled and made into an infusion to be drunk hot or eaten as a vegetable, are also used to relieve gastric pain.

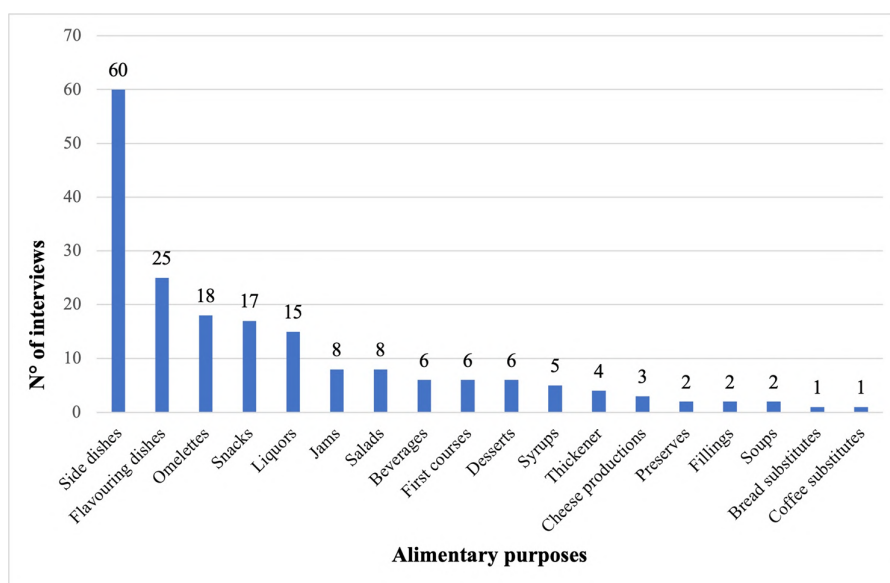


Figure 10. Different purposes within the alimentary use category sorted by number of interviews.

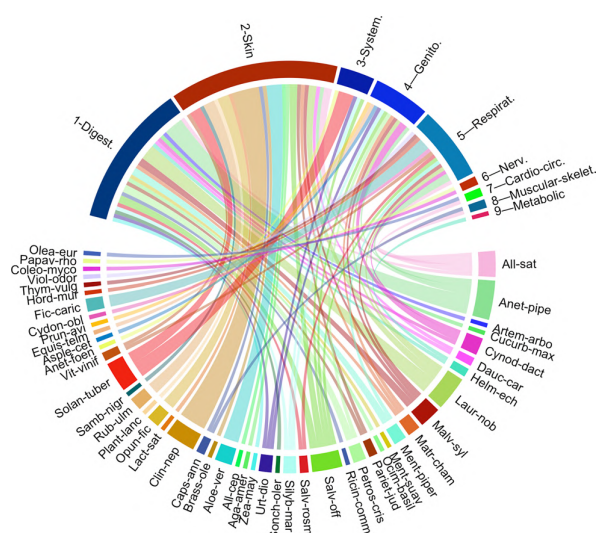


Figure 11. Chord diagram representing all medicinal taxa found during the interviews with the nine categories of medicinal use, processed with R software version 2023.06.0+421 + "ethnobotany" package. 1-Digest.: diseases of the digestive system; 2-skin.: diseases of the skin-ears-hair and wounds; 3-system.: systemic diseases; 4-Genito.: diseases of the genito-urinary system; 5-Respirat.: diseases of the respiratory system; 6-Nerv.: diseases of the nervous system; 7-Cardio-circ.: diseases of the cardio-circulatory system; 8-muscular-skeletal.: diseases of the musculoskeletal system; 9-Metabolic: metabolic diseases.

This species is also known to treat gastrointestinal disorders in Campania (Scherrer et al. 2005), Tuscany (Corsi et al. 1980), and Sicily (Tavilla et al. 2022) as a digestive and carminative, respectively. This use is also known for other Mediterranean territories, such as the mountains of Palestine (Ali-Shtayeh et al. 2000). *Helminthotheca echioides* has the same use. The stem of *Sonchus oleraceus* L. was harvested, the outer part was removed (as if peeling), and the juice was aspirated to relieve gastritis. *Anethum piperitum* is also used for skin conditions (2-skin-ears-eyes-hair diseases and wounds): wild

fennel is harvested in bunches and rubbed directly on the eyes to treat the styes. However, this has not been reported in other studies. The second most used taxon is *Laurus nobilis*, the dried leaves of which are mainly used to prepare decoctions for digestive and anti-inflammatory purposes. Decoctions are also used as expectorants (5- respiratory system diseases), which can be found in the Serre Calabre (Gentile et al. 2022).

Cynodon dactylon (L.) Pers. and *Malva sylvestris* L. have been used to treat stomach pain. For the former, the whole plant was used, the rhizome removed and boiled: the "mil" or "spear grass water" was then drunk. For the second, the leaves and flowers were decocted and filtered, and the mixture was drunk hot. These two species were also collected individually to prepare two different hot diuretic infusions, a use already known for *C. dactylon*, especially with its rhizome, in other Italian regions (Corsi et al. 1980; Uncini Manganelli and Tomei 1996; Ansaldo and Tomei 1997; Loi et al. 2002; Camangi and Tomei 2003; Maccioni et al. 2004; Leporatti and Guarrera 2007; Signorini et al. 2008, Montesano et al. 2012; Arcidiacono et al. 2010; Aleo et al. 2013; Cornara et al. 2014) but also in Calabria (Passalacqua et al. 2007; Tagarelli et al. 2010), for example in the municipalities of Arbëreshë e Occitane (Mattalia, Sökand, et al. 2020), in the area of Monte Reventino (province of Catanzaro) (Maruca et al. 2019), in the area of Poro and Calabrian Preserre (Vibo Valentia province) (Musarella et al. 2019), in the High Tyrrhenian area (Cosenza province) (Leporatti and Impieri 2007). The use of *Malva* species is common throughout the Italian Peninsula (Guarrera 2006): *M. sylvestris* leaves were used in Liguria for the preparation of diuretic decoctions or infusions (Cornara et al. 2009), which was also found in Sardinia (Bullitta et al. 2007; Lancioni et al. 2007), in Sicily (Aleo et al. 2013) and in Tuscany (Corsi et al. 1980; Uncini Manganelli and Tomei 1996; Camangi and Tomei 2003; Signorini et al. 2008). All these uses are already known in

other Italian administrative regions, such as Abruzzo, Lazio, and Molise (Idolo et al. 2010) and Campania (Salerno and Guarrera 2008; Savo 2009). In Molise, it was found to have a similar analgesic purpose as an antispasmodic (Menale et al. 2006).

It is interesting to note that the leaves of *Brassica oleracea* L. were boiled and placed on cloths previously soaked in hot oil, then wrapped around the affected parts of the body, with the leaves in contact with the body and the cloths on the outside, acting as a thermal gauze for muscular pain (8-muscular-skeletal diseases). A similar use was reported in another Italian region (Idolo et al. 2010). Two similar uses were found in Tuscany: the first method used the leaves of *B. oleracea* subsp. *oleracea* var. *acephala* DC. f. *serotina*, where it was necessary to use them raw and greased with butter, and then applied to the affected area of the body to alleviate any pain (Corsi et al. 1980). The second method used fresh leaves of *B. oleracea*, crushed, and then applied to the affected area (Uncini Manganelli and Tomei 1996).

Expectorant is the medicinal use most frequently found in the study area; many remedies are still prepared, some of which combine several species already mentioned in this study for other purposes. An example is the decoction of *Cydonia oblonga* Mill fresh fruit. The use of *C. oblonga* fruits for the treatment of sore throat and dry cough has been reported in Campania (Guarino et al. 2008). The dried fruit of *Ficus carica* L., with the addition of the leaves (fresh or dried) of *Laurus nobilis* L. could be administered both as food and as a tisane, and honey was added to sweeten the taste. This remedy has also been reported in Sardinia (Signorini et al. 2009). Another expectorant remedy was prepared by boiling the root of *Malva sylvestris*, leaves of *Anethum piperitum*, rhizome of *C. dactylon*, ear of *Hordeum murinum* L., and dried fruits of *F. carica* in a litre of water for an hour: the mixture was filtered and used as a cough syrup. Similar remedies have been found in Abruzzo, Lazio, and Molise National Park (Idolo et al. 2010). Interestingly, the decoction, or infuse, of *M. sylvestris* roots, leaves, and/or flowers is well known to treat inflammation of the respiratory system in many Italian regions (Corsi et al. 1980; Ansaldi and Tomei 1997; Perno et al. 1997; Ballero et al. 1998, 2001; Maccioni et al. 2001; Scherrer et al. 2005; Bullitta et al. 2007; Lancioni et al. 2007; Leporatti and Guarrera 2007; Salerno and Guarrera 2008; Signorini et al. 2008; Savo 2009; Signorini et al. 2009; Arcidiacono et al. 2010; Aleo et al. 2013; Cornara et al. 2014) and Calabria (Leporatti and Impieri 2007; Passalacqua et al. 2007; Bellusci 2017; Maruca et al. 2019; Mattalia, Sökand, et al. 2020). The use of dried *F. carica* fruits to treat cough or respiratory disease has also been found in other Italian regions (Corsi et al. 1980; Perno et al. 1997; Lentini 2000; Maccioni et al. 2001; Loi et al. 2002; Menale et al. 2006; Leporatti and Guarrera 2007; Guarino et al. 2008; Salerno and Guarrera 2008; Cornara et al. 2009; Savo 2009; Aleo et al. 2013) and Calabria (Leporatti and Impieri 2007; Passalacqua et al. 2007; Maruca et al. 2019; Mattalia, Sökand, et al. 2020). A study has highlighted that *M. sylvestris* and *F. carica* are used to also treat animal cough (Viegi et al. 2001). The expectorant capacity of *C. dactylon* rhizomes is known in Molise (Menale et al. 2006; Savo 2009), Liguria (Cornara et al. 2009),

and Tuscany (Signorini et al. 2008), whereas the whole plant is used in other areas (Di Sanzo et al. 2013). The use of the leaves of *L. nobilis* to treat sore throat or cough is also known in Campania; in particular, a leaves-based decoction is known, to which honey can also be added (Guarino et al. 2008; Savo 2009) or not (Scherrer et al. 2005; Salerno and Guarrera 2008); while in Sardinia the infusion of *L. nobilis* leaves is known (Ballero et al. 2001; Lancioni et al. 2007) in association with other plants and ingredients for the same purpose (Ballero et al. 1998).

Clinopodium nepeta subsp. *nepeta*, on the other hand, is used mainly for anti-inflammatory purposes, but also for disinfecting and healing skin wounds. Its leaves are plucked fresh, crushed by hand, or with stones, and the poultice is rubbed on insect bites or wounds. Singh et al. (2012) confirmed that the essential oil of this species contains 64 pharmacologically active compounds with antibacterial, antioxidant, and anti-inflammatory properties. The only species identified for anthelmintic purposes is *Cucurbita maxima* Duchesne. Its seeds are collected, dried in the sun, and eaten as they are to treat intestinal tapeworms. In other Italian regions, this remedy is used mainly for children (Salerno and Guarrera 2008; Aleo et al. 2013; Cornara et al. 2014). However, in Calabria, the use of *Cucurbita pepo* L. seeds for the same purpose has been reported (Passalacqua et al. 2007). *Solanum tuberosum* L. is a taxon that is unusually used as a remedy for migraine and muscular pains: the tuber is sliced, and, in the case of headaches, the slices are tied to the head with a band. The same use is reported for other areas of Calabria: Acri (Cosenza), Cirò (Crotone), and Gioia Tauro (Reggio Calabria) (Passalacqua et al. 2007). Tavilla et al. (2022) reported the use of cut tubers for the treatment of burns.

Allium sativum L. has many medicinal uses as an anti-inflammatory, analgesic, and decongestant, and is also used to regulate blood pressure; informants told us that to lower high blood pressure, the bulbs were harvested in summer, cleaned off the outer membrane, cut into cloves, and swallowed whole. However, to treat earache, garlic cloves have been inserted into the ear canal; these uses have also been reported by other authors in Italy (Camangi and Tomei 2003; Passalacqua et al. 2007) and other territories (Qaseem et al. 2019; Usman et al. 2021; Ullah et al. 2023). The medicinal use of this taxon has been confirmed phytochemically by the presence of several bioactive compounds, such as alliin, ajoene, allyl sulphide, and 1,2-vinyldiithin, which are responsible for its antioxidant and cardioprotective properties (Martins et al. 2016).

Two species have been mentioned as relaxing and/or sedatives. *Papaver rhoeas*, whose flowers were decocted and then a cloth moistened with the water of the decoction, was given to children to suck on to relax them until they fell asleep, which was also found in other Italian regions (Corsi et al. 1980; Perno et al. 1997; Loi et al. 2002; Camangi and Tomei 2003; Scherrer et al. 2005; Menale et al. 2006; Signorini et al. 2008; Cornara et al. 2009; Savo 2009; Signorini et al. 2009; Idolo et al. 2010; Aleo et al. 2013; Bellusci 2017; Maruca et al. 2019). The second species is *Coleostephus myconis* (L.) Cass. ex Rchb. f., whose decoction was used to promote sleep.

The cladodes of *O. ficus-indica* are utilized for the treatment of varicose veins, and a preparation that can be applied to the legs has been obtained. For the same purpose, the leaves of *Vitis vinifera* L. are still used for the preparation of two remedies: the first consists of boiling the leaves, pressing them, and applying them to the legs; the second consists of preparing an infusion of the leaves to be drunk hot. A remedy using the leaves of *V. vinifera* for the treatment of varicose veins was cited in Sicily, where the fresh leaves were ground and a kind of compress was created to be applied on the legs, which was also useful for circulatory disorders and fragility of capillaries (Aleo et al. 2013), as was found in Campania (De Feo et al. 1992), while in Passalacqua et al. (2007) *Brassica oleracea* L. was used in this study.

Other examples of medicinal uses found sporadically are abortive and laxative (*Petroselinum crispum* (Mill.) Fuss), analgesic (*Salvia officinalis*), anti-hemorrhoidal (*Solanum tuberosum*), anti-itching, anti-allergic (*Parietaria judaica* L.), and laxative (*Ricinus communis* L.).

Another interesting example is the use of dried and boiled ears of *Zea mays* L. to prepare an infusion to drink to promote renal cleansing, and it is known that the stigmas of *Z. mays* also have diuretic effects (Corsi et al. 1980; Maccioni et al. 2004; Menale et al. 2006; Leporatti and Impieri 2007; Guarino et al. 2008; Di Sanzo et al. 2013).

3.3. Handicraft use

For handicraft use, 21 interviews were conducted with 13 taxa (Figure 12).

The most common uses include making containers (three citations) baskets (3), brooms (2), and stuffing mattresses (3).

The most cited species was *Castanea sativa* Mill. (4 citations), which is used to make trellises for drying food, lobster pots, and baskets.

It is still a tradition to dry some foods in the sun in August. For this purpose, the tools of the past are still used and have been handed down from generation to generation, such as the “cannizza”, made with the stems of *Arundo donax* L., and the “farlazza”, made with wood fragments of *C. sativa*. Similar artefacts made with *A. donax* to dry figs in the sun (Salerno and Guarrera 2008) and baskets made with *C. sativa* wood have also been found in Campania, where they are called “coffe” and are used to contain the caught fish (Savo and Caneva 2009), and in other Italian regions (Cornara et al. 2014). In Calabria, the use of *A. donax* to make artefacts for drying food, such as “cannicciati”, is not new (Musarella et al. 2019). Stems of the same species are also used to make skewers for stacking dried figs or dried tomatoes. Another handicraft product still used and handed down by ancestors is the “panaru”. It is a specific type of basket with a handle, usually used for harvesting figs (*F. carica* leaves are placed at the bottom to avoid damage to the fruit) or, in smaller sizes, for collecting fresh eggs. In other areas of Italy, baskets are also made with *S. alba* branches (Corsi et al. 1980; Scherrer et al. 2005; Savo 2009; Savo and Caneva 2009; Arcidiacono et al. 2010; Idolo et al. 2010) or with other species of the genus *Salix* L. (Menale et al. 2006; Passalacqua et al. 2006; Salerno and Guarrera 2008; Signorini et al. 2008; Di Sanzo et al. 2013; Cornara et al. 2014; Maruca et al. 2019). In the past, to quickly create a container, the largest leaves of *F. carica* were used, inside which the objects were placed and then closed with thin branches of *S. junceum*, as if they were small bags.

Another typical use of *S. junceum* in southern Italy is to procure textile fibres: the plant was harvested and beaten with sticks to break and fray, and when the textile fibre was ready, it was placed in the loom, and blankets were made. The stems of *S. junceum* are also used to make brooms: the same use is recorded in other areas of Calabria (Passalacqua et al. 2006), in the Cilento National Park (Salerno and Guarrera

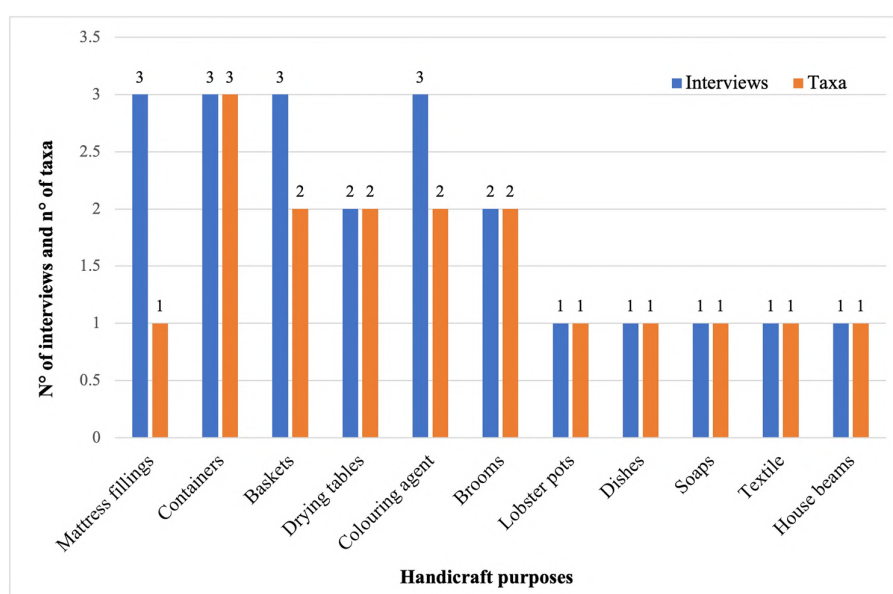


Figure 12. Handicraft purposes sorted by number of interviews and number taxa used.

2008), in Sicily (Arcidiacono et al. 2007), in Basilicata (Salerno et al. 2005), in Marche (Guarrera 1990) and in Trentino Alto-Adige (Pedrotti and Bertoldi 1930).

Ancient use of the cladodes of *O. ficus-indica* by farmers has been found; they usually stripped the cladodes from the plant to use them as a meal during work breaks after removing the thorns. A long time ago, the tools of today did not exist and it was common to prepare ink for writing at home by grinding the ripe fruits (which are black) of *Phytolacca americana* L.; this use has already been found in Tuscany (Corsi et al. 1980). There were fewer colours to choose from for fabrics, since they were all natural and handmade, so the fruits of *Solanum melongena* L. were boiled so that the peel released the colour into the water. Once the fruits were removed, the fabrics, especially curtains, were dipped in the water so that they took on a characteristic purple colour; this use was not reported in any other ethnobotanical work.

3.4. Cosmetic use

For cosmetic purposes, 12 interviews were conducted with 11 taxa (Figure 13).

The most prevalent cosmetic application is the creation of body perfumes (four interviews). Among these, the flowers of *Rosa* sp. flowers are the most utilized to produce rose-scented "rose water". The flowers were soaked in either cold or hot water for a few hours, and then filtered to create the fragrant water used for washing. The *Rosa* L. genus is also mentioned for this purpose in the Campania (Savo 2009) and Marche (Pieroni et al. 2004) regions.

In the past, castor beans from *Ricinus communis* L. were crushed to release their oil, which was then applied as a hair mask. Meanwhile, the nettle plant (*Urtica dioica* L.) was boiled and crushed, with the resulting poultice applied to the hair to make it shine. This use is also documented for *U. dioica* in the Marche region (Pieroni et al. 2004; Taffetani 2005). Other species of *Urtica* L. are utilized for hair washing in Tuscany

(Ansaldi and Tomei 1997; Camangi et al. 2003) and Spain (Akerreta et al. 2007).

3.5. Magical use

The use of magical practices in Calabria and southern Italy is still popular, particularly for addressing health and family issues. Only three instances of magical use were recorded, involving two rituals to ward off the evil eye and a ritual to remove warts. In the former case, *Capsicum annum* L. fruit was kept in a pocket (like in Ishtiaq et al. 2007; González et al. 2014; Yuca 2022), while a plant of *Agave americana* L. was placed at the entrance of the house. *Aloë arborescens* Mill. is typically used for this purpose, but the informant in this case claimed to be able to distinguish the two species and use them in the same way. *Spartium junceum* is used in a magical ritual to remove warts by tying knots in a branch behind the back, with the number of knots corresponding to the number of warts. The branch is then given to a person who hides it in a location not frequented by the person with warts, and when the person with warts passes by, the warts are believed to magically fall off.

3.6. Other less frequent uses

Occasionally, *Convolvulus soldanella* L., *Carpobrotus acinaciformis* (L.) L. Bolus, and *Tamarix gallica* L. were collected from the beach for ornamental purposes. Today, the flowering branches of *Retama raetam* subsp. *gussonei* (Webb) Greuter are still collected for use in floral compositions, particularly for bridal bouquets or as gifts. In the past, activities, such as breeding were more common, and agricultural production was carried out using outdated methods compared to those used today. In Italy, this species is endemic to Calabria and Sicily (Peruzzi and Cesca 2003; Ferrauto et al. 2015), but there are no other known uses for it. Elsewhere in the world, the plant is used for medicinal purposes (Pieroni et al. 2006;

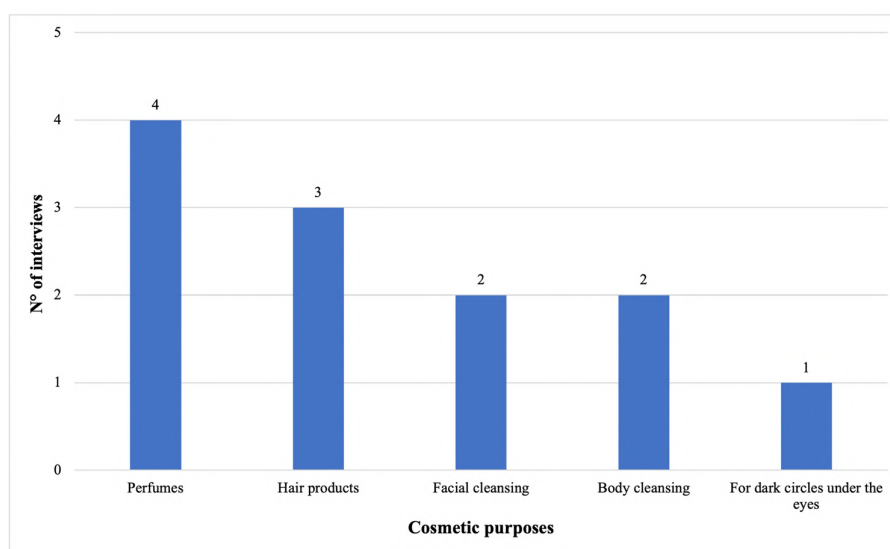


Figure 13. Cosmetic purposes sorted by number of interviews.

Karous et al. 2021). Rabbits were also bred in the region, and their feed consisted of small leaves of *Robinia pseudoacacia*, a use that has been previously reported in Liguria (Cornara et al. 2014) and Tuscany (Viegi et al. 1999).

In the production of dairy products, various plant parts from *Ficus carica*, including young branches and fresh fruits, were gathered, and mixed with milk to curdle it, a practice that has been documented in various regions, such as Campania (Scherrer et al. 2005; Savo 2009), Sicily (Arcidiacono et al. 2010), and Calabria (Musarella et al. 2019). Similarly, the largest flowers of *Scolymus hispanicus* were collected, dried in the sun, and then boiled in milk to produce vegetable rennet. *Achillea maritima* (L.) Ehrend. and Y.P. Guo, also known as sea daisy, is commonly found on beaches and was traditionally used to cleanse the body of tar by rubbing it on the affected areas.

Other uses for these plants are less common, including construction (*Robinia pseudoacacia*), entertainment (*Avena barbata* Pott ex Link), and religious purposes (*Asparagus acutifolius* L.).

4. Conclusions

The study carried out on the Tyrrhenian side of the Aspromonte Massif has shown that there are still people who use plants in a variety of ways, or at least preserve the memory of these uses, confirming the hypothesis that ethnobotanical traditions in southern Italy are preserved over time.

Food uses are the most common: in fact, plants are often associated with food, as an essential source of vitamins and various nutraceutical elements. Medicinal uses are also very common: the medicinal recipes handed down by the local population seem to be very effective, and this is often confirmed by the fact that bioactive molecules are extracted. The results of this research have shown that many of the uses recorded in the study area were already known in other areas of Calabria and other Italian regions, and in some cases abroad. This confirms how, over time, humans have selected the most effective plants (many of which are common to areas that are sometimes very distant from each other) to satisfy their essential needs (food, health, and well-being) and others of secondary importance, and were able to share this information by word-of-mouth.

During our survey, two taxa were found that are not previously reported for the region of Calabria: *Reichardia crassifolia* (Willk.) Guarino and Pignatti, a native species reported for the first time in peninsular Italy and used as a food plant, and *Tetragonia tetragonoides* (Pall.) Kuntze, an alien species reported here for the first time in Calabria and used for the preparation of omelettes.

Uses not previously mentioned in the literature include *Agave americana* L. placed at the entrance to the house to ward off the “evil eye” (*malocchio*, in the local dialect), as was already known for *Aloë arborescens*; *Raphanus raphanistrum* L. subsp. *landra*, a taxon used as a garnish, as previously reported for northern Italy; *Solanum melongena* L., used to obtain a purple colour from a decoction of the rind used for dyeing textiles.

The presence of a good number of alien species among the several native ones, confirms the well-established tradition of using them for several purposes, as already highlighted by several scholars.

Unfortunately, the percentage of people who still have this knowledge is very low, as most of them are elderly and many of them have died without passing on this knowledge.

Globalization, changing lifestyles, and work that is no longer tied to agriculture have meant that the link with the rural environment is increasingly weakened in favour of quick and ready-made foods, synthetic medicines, and manufactured goods that can be bought in shops.

However, unless the importance of the cultural heritage preserved in places where the use of plants is still alive is emphasized, this information will be lost forever.

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APPENDIX 4. A review of *Opuntia ficus-indica* ethnobotany in Italy and North Africa

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Review Article

A review of *Opuntia ficus-indica* (L.) Mill. ethnobotany in Italy and North Africa

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Abstract: *Opuntia ficus-indica* (L.) Mill., commonly known as prickly pear, is a versatile plant widely used for food, medicinal, and cosmetic purposes in various regions of the Mediterranean and North Africa. This study provides a comparative ethnobotanical review of prickly pear uses in Algeria, Morocco, Tunisia, and Italy. In total, 74 articles were selected from ethnobotanical uses in Italy, Algeria, Morocco and Tunisia. In the Maghreb, the plant is used for fruit production and processed products, such as jams, oils, and flours, as well as for traditional medicinal purposes. In Algeria and Morocco, the fruits and cladodes are used to treat digestive disorders, diabetes, and skin diseases. In Tunisia, products derived from *O. ficus-indica* are also applied in the cosmetic industry and for erosion control. In Italy, particularly in Sicily and Calabria, the prickly pear is a vital resource, used for both food consumption and for medicinal purposes. The cladodes, rich in mucilage, are applied as topical remedies for skin problems, while the fruits are a key ingredient in the preparation of traditional desserts. Furthermore, *O. ficus-indica* has historically been used as forage and to produce natural dyes. Results indicate that the versatility of this species, combined with its ability to adapt to extreme climates, makes it a valuable resource for the development of new nutraceutical and cosmetic products. However, further scientific research is necessary to explore the bio-functional potential of this plant and to promote its broader and more sustainable use, especially in arid and semi-arid regions.

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1. Introduction

In the last few decades, there has been an increase in global awareness of human nutritional habits, with a significant interest in natural and healthier foods [1]. In addition to their nutritional value, plants and their components (stems, leaves, roots, flowers, and fruits) are also being investigated for their potential beneficial effects on human well-being. This is thought to be due to the presence of bioactive compounds [2,3].

The cactus *Opuntia ficus-indica* (L.) Mill., commonly referred to as prickly pear, cactus pear, or Indian fig tree, represents the most economically significant cactus crop [4]. The plant is cultivated primarily for its highly nutritious fruits, which are commonly referred to as "tunas" [5]. *Opuntia ficus-indica* is the most widespread within the Cactaceae family. The species demonstrates a high degree of adaptability to diverse climatic conditions. Its principal cultivation regions encompass the Mediterranean Basin, with a particular concentration in North Africa and Italy [7].

The species is distinguished by an aerial structure comprising cladodes, or paddles (Figure 1a), which serve to support the plant and store water. Additionally, they are a rich source of bioactive compounds with health-promoting properties, as evidenced by previous studies [8,9].

From an environmental point of view, cactus cladodes are an effective tool in the fight against desertification, erosion and soil problems [10-12]. The plant parts are fleshy, which enables them to tolerate prolonged drought conditions [13,14]. Additionally, the plant produces fleshy spinescent fruits, commonly known as cactus pear or prickly pear fruits (PPFs) (Figure 1b), which are typically consumed as fresh seasonal fruit [15].

Cacti employ a distinctive metabolic pathway, known as Crassulacean Acid Metabolism (CAM), to fix carbon dioxide. This process enables them to achieve a conversion efficiency of four to five times greater than that observed in C-4 plants [16]. Of note is the crop species *O. ficus-indica*, which plays a significant role in modern ethnobotanical culture [6].

In recent years, the cladodes of *O. ficus-indica* have garnered increasing attention for their ecological, environmental, and socio-economic benefits. Due to their rich composition, including water (88-95%), proteins (4-10 g/100 g of dry matter), lipids (1-4 g/100 g of dry matter), carbohydrates (64-71 g/100 g of dry matter), and fibers (around 18 g/100 g of dry matter) [17], as well as minerals and vitamins [18], they are considered a promising raw material for animal feed. Additionally, they are used in the production of renewable fuels and chemicals for industrial, food, medical, and cosmetic applications [19,20].

The present study represents a comparative ethnobotanical review of the different uses of *O. ficus-indica* in the Maghreb (Algeria, Morocco, and Tunisia) and Italy.

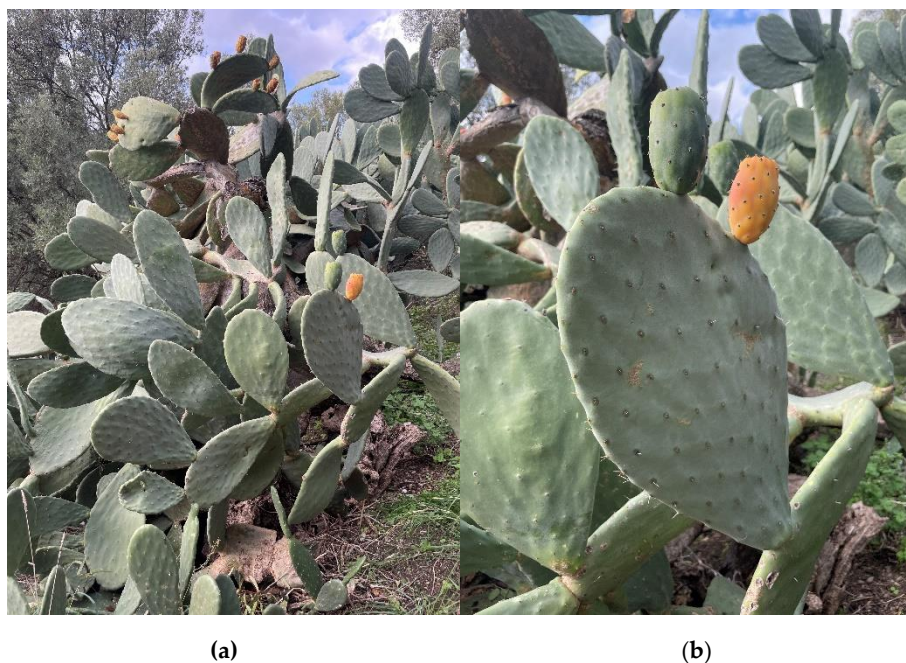


Figure 1. (a) Typical aerial structure of *Opuntia ficus-indica* (L.) Mill. (Cactaceae); (b) cladodes and fruits (Ph. Miriam Patti, 01/12/2022, Bova, Reggio Calabria, Italy).

2. Materials and Methods

To collate the data, a comprehensive literature review was conducted on the *O. ficus-indica* plant and its ethnobotanical applications across the primary online research platforms, namely Scopus and Google Scholar. The search was carried out by entering '*Opuntia ficus-indica*' AND 'ethnobotany' on the search platforms. All ethnobotanical

articles that included the use of *O. ficus-indica* were considered. The scientific articles and books available for consideration included those that documented traditional ethnobotanical uses of *O. ficus-indica*, encompassing all potential applications, including food, medicine, and agropastoral practices. For North Africa, 24 bibliographic sources were selected, while for Italy, 50 bibliographic sources were selected.

Once the bibliographic sources had been selected, data were gathered on the local dialect name, the type of use, the plant used and the method of utilization, where applicable.

3. *Opuntia ficus-indica* in North Africa (Algeria, Morocco and Tunisia)

A total of 24 articles talking about ethnobotanical uses on *O. ficus-indica* in Morocco, Tunisia and Algeria were selected. Historical records indicate that the cactus pear was introduced to North Africa by the Spanish during the 16th century [21]. The area assigned to this species is currently in continuous expansion in Algeria, Morocco, and Tunisia, with the total area exceeding 30,000, 120,000, and 600,000 hectares, respectively [22].

In northern Algeria, the entire plant is utilized as a fence around houses and towns, with the fruits produced by the same fence plants are destined for human consumption. In contrast, in the south, the cladodes are used to feed small animals [7].

In Morocco, a considerable proportion of the fruit is processed into a variety of products, including jam, vinegar, flour and seed oil. In Tunisia, the production of fruits of *O. ficus-indica* is more intensive than in other countries of the Maghreb. The processed products are employed in both the agri-food and cosmetic industries. Furthermore, the plants have been applied in the control of erosion [22].

3.1. Common names of *Opuntia ficus-indica*

The coexistence of both Arabian and Berber cultures in Maghreb countries leads to the diversification of local languages and dialects and, consequently, to the diversification of names given to different crops. *Opuntia ficus-indica* has different common names, even in the same country. In Algeria, a single name, "El Hendi", was identified [23]. In Morocco, multiple local designations for *O. ficus-indica* have been documented, including Sabbar, Handiya, Karmouss n'sara [24], Nawwar and Al'Handiyya [25].

3.2. Type of uses of *Opuntia ficus-indica*

The fruits and other parts of this species have been employed in traditional medicine for a variety of purposes in numerous countries [26].

In Algeria, the fruit is used raw or in decoctions for the treatment of digestive disorders and is held in high regard for its anti-diarrheal effect [23,27,28]. Additionally, it is employed in the manufacture of hair care products [23,29].

In a previous study, Sarri *et al.* [23] demonstrated the antidiabetic effect of the flower. Other significant applications include the preparation of infusions and decoctions with *Opuntia* cladodes and flowers for the treatment of intestinal inflammation and cystitis [30-33].

Additionally, the mucilage present in the cladodes is employed as an ointment for the treatment of dermatological conditions [32].

In addition to the medicinal applications, no food-related uses were identified in this region. Table 1 presents a comprehensive overview of the various applications of *O. ficus-indica* in Algeria.

In Morocco, *O. ficus-indica* has a long history of use in traditional medicine. As documented by Bellakhdar *et al.* [33], the flowers are employed for their diuretic and antibiotic effects, and they are utilized in infusions to treat uterine, kidney, and bladder infections. The same applications were documented by Fatiha *et al.* [34], additionally confirmed the utilization of the entire plant in the treatment of genitourinary disorders.

In a further investigation, Merzouki *et al.* [25] identified additional effects, namely antidiarrheal and calefacient properties (a sensation of warmth). Furthermore, dried and ground flowers (flower powder) have been employed in the treatment of gastric discomfort [24,35-38]. The fruits and flowers have been taken in decoctions, powders, and infusions (for oral and external use), and have been reported to treat respiratory, skeletal, circulatory, and urinary problems [21,34,36,37]. In Morocco, *O. ficus-indica* has been employed in the treatment of diabetes mellitus [38-41]. As in Algeria, according to Lyoussi *et al.* [42], mucilage from the plant is rubbed on the skin to treat skin inflammation. However, there is less information on Tunisia than on other North African states. Nevertheless, some applications have been recorded regarding the use of decoctions with *O. ficus-indica* leaves to treat the kidneys and eliminate kidney stones [43-46].

Table 1. Ethnobotanical uses of *Opuntia ficus-indica* (L.) Mill. (Cactaceae) in Algeria.

Country	Common name	Purpose	Plant Part	Method of use	References
Algeria	El Hendi	Antidiarrheal	Fruits	Raw	Baziz (2021)
		Digestive disorders	Fruits	Raw	Bendif (2021)
		Digestive disorders	Fruits	Raw	Hamel <i>et al.</i> (2018)
		Hair care			
		Digestive disorders	Fruits	Raw	Mechaala <i>et al.</i> (2022)
		Antidiarrheal			
		Anti-Flu			
		Dermatologic	Cladodes	Poultice	Miara <i>et al.</i> (2019)
		Hair care	Fruits	Raw	
		Antidiarrheal	Fruits	Decoction	Sarri <i>et al.</i> (2015)
		Antidiabetic	Flowers	Beverage	Souilah <i>et al.</i> (2022)
		Antidiarrheal	Fruits	Raw	
		Urinary inflammations and cystitis	Cladodes	Infusion or beverage	Zatout <i>et al.</i> (2021)
	Fruits				

In 2018, Mouhaddach *et al.* [47], conducted a more detailed study on the medicinal uses of different parts of the cactus, including cladodes, flowers, seeds, and roots. The cladodes have been demonstrated to possess analgesic and anticholesterolemic properties. They are cultivated through the process of drying and growing, and the resulting powder can be taken with water or milk to provide relief from a variety of aches and pains, including stomachaches, back pain, and leg pain. Additionally, the cladodes can be sliced and prepared in brine to reduce cholesterol levels. The mucilage derived from cladodes is employed in both medicinal and cosmetic applications. The application of a mixture of freshly collected cactus material, milk, and mucilage to the liver is believed to have a curative effect on liver diseases. Similarly, the topical application of this mixture to the hair is thought to result in a softer appearance. The flower powder decocted in water has been demonstrated to have therapeutic effects in the treatment of kidney and prostate diseases, as well as in the alleviation of leg and back aches. When mixed with honey, this powder has been shown to possess efficacy in the management of asthma and liver disease. Conversely, seed powder has been employed in the treatment of dermatological problems and cardiovascular disorders. Finally, dried and ground roots have been combined with honey or milk for the treatment of asthma.

A comprehensive overview of these applications is presented in [Table 2](#).

Table 2. Ethnobotanical uses of *Opuntia ficus-indica* (L.) Mill. (Cactaceae) in Morocco and Tunisia.

Country	Common name	Purpose	Plant part	Method of use	References	
Morocco	Hendi	Urinary inflammations and cystitis	Flowers	Infusion or Decoction	Ammor et al. (2020)	
	Kermous Hendiya	Urinary inflammations and cystitis	Flowers	Infusion	Bellakhdar et al. (1991)	
	-	Antidiabetic	Seeds	Extract	Berraaouan et al. (2015)	
	Handya, Zaaboul	To treat urolithiasis	Flowers Fruits	Infusion	Chakit et al. (2022)	
	Híndi (arabe)	Digestive disorders	Flowers	The powdered flower is used against stomach disorders	De Natale & Pollio (2012)	
	Hindiya	Stomach pain	Flowers	Powder	El-Hilaly et al. (2003)	
	Dreg, lhandia	Genito-urinary disorders	Entire Plant	Infusion	Fatiha et al. (2019)	
	Aknari	Digestive disorders	Kidney disease	Flowers	Decoction	Idm'hand et al. (2020)
			Stomach pain	Fruits	Raw	
	Hendiya, Kermous	Antidiabetic	Flowers	Raw	Jouad et al. (2001)	
		Dermatologic	Mucilage	Rubbing the ointment for skin disease		
	El handia	Stomach pain	Flowers	Powdered and ingested	Lyoussi et al. (2023)	
	Nawwar, Al'Handiyya	Diuretic	Flowers	Infusion	Merzouki et al. (2000)	
Antidiarrheal		Flowers	Infusion			

Calefacient		Mixed with 'Rass al Hannout' (spice mix) preparation and ingested	
		The dry material was ground to powder and then taken with water to alleviate stomach suffering	
Analgesic		Cladode powder was swallowed with water or milk to relieve back pain	
		Cladode powder was mixed with water and then applied to the legs to alleviate leg ache	
To treat cholesterol	Cladodes	Young cladodes were sliced and prepared in brine to reduce cholesterol levels	
Liver diseases		Mucilage was collected from cladodes and then freshly mixed with milk	
Hair care		Mucilage was collected from cladode and then freshly applied to the hair To make hair softer	Mouhaddach <i>et al.</i> (2018)
Kidney diseases		Decoction of dry and ground flowers	
Analgesic		Decoction of dry and ground flowers	
Used for asthma	Flowers	Dry and ground flowers was mixed with honey	
Prostate diseases		Decoction of dry and ground flowers	
Liver diseases		Dry and ground	
Dermatologic	Seeds	Seeds were dried and ground to cure diseases of the skin	
Cardiovascular		Seeds were dried and ground	
Respiratory	Roots	Dry and ground roots was mixed with honey or milk Used for asthma	
Respiratory	Flowers	Decoction, powder, infusion (oral and external use)	

		Digestive	Fruits		
	Sabbar, Handiya, Karmouss nsara	Skeleton Circulatory Urinary Diuretic			Ouhaddou et al. (2014)
	Prickly pear	Antidiabetic	Flowers Fruits	Powder	Tahraoui et al. (2007)
		Elimination of kidney stones	Cladodes Fruits	Decoction Cataplasm	
	Figuier de Barbarie Figuier d'Inde	Stomach pain Antidiarrheal Dermatologic	Fruits	Raw	Ben salah et al. (2019)
Tunisia	-	Kidney disease	Cladodes	Extract	Wannes & Tounsi (2022)

4. *Opuntia ficus-indica* in Italy

A total of 50 bibliographic sources has been selected regarding the ethnobotanical uses of *O. ficus-indica*. Prickly pear cacti were introduced to Europe by the first Spanish colonists between the end of the 15th century and the beginning of the 16th century [48].

The commercially cultivated *O. ficus-indica* is grown for fruit production in Southern Italy, particularly on the island of Sicily, where over 4000 ha of specialized plantations yield 60000 t of fruit [49].

The introduction of *O. ficus-indica* has been met with considerable enthusiasm in Sicily, where it has become a significant fruit crop and medicinal plant [50]. There is evidence that this species was being used as a food source for humans at least 9,000 years before the present day [51], or as early as 12,000 years ago [52]. This would have been prior to the species being cultivated [53].

Italy, and Sicily in particular, represents an atypical example in the appreciation of *O. ficus-indica*. The exploitation of the cactus pear has a long history, with multiple uses documented since the 18th century. These include the use of the fruit as a filler in farming systems and as an emergency fodder. It was referred to as "bread for the poor" [54,55]. Furthermore, this taxon is important in other regions of the world, including Mexico, where prickly pear is extensively utilized as animal fodder [56].

In 1975, the establishment of modern plantations for the fruit industry marked a significant turning point. Cactus pear production is particularly well-suited to environments that are unsuitable for other crops. In Italy, cactus pear cultivation is concentrated in Sicily, accounting for 90% of the total production. Most of this cultivation occurs in the San Cono hills, in south-western Ethneo, and in the Belice valley [22,57].

4.1. Common names of *Opuntia ficus-indica*

The plant is commonly known as "fico d'India" or "ficodindia". Other local Italianized terms are also used, but dialectal names are generally adaptations of the main term.

Analysing the etymology of the name "Fucurinia", it is assumed to come from India, but it comes from the so-called West Indies, i.e. the Americas [58]. Research conducted in various countries in southern Italy has shown various local names for the plant, as well as for the fruit: Ficarazzi, Fichilindi, Fichi a paletta, Ficundiani, Ficundiana, Ficundiano, Ficuniano, Fik de mori, Fik palet, Pittara, Sico tu trucu, Sicovindo, Stidda (Calabria); Fecurìnia, Ficundiano, Ficarenia, Ficurinie, Figurine (Campania); Zavata (Emilia-Romagna); Figu turco (Liguria); Agnus (Piemonte); Sicodiani (Puglia); Figu morisca (Sardinia); Ficudinia, Ficu d'innia, Ficudinnia, Ficurinnia (Sicily); Erba da calli (Toscana) [59].

4.2. Types of use of *Opuntia ficus-indica*

Opuntia ficus-indica has been employed in a multitude of ways (Tab. 3). In the modern era, prickly pear cacti are cultivated primarily for their large sweet fruits (commonly referred to as "tunas"), which are available in local and commercial markets worldwide [60,61].

The primary use of prickly pears is as fresh fruit, although they are also employed in the production of cakes and preserves [62]. Furthermore, they constitute the principal ingredient in the preparation of typical Calabrian sweets: "*i mustazzola*" and "*i sulicchiati*". To prepare them, the thorns of the fruits are removed, the fruit is cut into pieces, boiled, and then added to the dough [63].

In Sicily, this taxon has become so well-established that it may be considered a typical specimen of the island's coastline. In Sicilian culture, two dishes are prepared using *O. ficus-indica*: "*Mostarda di ficurinia*" or "*Pizichintì*", which is a pastry made with the mucilage of this species boiled and mixed with a dough made from wheat, almonds, hazelnuts,

cinnamon and sugar, and "*Sucu pa pasta cu li ficurinnia*", a sauce for pasta made with olive oil, garlic, and pulp of the seedless *O. ficus-indica* fruit [64].

It is a plant with several uses in ethnobotany [65]. In the popular traditions of Sicily, *O. ficus-indica* is employed in human medicine. In ancient remedies, the mucilage of the prickly pear cactus is used to treat coughs and whooping coughs. A similar use has been documented in Sardinia [66], and Campania [67].

It is notable that the same plant can have different effects depending on the preparation method. For instance, an infusion [68-71], or a decoction of flowers [72-76], has been observed to have diuretic properties. Additionally, the mucilage and epidermis of the prickly pear fruit have been demonstrated to possess hemostatic properties [63,71,75,77]. Furthermore, a concentrated decoction of the root of the prickly pear plant with olive oil has been documented to have a curative effect on meteorism [68]. These findings have been corroborated by research conducted in other regions, including Brazil [78].

Table 3. Ethnobotanical uses of *Opuntia ficus-indica* (L.) Mill. (Cactaceae) in Italy.

Survey area	Common name	Purpose	Plant part	Method of use	References
Apulia	Fid'dinie	Diaphoretic Laxative For skin problems	Cladodes	-	Bianchi & Gallifuoco (2004)
	Ficarizza	Food Laxative	Fruits	Raw as snack	Biscotti et al. (2021)
	Sicodiani	For wounds	Cladodes	-	Frigino et al. (1999)
Basilicata	-	Food	Fruits	-	Caneva et al. (1997)
Calabria	Ficu'nniana	Skin problems	Cladodes	The cladode is heated in ash and applied to the corresponding part of the skin when the spleen is swollen and there is pain. Again, after being heated, the cladode is also used as a resolvent for boils and as a healer for burns.	Barone (1963)
	Ficu ndiani	Agropastoral	Cladodes	Before planting, pieces of cladodes were interred as fertilizer	Gentile et al. (2022)
	Ficundianu, Stidda	Healing Liver disorders	Cladodes	Cladodes roasted and placed directly on the skin, or even the mucilage of these mixed with olive oil are applied to sores and burns. The mucilage of the crushed cladodes, reduced to a pulp and left to drain through a cloth, is drunk to cure various liver ailments	Leporatti & Pavesi (1989)
	Ficundiana	Dermatologic	Cladodes	The epidermis of the cladodes is removed and used to heal the wounds and skin excoriation	Maruca et al. (2019)
	Fik palet,	Antirheumatic Food	Cladodes	Used topically as antirheumatic for the knees Peels sundried and then batter-fried Liquor	Mattalia et al. (2020a)

	Fichi a paletta, Fik de mori			Raw as snack	
	Fichilindi	Food	Cladodes	Raw or baked	Mattalia et al. (2020b)
	Pittara	Dermatologic Ludic	Cladodes	The mucilage used as a wound cicatrizer Cladodes were cut and a handcar was realized by assembling the pieces with the cane	Musarella et al. (2019)
	Sico tu trucu, Ficarazzi (fruits); Pittara (plant)	Food	Fruits	Raw as snack	Nebel et al. (2006)
	Ficundianu, Stidda	Antispasmodic Diuretic	Flowers	Infusion	Passalacqua et al. (2007)
	Ficuniano	Antispasmodic Antidiarrhoeic Diuretic To treat bronchitis Anti-inflammatory Magic remedies	Flowers Fruits Cladodes	Infusion A “paletta” (cladode) was placed near the fireplace. It was believed that when the stem of the plant dried, the fever or the hepato-splenomegaly would disappear	Tagarelli et al. (2010)
Campania	-	Back pain	Cladodes	-	De Feo et al. (1992a)
	-	For corns and chilblains	Cladodes	-	De Feo et al. (1992b)

	-	Antirheumatics	Cladodes	-	De Feo & Senatore (1993)
	Figurine	Food	Cladodes	Raw or boiled in salads	De Natale et al. (2020)
	Ficurenia	Food	Fruits	Raw as snack	Di Novella et al. (2013)
	Figurine	Dermatologic	Cladodes	Mucilage used as a skin lenitive	Mautone et al. (2019)
	Ficurinie	Food	Fruits	Raw as snack	Menale et al. (2016)
	Fecur`nia	Food	Fruits	Fruits were deprived of the thorns, and the peels were dried in the sun, and preserved for the winter to be fried with potatoes. The pulp of the fruits, on the other hand, was consumed fresh	Salerno & Guarrera (2008)
		Agropastoral	Cladodes	The cladodes are broken up and interred where vegetables, especially cucumbers, are planted to make the soil more fertilized, moist and fresh.	
		Respiratory disease	Flowers Cladodes	Decoction for cough, bronchitis and pneumonia	Savo et al. (2013)
		Making ships go faster	Cladodes	Cladodes are rubbed on the hull of ships to make them go faster	
Latium	-	Used for pertussis	Cladodes	-	Guarrera (1994)
Liguria	-	Treat varicose veins	Cladodes	Frictions with plant mucilage to treat varicose veins	Maccioni et al. (1994-1995)
	-	Astringent	Cladodes	-	Maccioni et al. (2000)

Marche	-	Purgative effect	Fruits	-	Guarrera (1981)
	-	For burns	Cladodes	-	Atzei <i>et al.</i> (1994)
	-	Dislocation and swelling			
	-	Skin problems	Cladodes	-	Ballero <i>et al.</i> (1994)
Sardinia	Figu morisca	Dermatologic	Cladodes	Direct application for skin disease, viral infection (herpes) and joint pains	Ballero <i>et al.</i> (2001)
		Antitussive	Fruits	Jam for cough catarrhal	
		Antirheumatics		Used for myalgia and arthritis	Bruni <i>et al.</i> (1997)
		Skin problems	Cladodes	-	
		For burns		Used for burns, oedemas, insect bites and nettle inflammation	Palmese <i>et al.</i> (2001)
	-	Diuretic	Flowers	Decoction	Amico & Sorce (1997)
	-	Diuretic	Flowers	Decoction	Arcidiacono <i>et al.</i> (1999)
Sicily		Digestive disorders	Cladodes	A liquid is extracted from the mucilage of the cladodes	
	Ficudinia	Food	Fruits	With the fruits, typical sweets are prepared: " <i>mustazzola</i> " and " <i>sulicchiati</i> ". To prepare, the fruits are cleaned of their thorns and cut into small pieces, then boiled, then added to the mixture	Arcidiacono <i>et al.</i> (2010)
	-	Diuretic	Flowers	Decoction	

	Hemostatic	Cladodes	Mucilage is applied directly to the skin as a hemostatic	Barbagallo et al. (1979)
-	Diuretic	Flowers	Infusion	Catanzaro (1968)
	Digestive disorders	Roots	Decoction with olive oil treat meteorism	Catanzaro (1970)
-	Diuretic	Flowers	Decoction	Galt & Galt (1978)
Ficudinnia	Fodder	Fruits	Raw fruit given to animals	
	Diuretic	Flowers	Infusion and decoction	
Ficurinnia	Hemostatic		Mucilage and epidermis are hemostatic	Guarrera (2009)
	Domestic	Cladodes	Cladodes were used as a container for the crystallization of " <i>manna di pala</i> ", obtained from the sap of <i>Fraxinus sp.</i>	
-	Urological disease			Leonti et al. (2009)
	Kidney disease	Flowers	Decoction	
-	Diuretic and gastrointestinal refreshing	Flowers	Decoction with flowers	Lentini et al. (1988)
-	Diuretic	Flowers	Decoction	Lentini et al. (1994)
-	Emetic			
-	Skin inflammation	Cladodes	-	Lentini et al. (1995)
-	Stomatitis			
-	For kidney stones	Cladodes	-	Lentini et al. (1997)
Ficurinnia	Food	Fruits	" <i>Sucu pa pasta cu li ficurinnia</i> ", sauce for pasta with fruits without seeds	

				<i>"Mostarda di ficurinia"</i> , a typical dessert prepared with boiled <i>Opuntia</i> fruit mucilage and other ingredients.	Lentini & Venza (2007)
		Laxative			
		Treat tuberculosis	Cladodes	Infusion and decoction	
	Ficu d'innia, Ficudinia	Food	Fruits	Make cake and preserves	Licata et al. (2016)
	-	Kidney disease	Flowers	Treat renal colic	Pitrè (1896)
	-	Antitussive	Cladodes	-	Chiavoni & Raffo (1994)
Tuscany					
	Fico d'India	Intestinal astringent, cicatrizing	Cladodes	Cladodes, well crushed to obtain a poultice, placed between two gauzes, is applied on slow-healing wounds	Manganelli & Tomei (1999)
		For diarrhea	Fruits	Fresh fruit is eaten for diarrhea	

As documented by Ballero et al. [66], the mucilage of *O. ficus-indica* is employed directly in the treatment of dermatological problems, herpetic infections (herpes), and joint discomfort in the Fluminimaggiore region of southwestern Sardinia.

An important use is that reported by Leonti et al. [50], who indicate that prickly pear petals can be used to treat urological problems. Similarly, Pitrè [79] and Lentini et al. [80] cite the same part of the plant as a cure for kidney colic and kidney stones. Alternatively, a paste comprising desiccated cactus flowers was applied topically to relieve the symptoms of measles [69].

In southern Italy, *O. ficus-indica* is employed for a variety of purposes, including food [81], medicinal [82-94], but also ludic, agropastoral and magical. The fruits and cladodes are consumed raw as snacks in Calabria [1,95-99] and Campania [100-102]. The mucilage within the cladodes is utilized topically for dermatological problems in Calabria [103-107] and Campania [108,109].

It is notable that the same plant may exhibit different effects. For instance, the fruit of *O. ficus-indica* designated as "*ficurinnia*", has been observed to induce constipation when consumed with seeds. Conversely, when consumed without seeds, it has been demonstrated to function as a laxative [64].

The mucilaginous cladodes are used as a popular medicine treatment for gastritis, with the mucilage extracted and consumed orally [63].

Some applications are more localized and specific. For example, the use of *O. ficus-indica* cladodes rubbed on the hull of ships was observed on the Amalfi Coast (Campania) [67], with the apparent objective of increasing the speed of the vessels. Another application is as a fuel source for ovens or as a bird trap [77].

In 1978, Galt & Galt [69] conducted a more detailed study on the use of some wild plants on the islands of Pantelleria in Sicily. They focused on *O. ficus-indica* (*ficus-dinnia*), which, although cultivated by some, grows wild on the island. Cactus fruits are utilized as a dietary supplement for swine. The cactus pads were harvested and placed over the young tomato plants, providing protection from direct sunlight. In the past, the pads were also employed as makeshift plates for men, who consumed their midday meals in the fields.

In Sicily, cactus pads were employed as containers for the crystallization of "*manna*" or "*manna di pala*", a vegetable product derived from the sap of certain *Fraxinus* species (*F. ornus* L. subsp. *ornus* and *F. angustifolia* Vahl subsp. *angustifolia*). It is a natural sweetener with mild laxative, emollient and cough-sedative properties [74].

A practice unique to the National Park of Cilento and Vallo di Diano is the utilization of the "skin" (epicarp) of the fruits of the prickly pear, which were previously denuded of thorns, dried in the sun, and preserved throughout the winter for frying with potatoes [110]. Another noteworthy application of cladodes is their incorporation into the soil surrounding vegetable crops, particularly cucumbers, to enhance soil fertility [110]. A comparable utilization was documented by Gentile et al. [111].

Malaria is an endemic disease in Italy, but it was eradicated by the mid-20th century. Tagarelli et al. [112] elucidated the prophylactic and therapeutic remedies employed by folk medicine to treat malaria in Calabria (southern Italy), where it was perceived as a condition of supernatural origin. Therefore, recourse was had to magical remedies believed to be linked to the disease. A cladode, known locally as a "*paletta*", was placed in proximity to fireplaces. It is hypothesized that the application of the plant in a dried state may result in the alleviation of symptoms such as fever and hepatosplenomegaly.

The *O. ficus-indica* plant is also employed in northern Italy. In Tuscany, it is utilized as an antitussive [113], a gastrointestinal tonic and astringent [114] and to treat diarrhea [120]. In the Marche region, the laxative effect consuming the fruit at its maximum ripeness has been identified [115]. In the Liguria region, cladodes are employed for their astringent effect and to treat varicose veins by fractionating the plant mucilage [116,117].

5. Conclusions

The ethnobotanical studies conducted in North Africa have demonstrated the significance of *O. ficus-indica* as a vital source of sustenance, forage, and hydration for local communities and their livestock. Additionally, it serves as a valuable resource to produce cosmetics and traditional medicinal remedies. Despite the growing interest in this species in North Africa, the surveys conducted in Algeria are less comprehensive than those conducted in Morocco, and its traditional uses are limited to flowers and fruits. In rural Moroccan communities, all parts of the prickly pear are utilized, with one part often employed for a variety of medicinal purposes. The medicinal applications of *O. ficus-indica* are numerous and comparable in both Morocco and Algeria. However, the most frequently cited effects are its digestive and diuretic properties. In conclusion, the promising features for future studies are the promising nutritional and medicinal properties associated with the high adaptability of *O. ficus-indica*, even in the most extreme environments of North Africa.

In Italy, particularly in Calabria and Sicily, this taxon is fully exploited in all its parts. This includes the dietary use of fruits and cladodes, the medicinal use of the mucilage as a healer and disinfectant, and the preparation of infusions to treat kidney and digestive problems. This demonstrates the ubiquitous nature of this species and its potential for use in a wide range of applications.

The non-food uses of prickly pear offer excellent potential, given the bio-functional, medicinal, nutraceutical, and cosmetic properties that can be exploited. Several products have been the subject of recent patent applications [22,118].

A plethora of methodologies exists for the processing of *O. ficus-indica* fruits, cladodes, and seeds. The extensive range of products and by-products derived from cacti has the potential to confer significant benefits to a vast number of people, including those residing in arid and semi-arid regions across the globe. Cacti represent a significant source of bioactive compounds, making them an excellent candidate for nutraceutical preparations and functional foods. The scientific data have revealed a high content of certain chemical constituents in fruits, cladodes, seeds, and flowers of this cactus, which can add value to the products derived from this species. Furthermore, some constituents have demonstrated potential as health-promoting substances. Further exploitation of the functional properties of cactus products in the food, cosmetic, and pharmaceutical industries is a possibility, although further scientific research in these fields is required.

Despite the extensive knowledge gathered on *O. ficus-indica*, there remains a significant research gap regarding its lesser-known traditional uses and the potential of some of its biofunctional properties. This gap underscores the importance of further investigation to fully exploit and valorize this species, especially in underexplored regions, and to promote its potential applications across diverse sectors such as nutrition, medicine, and cosmetics.

Despite the considerable advances that have been made, there is still much to be discovered, presenting exciting prospects for future research and innovation.

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APPENDIX 5. Floristic update on the SAC “Pentidattilo” (Calabria, Southern Italy)

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Floristic Update of the SAC “Pentidattilo” (Calabria, Southern Italy)

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Abstract. The main aim of the Habitats Directive and the Birds Directive approved in 1992 by European Union is to preserve biodiversity through the conservation of natural habitats, wild flora and fauna in all European member states. To this end, the Natura 2000 Network was established: it identifies Special Areas of Conservation (SACs) (former Sites of Community Interest (SCIs)) and Special Protection Areas (SPAs). In order to analyze the biodiversity of an area of exceptional natural, historical and cultural importance such as the ‘Pentidattilo’ SAC, its vascular flora was sampled and all its habitats detected between December 2021 and May 2023. Thanks to this study, it was possible to update previous floristic knowledge, from around 25 years ago until 2018. To date, 343 taxa belonging to 61 families have been recorded: among these, the most representative is the Asteraceae, followed by the Fabaceae and Poaceae. Using the software QGIS 3.28, the boundaries established by the Natura 2000 Network for the ‘Pentidattilo’ SAC were drawn and all surveys were conducted within them. Using the orthophotos of the area and the previously published cartography for monitoring the Natura 2000 Network, 14 habitats were identified, of which 5 of Habitats Directive.

Keywords: Biodiversity · Conservation · Endemism · Flora · GIS · Habitat directive · Habitats · Reggio Calabria

1 The European Framework on Biodiversity Conservation

1.1 Habitats Directive (Council Directive 92/43/EEC)

The Directive approved in 1992 as the Habitats Directive and the Birds Directive established by the Directive of 30 November 2009, form the basis of the EU policy on biodiversity conservation through the legal establishment of the Natura 2000 Network [1, 2]. The main purpose of the Directive is to preserve biodiversity through the conservation of natural habitats, wild flora and fauna of the European Member States [3].

To this end, the aforementioned directive lays down measures to ensure that the habitats with species of Community interest found there are maintained or, where appropriate, restored to an adequate state of conservation [4]. The Directive is based on two pillars: the Natura 2000 ecological network and the protection regime for the species listed in

the text [5]. The Directive lays down rules for the management of Natura 2000 sites in various aspects, financing, impact assessment, the preparation of national and international reports for the implementation of the provisions, possible derogations and, finally, recognizes the importance of landscape elements that play an ecological connection role for flora and fauna.

1.2 Natura 2000 Network: SCIs, SACs, SPAs

The Natura 2000 Network is the specific instrument established under the Habitats Directive 92/43/EEC to ensure the long-term maintenance of threatened or rare natural habitats and species of flora and fauna at the European level. This network identifies Sites of Community Interest (SCIs) that are subsequently designated as Special Areas of Conservation (SACs) and also Special Protection Areas (SPAs), the latter established under the 2009/147/EC “Birds” Directive for the conservation of wild birds. These areas identified by the Natura 2000 Network are not considered strictly protected reserves where human activity is prohibited; in fact, the Habitats Directive aimed to ensure the protection of nature while also taking into account economic, social and cultural needs, as well as regional and local particularities. For this reason, private entities can own Natura 2000 sites and ensure their economically and ecologically sustainable management. In fact, the legislator has recognized the value of all those areas where the presence of man and his activities has made it possible to maintain a balance between man and nature. For example, agricultural areas, are linked to many animal and plant species that are now rare and whose survival is closely linked to human activities, such as grazing or non-intensive agriculture. For the realization of this objective of sustainable growth, the Habitats Directive, identifies four main instruments:

- 1) the establishment of a network of sites for the protection of the aforementioned habitats and threatened species, classified in Annexes I and II thereof;
- 2) the application of strict protection methods in each territory where the protected species are surveyed;
- 3) implementation of measures to integrate harvesting activities with the conservation of populations of protected species;
- 4) implementation of constant monitoring programs on the conservation status of both habitats and species with the subsequent preparation of a report containing information on the implementation of various activities.

Regarding the conservation measures to be adopted in Natura 2000 sites, two supporting documents have been drawn up at national level: “Guidelines for the management of Natura 2000 Sites” and “Manual for the drafting of Management Plans for Natura 2000 Sites”. In Italy, the SCI, SAC and SPAs cover a total of about 19% of the terrestrial territory and over 13% of the marine territory. Specifically, Calabria Region has recognized, to date, 185 SCIs covering an area of over 300,000 km² and designated them as SACs in the three year-period 2016–2018. Among these, of particular interest is the SAC that include the area of the rural village of Pentidattilo in the Metropolitan City of Reggio Calabria. It was established by the decree of the Ministry of the Environment and Protection of Land and Sea of 27 June 2017 with the designation IT9350131 “Pentidattilo” (Fig. 1).



Fig. 1. Panoramic view of the cliff and the ancient village of Pentidattilo (Reggio Calabria, Italy). Photo: L.R. Mauro.

2 The SAC IT9350131 “Pentidattilo”

2.1 Study Area

Calabria is one of the richest Italian regions in terms of biodiversity due to its floristic [6–16] and vegetational [17, 18] peculiarities that characterize many important habitats [19–21]. The “Pentidattilo” SAC is located in the locality of the same name and belongs to the municipality of Melito di Porto Salvo, in the metropolitan city of Reggio Calabria. This SAC covers 104 ha and lies between a minimum altitude of 165m a.s.l. and 454m above a.s.l. There are two main lithological units in the area: the first is made up of massive, well-cemented arenaceous conglomerates (the actual cliff) with oblique stratification of Oligo-Miocene age; the second, on which the first rests, which is made up of phylladic, blackish, polished metamorphic rocks of the Paleozoic age. The soils that characterize the area have a high organic carbon content and a generally acidic pH, rapid drainage and consequently low water retention [6].

The reference thermopluviometric station is the one in nearby Melito di Porto Salvo town, from whose data it can be deduced that the hottest month is August, with an average temperature of 26.9 °C, while the coldest is January with 11.3 °C; the average annual temperature is around 18 °C. As for annual rainfall, it is around 490 mm: in particular, the rainiest month is November with 85.7mm, while the least rainy is July with only 4mm of rain [22].

According to the bioclimatic classification proposed by Rivas Martínez, Pentidattilo has a Mediterranean pluvioseasonal oceanic type bioclimate and falls within the thermo-Mediterranean belt with dry ombrotype [23].

2.2 Habitats and Typical Species

For a correct study of habitats and plant taxa present in them, especially endemic ones, the most suitable tool is always phytosociology, preceded and/or combined with taxonomical studies [24, 25]. Rocky habitats are widespread throughout the world and represent important sites for biodiversity conservation [24, 26]. The “Pentidattilo” SAC is of considerable importance for its flora and particular rock vegetation: it represents one of the most characteristic combinations of morphology and vegetation in the entire Aspromonte Massif [17]. The site is dominated by Mediterranean maquis and is also characterized by the presence of sub-steppe grasslands with grasses and therophytes, thermo-Mediterranean pre-steppe shrublands, and a scattered cover of oaks. The presence of rocky slopes, consisting mainly of silicates, allows the colonization of chasmophytic vegetation. The surrounding landscape appears typically Mediterranean with scattered oak forests and a prevalence of Mediterranean scrub phytocoenoses. The plant association that best represents the potential flora of the area is the *Oleo-Quercetum virgiliana*. This is represented by forests dominated by thermophilous deciduous oaks such as *Quercus pubescens* Willd. [= *Q. virgiliana* (Ten.) Ten.]; this is a typical thermoxerophilous plant community and is found in predominantly sunny and arid stations. Significant is the presence of a complex system of sandstone cliffs that host specialized phytocoenoses rich in taxa of high phytogeographic interest and therefore to be protected and preserved, such as: *Allium pentadactyli* Brullo, Pavone & Spamp., *Silene calabra* Brullo, Scelsi & Spamp. And *Anthemis chia* L. [6]. Regarding these species, the first two are endemic with a restricted range, while the last is assessed as a vulnerable species and included in the Regional Red List [27].

The “Pentidattilo” SAC hosts five EU habitats that are part of the Natura 2000 network; Table 1 lists the habitats present in the this area.

Habitat 3290 presents a dry riverbed almost all year round with sporadic residual pools; the typical species present are: *Agrostis stolonifera* L. subsp. *Stolonifera*, *Cyperus rotundus* L., *Paspalum distichum* L. and *Polygonum aviculare* L. subsp. *Aviculare*.

In the habitat 5330 there are shrubs typical of thermo-Mediterranean areas, both woody and herbaceous perennials, such as: *Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz, *Asparagus acutifolius* L., *Macrobriza maxima* (L.) Tzvelev (= *Briza maxima* L.), *Euphorbia dendroides* L., *Olea europaea* L. (= *Olea europaea* L. subsp. *Oleaster* (Hoffmanns. & Link) Negodi) and *Pistacia lentiscus* L.

The habitat 6220* is characterized by grasslands with small xerophilous species and perennial plants which also host annual species such as: *Brachypodium retusum* (Pers.) P.Beauv., *Hyparrhenia hirta* (L.) Stapf subsp. *Hirta*, *Bituminaria bituminosa* (L.) C.H.Stirt. And *Convolvulus althaeoides* L.

The habitat 8210 hosts chasmophytic communities occurring on carbonate rocks with typical species that are almost all endemic such as: *Crepis aspromontana* Brullo, Scelsi & Spamp., *Dianthus brutius* Brullo, Scelsi & Spamp. Subsp. *Pentadactyli* Brullo, Scelsi & Spamp., *Lomelosia cretica* (L.) Greuter & Burdet, *Centaurea pentadactyli* Brullo, Scelsi & Spamp. And *Silene calabra* Brullo, Scelsi & Spamp.

Finally, in the last habitat, 92D0, we can find riparian bushes with a tall shrubby structure characterized by species of the genus *Tamarix*, *Nerium oleander* L. subsp. *Oleander* and *Vitex agnus-castus* L.

Table 1. Surfaces of the habitats present in “Pentidattilo” SAC (Dir.92/43) with the description of pressures and threats for each habitat.

Habitat Directive 92/43 Code	Description	Surface (ha)	Pressure factors	Threats
3290	Intermittently flowing Mediterranean rivers of the Paspalo-Agrostidion	4.28	- Change of hydraulic conditions - Grazing	- Habitat loss - Loss of floristic diversity and degradation of vegetation
5330	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	35.95	- Fire - Grazing - Variations in use with a prevalence of tourist-commercial activity - Recreational activities	- Habitat degradation and fragmentation - Loss of floristic diversity and degradation of vegetation
6220*	Calcareous rocky slopes with chasmophytic vegetation	26.6	- Variations in use with a prevalence of tourist-commercial activity - Recreational activities - Excessive and unregulated grazing - Soil erosion	- Habitat degradation and fragmentation - Loss of floristic diversity and degradation of vegetation
8210	Calcareous rocky slopes with chasmophytic vegetation	4.59	- Localized soil erosion phenomena - Fires - Landslides	- Loss of floristic diversity and degradation of vegetation
92D0	Southern riparian galleries and thickets (Nerio-Tamaricetea and Securinegion tinctoriae)	0.67	- Fire - Grazing - Excavations - Illegal landfills - Hydraulic-forestry arrangements	- Disturbance/Loss of floristic species - Loss of floristic diversity and degradation of vegetation - Soil erosion

2.3 Pressure Factors and Threats to Habitats and Species

Over the years, it has been important to analyze and understand the main risk factors of individual habitats in order to better estimate specific intervention methods for the conservation of these areas (Burc n.94 of 16 September 2016 Calabria Region). Therefore, Table 1 shows the most important pressure factors and threats for each habitat.

2.4 Status and Conservation Objectives of the “Pentidattilo” SAC

In the past, approved management plans had shortcomings in terms of conservation measures for individual SACs [28]. Therefore, the Biodiversity Observatory has undertaken meticulous work on the conservation measures needed for individual habitats and species for the designation of Calabria’s Natura 2000 sites as Special Areas of Conservation. Specifically, the area of interest of this work falls within the plans provided by the Metropolitan City of Reggio Calabria in the Burc n. 94 of 16 September 2016, drafted by the Department of Environment and Territory of the Calabria Region in the Annex A “Introductory report and site-specific conservation measures”. In particular, for the “Pentidattilo” SAC, the objectives of the conservation measures are to promote the restoration of natural balances, guaranteeing the normal dynamism of the vegetation and the increase and continuity of habitats and species.

3 Flora and Habitats of “Pentidattilo” SAC

3.1 The Flora

The floristic list represents a fundamental tool for understanding the composition and dynamics of a specific habitat [29]. The flora of Pentidattilo SAC has been investigated by Brullo et al. [17], who in their work on the vegetation of Aspromonte massif highlighted some vegetational aspects of this locality, reporting in their phytosociological surveys numerous species, including many endemics and new taxa described for the first time for science. However, the list that can be extrapolated from their work is certainly not exhaustive as far as the floristic knowledge of this ancient Aspromonte village is concerned: in fact, only 86 taxa could be counted from it. Subsequently, Musarella and Tripodi [6] brought new knowledge compared to the aforementioned work, analyzing the flora of the cliff and ruins of Pentidattilo, which represent only a small part of the “Pentidattilo” SAC. These authors increased the floristic knowledge of the ancient village and the immediately surrounding areas to 251 taxa, including taxa already reported in [17].

As a result of this work, the flora of the “Pentidattilo” SAC currently includes 343 taxa belonging to 61 families. The most representative is Asteraceae with 60 taxa, followed by Fabaceae with 38 and Poaceae with 30. Most of the taxa are native plants; these are 91% of the total, with 313 taxa. Alien species (archaeophytes and neophytes, introduced respectively before and after the discovery of America), are 8%, with 26 taxa. Lastly, there are 4 cryptogenic taxa, i.e. those of uncertain origin, referring to just 1% of the total.

3.2 The Habitats

The characterization of the flora and the significant increase in taxa recorded in this work allowed for a more complete definition of all the habitats falling within the SAC. The mapping of all the habitats was drawn, for which the total area within the SAC was also calculated. From the analysis of the available orthophotos for the “Pentidattilo” SAC, 14 habitats were identified, of which 5 of the Habitats Directive had already been identified as part of the Natura 2000 Network habitat monitoring carried out in 2018. All the habitats detected were coded according to the codes of Carta Natura 2019. Specifically, Table 2 reports all the 14 mapped habitats and Fig. 2 compare two habitat maps of the “Pentidattilo” SAC before and after this study.

Table 2. List of habitats of the “Pentidattilo” SAC with codes and names according to Carta Natura 2019.

Carta Natura Code 2019	Carta Natura Name 2019
84	Vegetable gardens and complex agricultural systems
24.1_m	Watercourses with little or no vegetation
24.225_m	Mediterranean riverbeds
32.22	Maquis with <i>Euphorbia dendroides</i>
32.22 / 62.11	Maquis with <i>Euphorbia dendroides</i> / Mediterranean cliffs
32.23	Garrigue with <i>Ampelodesmos mauritanicus</i>
32.23 / 62.11	Garrigue with <i>Ampelodesmos mauritanicus</i> / Mediterranean cliffs
34.6B	Steppes of tall Mediterranean herbs with <i>Hyparrhenia hirta</i>
34.8_m	Subnitrophilous grasslands
44.81	Riparian woods with tamarisk, oleander, chasteberry
53.62	Communities of <i>Arundo donax</i>
83.11	Olive groves
86.1_m	Population centres
86.1_s	Road and rail infrastructure

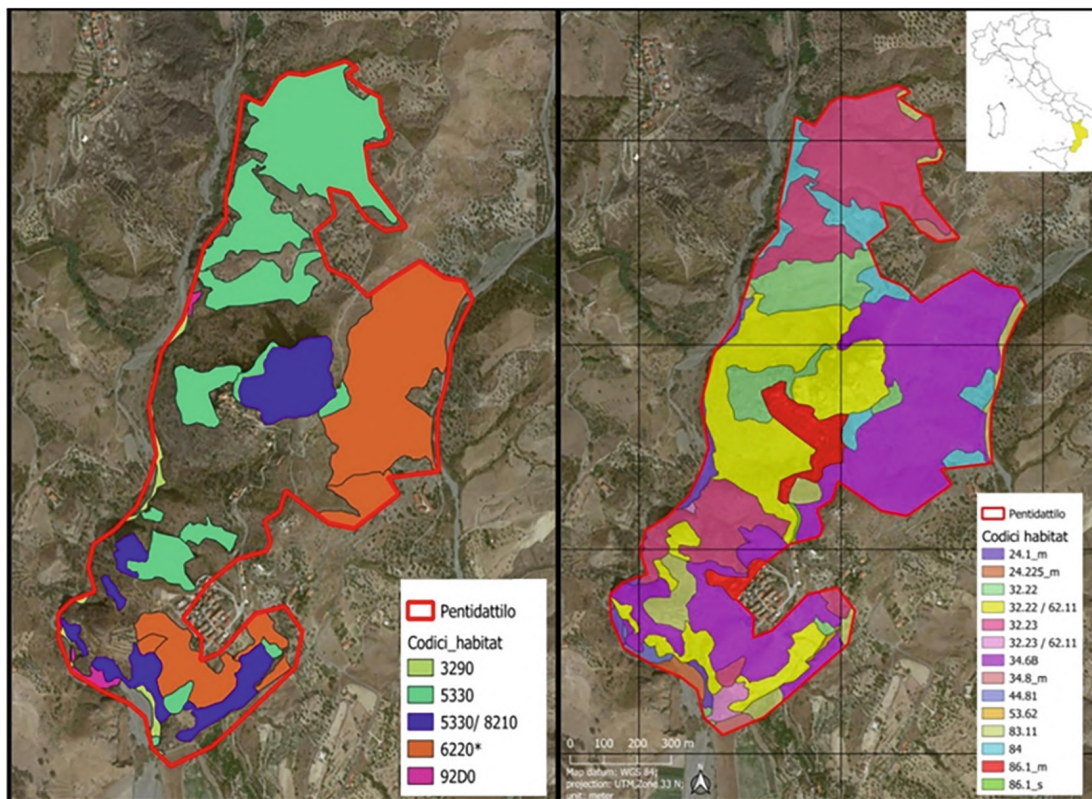


Fig. 2. Comparison of the Habitats Directive (left) and the Carta Natura (right) habitat maps of the “Pentidattilo” SAC.

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