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REVIEW ARTICLES

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 We considered 9 published papers and 11 unpublished sources from field interviews.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 37 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 agro-ecosystems 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 Pliscoff 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 vast number 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 with endemism (Bernardo 2000; Spampinato 2014): however, it has only been partially studied from an ethnobotanical point of view, considering several aspects of food and medicine 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 km^2, is located in the central Mediterranean Sea and stretches approximately 250 kilometres from north to south (Figure 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 the recorded information

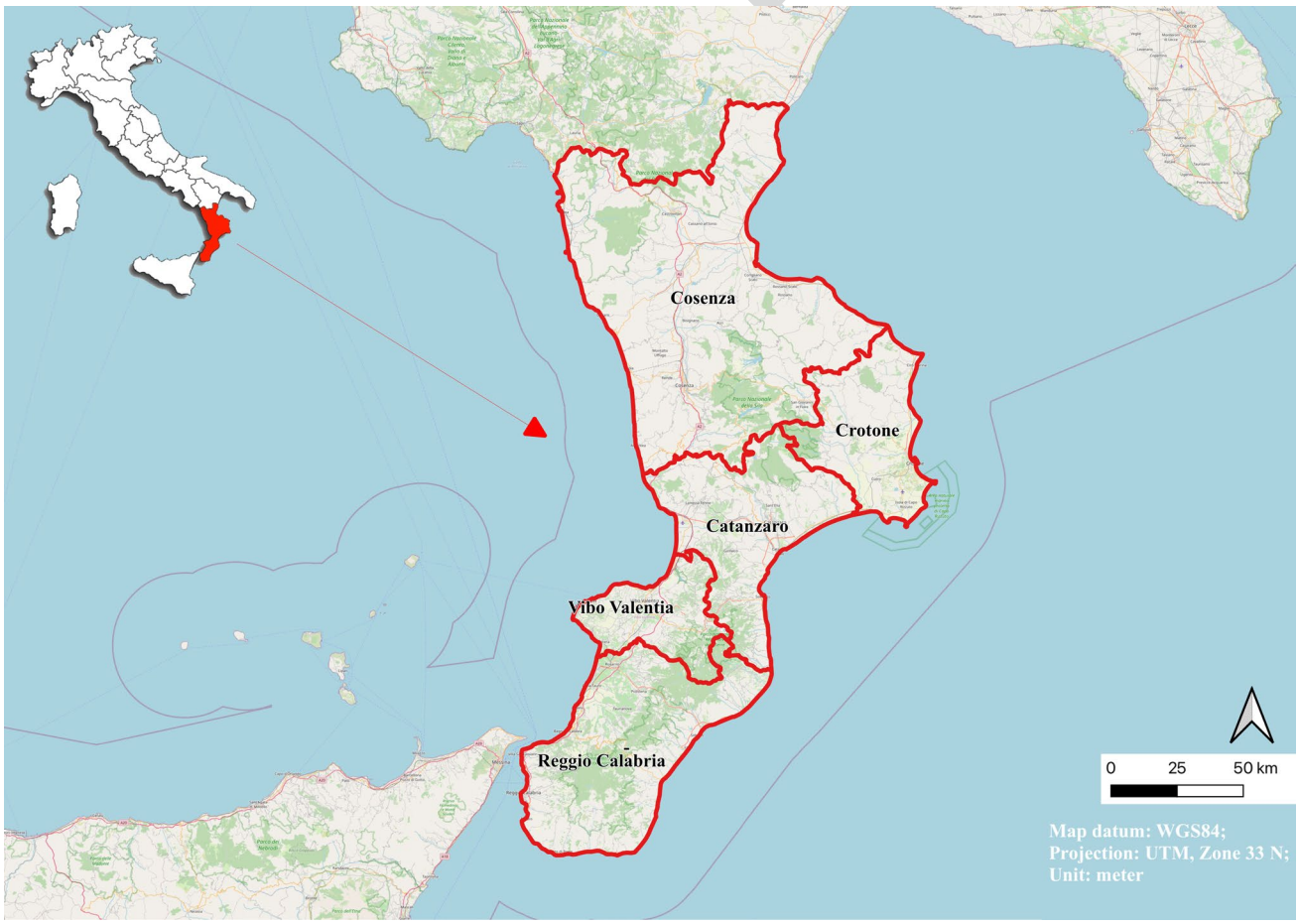

Fig. 1 Calabria region. In red are highlighted the provinces of Catanzaro, Cosenza, Crotone, Vibo Valentia and the Metropolitan City of Reggio Calabria

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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 297 taxa, of which 37 subspecies, from 70 botanical families. The list of the botanical families with the number of citations and the taxa of each family are given in Online Resource 1.

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 2 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), *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%) (Figure 2).

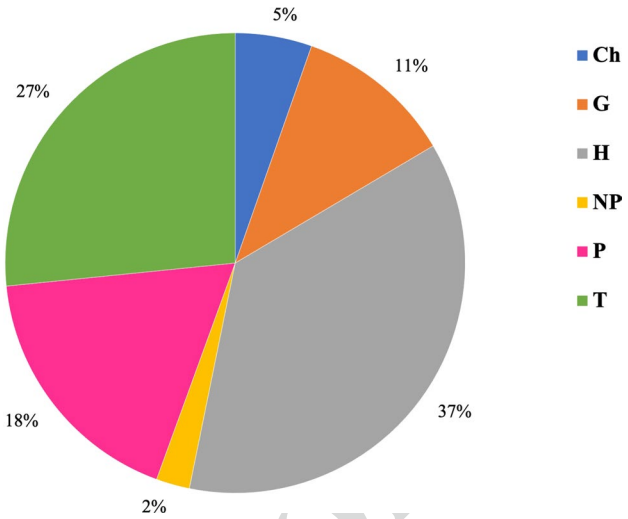

Fig. 2 Biological forms of taxa recorded. *Ch* Chamaephytes, *G* Geophytes, *H* Hemicryptophytes, *NP* Nanophanerophytes, *P* Phanerophytes, *T* Therophytes

Regarding the chorological types (Figure 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 ethnobotanical 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 (Figure 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.

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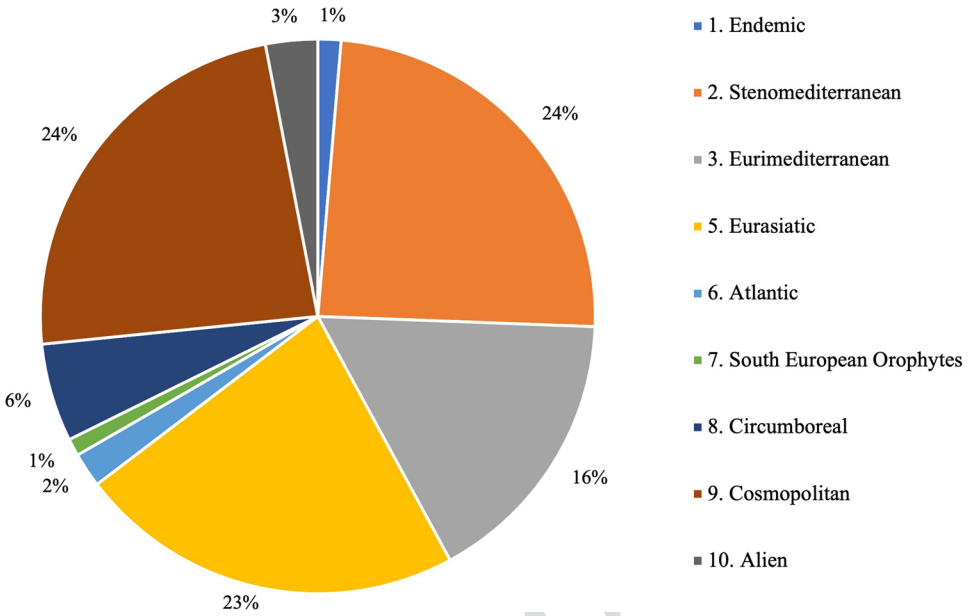

Fig. 3 Chorological types of the taxa recorded

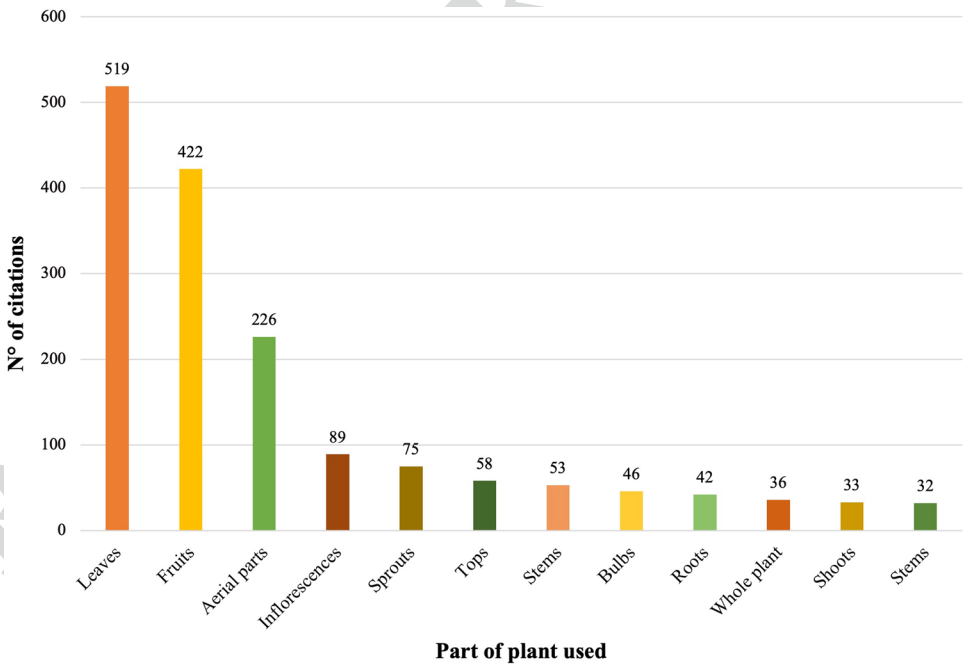

Fig. 4 The most relevant part of plants used for food use

2020b; Gentile et al. 2022 (Calabria); Pieroni and Cattero 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) (Figure 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

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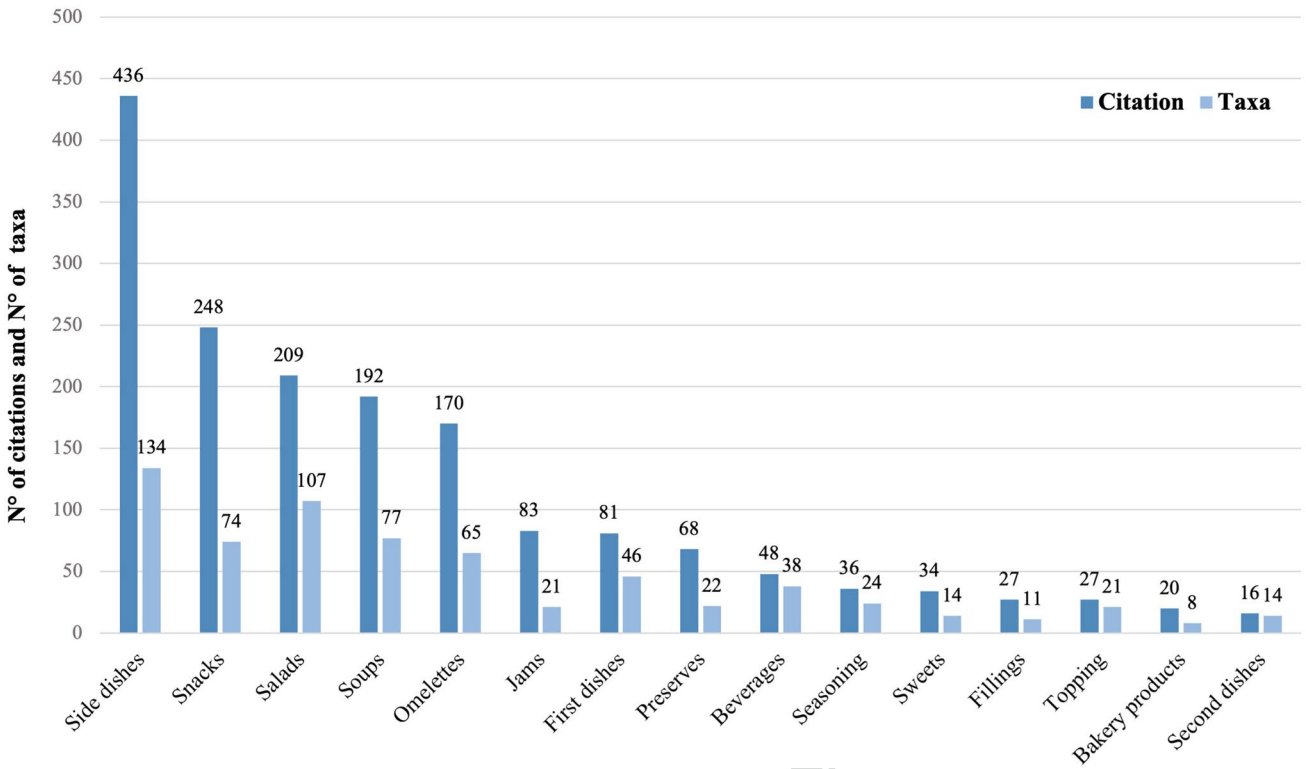

Fig. 5 Food purposes with the number of citations and number of taxa for each, ordered by number of citations

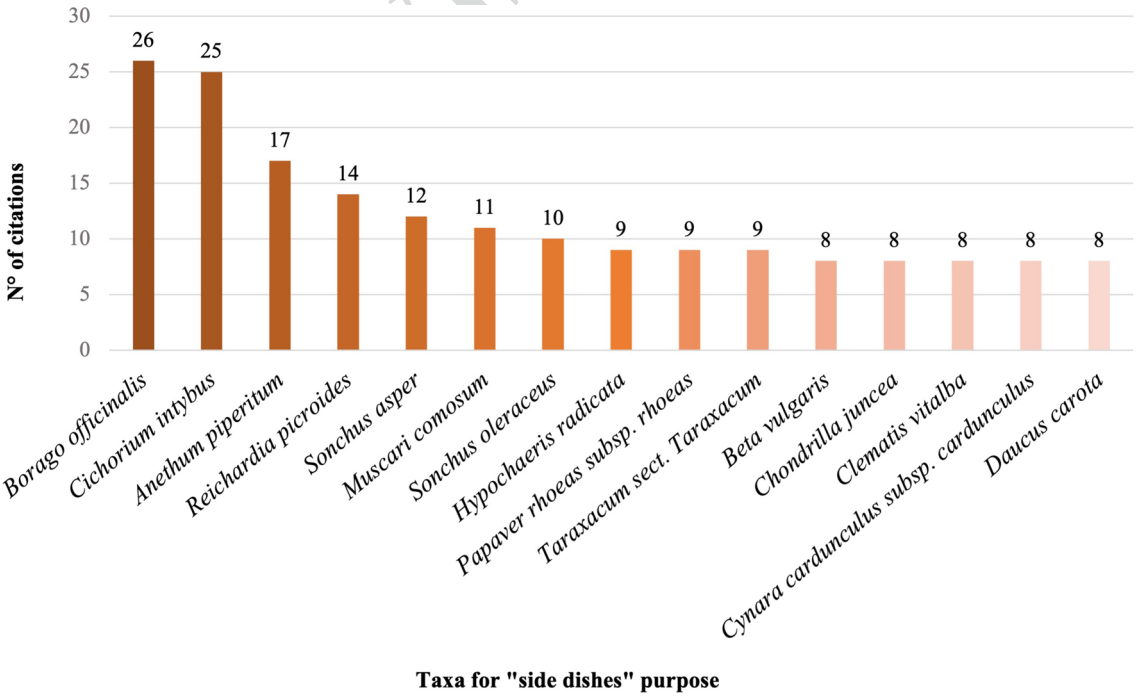

Fig. 6 Most recurrent taxa used as a side dish sorted by number of citations

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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 (Figure 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 Manganelli 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) (Figure 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

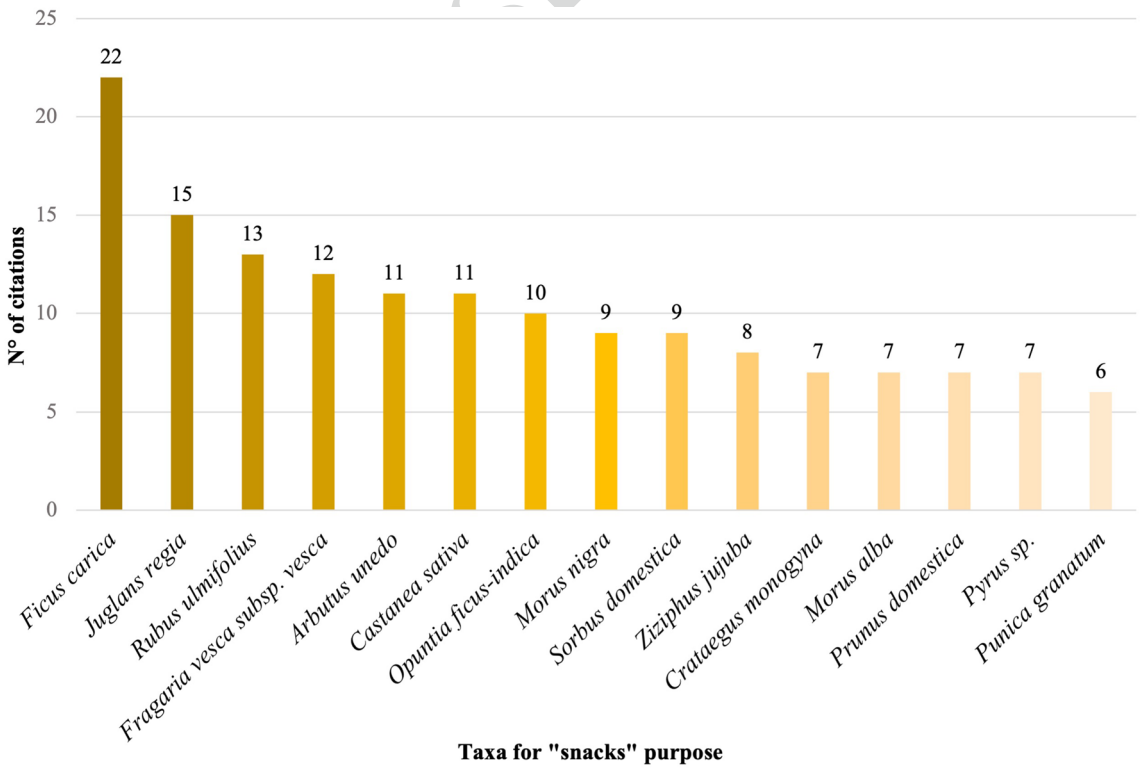

Fig. 7 Most recurrent taxa for snack purpose ordered by number of citations

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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 Figure 8.

The most commonly used species in the 'salads' category is *Portulaca oleracea*, which has been mentioned 20 times (Figure 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

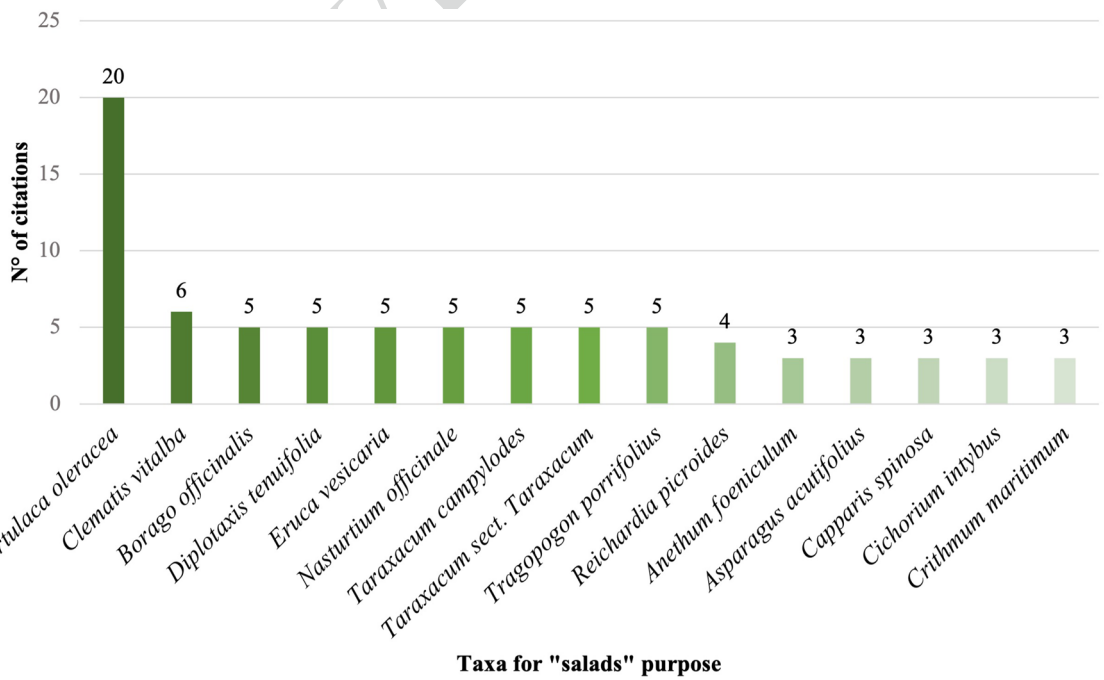

Fig. 8 Most common taxa recorded with the "salads" purpose sorted by number of citations

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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 (Figure 5). The shoots of *Asparagus acutifolius* are the most significant species used for this purpose (23 citations) (Figure 9).

In a survey conducted in Spain, it was observed that the wild shoots of *A. acutifolius* have a more palatable taste than the cultivated plant *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 (Figure 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,

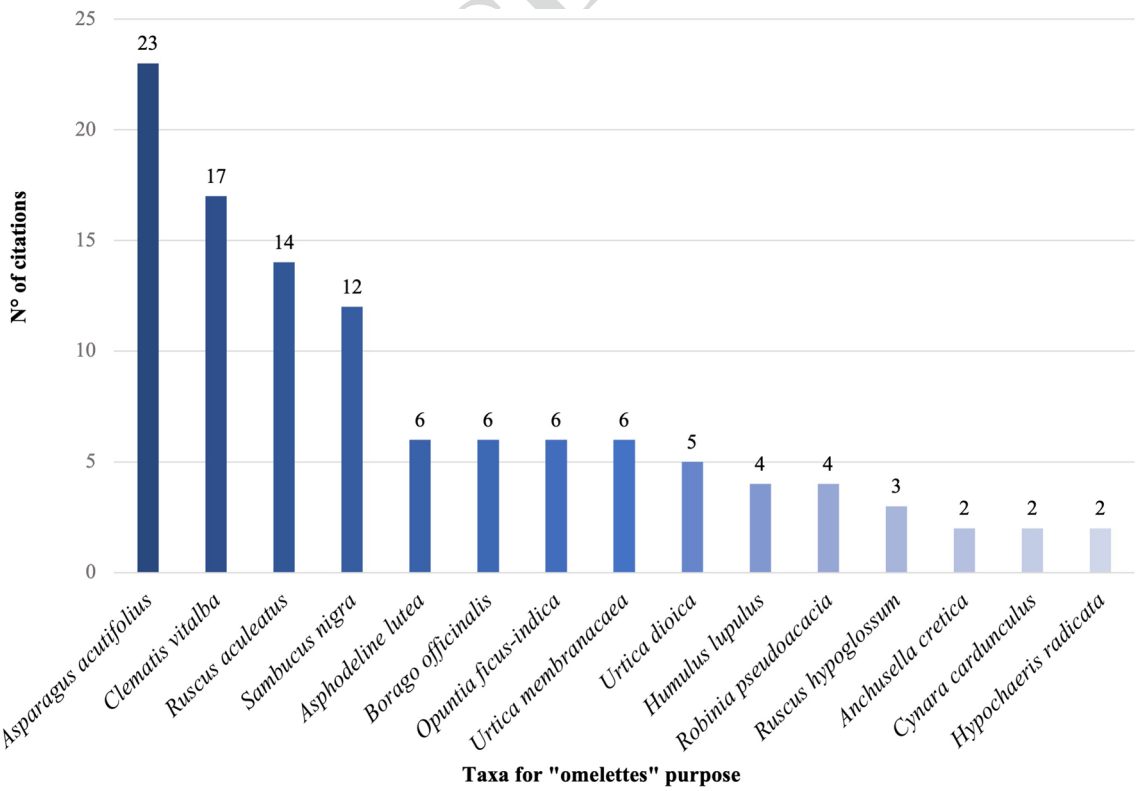

Fig. 9 Taxa most used for the “omelettes” purpose in order of number of citations

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Guarino et al. 2008, Savo et al. 2019; Molise—di Tizio et al. 2012; Puglia—Biscotti et al. 2018; Sicilia—Arcidiacono 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 (Alarcon et al. 2015; Rigat et al. 2016; Motti et al. 2022).

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.

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.

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.

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 CO_2 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 could be adapted to other regions worldwide with positive outcomes on a planetary scale, according to the urgent directive of "thinking globally, acting locally".

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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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