



Review

Neglected and Underutilized Plant Species (NUS) from the Apulia Region Worthy of Being Rescued and Re-Included in Daily Diet

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Abstract: Neglected and underutilized species (NUS) are cultivated, semi-domesticated, or wild plant species, not included in the group of the major staple crops, since, in most cases, they do not meet the global market requirements. As they often represent resilient species and valuable sources of vitamins, micronutrients, and other phytochemicals, a wider use of NUS would enhance sustainability of agro-systems and a choice of nutritious foods with a strategic role for addressing the nutritional security challenge across Europe. In this review, we focused on some examples of NUS from the Apulia Region (Southern Italy), either cultivated or spontaneously growing species, showing interesting adaptive, nutritional, and economical potential that can be exploited and properly enhanced in future programs.

Keywords: NUS; sustainable food supply; nutritional security; Apulia Region



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1. Introduction

Often considered a central argument in the scientific debates at a local or global scale, the biodiversity loss issue is becoming a critical challenge that needs to be carefully considered in future years. Following this debate, the newly launched EU Biodiversity strategy has put forward measures to address the biodiversity loss across the European Union [1]. Within this issue, a lively interest has been addressed towards the agro-biodiversity, which includes cultivated species and landraces, wild flora, soil microorganisms, pollinators, and the relative interconnections between plant and environment or genetic resources and agricultural management/practices [2]. Furthermore, local knowledge and culture also have an important role and should be considered part of agro-biodiversity [2].

Localized in the central part of the Mediterranean area, Italy offers a wide variety of ecological, pedoclimatic, and orographic conditions. The Italian flora is characterized by rare and endemic plants, with many domesticated crops and vegetables showing high genetic and phenotypic variability [3]. In the Italian territory, particularly South Italy, small family-owned farms and rural areas are rich in vegetable germplasm, represented by wild flora, different landraces, and plant species closely linked to the local historical memory [3].

The neglected and underused plant species (NUS) are cultivated varieties, semi-domesticated, or wild plant species that tend to be underutilized locally or globally, due to their relatively low value for the global production and marketplace, since they most often do not meet the modern standards of uniformity [4] as major cultivated varieties [4–7]. Indeed, starting from the Green Revolution, we assisted the decline of many local/traditional species and varieties, which were less competitive compared with commercial cultivars, and, therefore, they have been replaced by high-yielding and uniform cultivars developed by modern breeding programs [2,7]. This genetic erosion has been also amplified by urban

spreading, changes in socio-economic conditions, and destruction of natural environments due to increased human activities [3].

As a source of vitamins, micronutrients, and other phytochemicals, NUS have the potential to play a strategic role for addressing nutritional security challenges [6]. A wider use of NUS would also enhance adaptability and resilience to biotic and abiotic stress factors and ultimately might lead to a more sustainable supply of diverse and nutritious foods [8]. In fact, many autochthonous plant species are characterized by a high nutritional value compared to cultivars or similar species belonging to the same family.

Furthermore, landraces and wild relatives can provide genetic traits that are useful for increasing biotic resistance and tolerance to abiotic stress in future breeding programs, especially when creating more sustainable and resilient production systems [9–12].

In this review, we focus on some examples of NUS from the Apulia Region (Southern Italy), either cultivated landraces or spontaneously growing as a part of the local flora, that are worthy of being rescued and enhanced for their interesting nutritional properties and economical potential.

1.1. Multicolored Carrots

Carrot (*Daucus carota* L.) is one of the most popular and consumed root vegetables worldwide and it is especially known in Western dietary regimes as an important source of dietary carotenoids, such as α -carotene and β -carotene, which are also known as provitamin A [13]. In fact, the popularity of carrots is mainly linked to their nutritional value, which makes them an economically important horticultural crop.

Carrot is consumed as a fresh vegetable, used in many traditional dishes or soups, commercially transformed into juices and concentrates, canned, or dried powdered [14]. Although the most common genotypes are orange-colored, in some countries, such as those in southern Europe, Turkey, China, or India, multicolored carrots are also well known [15]. In fact, the primary genotypes of carrots were yellow or purple and they originally spread from Afghanistan across the Middle East, North Africa, Europe, and China. During the domestication processes, yellow carrots have been preferred, leading to the final development and cultivation of orange carrots, the most prevalent at present [15–17]. On the other hand, black/purple carrots (*Daucus carota* ssp. *sativus* var. *atrorubens* Alef.), deriving from the primary domestication center and pigmented both in the epidermis and the inner central core of the taproots, are still cultivated and highly appreciated in some countries and represent one of the most used anthocyanin sources as food colorant, due to the high stability of the processing conditions and storage [18].

In Italy, some documents report the presence of multicolored carrots through 13th and 14th centuries [16]. In the Apulia region, multicolored carrot landraces (Figure 1) are cultivated from local farmers in different villages, and they have been officially inserted in the list of species at risk of genetic erosion, according to the Apulian Rural Development Program (2007/2013). In particular, only three different landraces related to the area of production (Polignano, Tiggiano, and Zapponeta) have been described. In the case of Polignano landrace, these carrots are currently cultivated in an area of about 20 ha, with cultivation practices at risk due to the age of elder farmers and the difficulty for farmers to collect reproductive material/seeds. The Polignano and Tiggiano carrots have been the subject of several studies in recent years, particularly due to the anthropic cultural heritage associated with them and their high nutritional value [16–21]. In fact, their typical yellow-purple color has been associated with increased levels of some classes of polyphenols compared to the commercial orange varieties. Among the multicolored carrots, the yellow carrots have showed a slight reduction in the content of carotenoids and phenolic compounds, whereas the purple-yellow and purple-orange carrots ensure high levels of polyphenols, mainly chlorogenic acid and anthocyanins, maintaining, at the same time, a carotenoids content similar to orange carrots (Table 1) [16,18,22–24]. Due to the presence of high levels of phenolic compounds, the extracts from yellow-purple carrots have shown to be high in vitro antioxidant capacities compared to the orange carrots, but

their nutritional significance can be also extended to other molecular properties, since a body of evidence has associated polyphenols dietary administration to anti-inflammatory, anti-aging, and anti-tumoral effects, thus providing a preventive effect against chronic and inflammatory human diseases [23,24]. Based on these nutraceutical features, multicolored carrots represent important horticultural species that can be valorized in breeding programs aimed at biodiversity preservation and sustainable agriculture.

Multicolored carrots (<i>Daucus carota</i> L.)	
Origin	Originated from Central Asia and spread across Middle East, North Africa, Europe and China
Environmental conditions required for growth	Moist and calcareous soils
Resistance to adverse environment	Resistant to cold
Edible tissues or part of the plant	Roots
Ethnobotanical usages	Mainly consumed as fresh products
Nutritional/nutraceutical properties	Rich in minerals, phenolic compounds, anthocyanins and carotenoids (especially β -carotene); antioxidant properties

Figure 1. Scheme of the main features of multicolored carrots.

Table 1. Some examples of phenolic compounds, anthocyanins, and carotenoid content in multicolored carrots.

Multicolored Carrots (Different Accessions/Landraces)	Total Phenolics	Total Anthocyanins	Total Carotenoids
Yellow- or orange-purple carrots	15.04–38.69 mg GAE ¹ /g DW [22]	17.3–17.9 μ mol/g DW [22]	0.334–0.771 mg/g DW [22]
Polignano carrots from Apulia	0.676 mg GAE/g [16] 4.5 mg CGA ² /g DW [18]	5.06–7.82 mg KE ³ /g DW (Blando 2021)	0.433 mg/g [16] 0.332 mg/g DW [18]
Tiggiano carrots from Apulia	~2.6 mg CGA/g DW [24]	~1 mg C3GE ⁴ /g FW [24]	~0.400 mg/g DW [24]


¹ GAE: Gallic acid equivalents; ² CGA: Chlorogenic acid; ³ KE: Kuromanin equivalents; ⁴ C3GE: cyanidin-3-glucoside equivalents.

1.2. Roquette

Roquette (Figure 2), also known as arugula, belongs to the Brassicaceae family and is an important leafy salad worldwide. In the Mediterranean region, the main cultivated roquette species are: *Eruca vesicaria* L. Cav. (formerly *E. sativa* Mill.) [25], which is prevalently cultivated in rich soils, or alternatively can be found mixed with ruderal flora in marginal areas; *Diplotaxis tenuifolia* L., which has succulent leaves and is well adapted to harsh and poor soils and is mostly collected as a wild species [26]. In Apulia, *Eruca vesicaria* is currently suffering a strong genetic erosion, due to the growing attention focused on the wild *Diplotaxis tenuifolia*, which is preferred for culinary preparations. However, *E. vesicaria* is still cultivated in small gardens in the area of Bari but with rare cases of global marketing placement.

Roquette is characterized by a pungent and bitter taste, provided by a range of beneficial compounds (Vitamin C, carotenoids, phenolics, and glucosinolates) (Table 2) that contribute to its antioxidant capacity. Conversely, it can also accumulate anti-nutrients

(e.g., nitrates) and heavy metals [27–31]. Besides the culinary uses, roquette has interesting medicinal properties, such as diuretic and depurative effects [26], and its extracts have antimicrobial properties [32], antigenotoxic properties in *D. melanogaster* [33], and cytotoxic effects in tumoral cell lines [34].



Roquette (<i>Eruca vesicaria</i> L.)	
Origin	It is widespread around the world
Environmental conditions required for growth	Rich soils in marginal areas
Resistance to adverse environment	Tolerance to nitrates and heavy metals
Edible tissues or part of the plant	Leaves
Ethnobotanical usages	Prevalently used as leafy/green salad
Nutritional/nutraceutical properties	Rich in vitamin C, carotenoids, phenolic compounds and glucosinulates; antioxidant properties

Figure 2. Scheme of the main features of roquette. (Source photo: biodiversitàpuglia.it [35]).


Table 2. Some examples of phytochemical compounds in roquette.

Roquette Leaves	Total Phenolics	Total Carotenoids	Vitamin C
“Nature” and “Naturelle” genotypes	0.446–1.024 mg GAE ¹ /g FW [28]	0.076.2–0.137 mg/g FW [28]	0.0256–0.079 mg/g FW [28]
Italian <i>E. sativa</i>	3.62 mg GAE/g DW [36]		
Bulgarian <i>E. sativa</i>	4.45 mg GAE/g DW [36]		
<i>D. tenuifolia</i> (wild rocket)	Quercetin: 0.0189–0.0774 mg/g FW [37]	0.0847 mg/g DW [38] Lutein: 0.0455–0.0545 mg/g FW [37]	0.2078–0.8174 mg/g FW [37]
<i>E. vesicaria</i> (garden rocket)	1.93 mg GAE/g FW [39] 9.20 μmol/g DW [40]	0.13 mg/g DW [38]	0.02967 mg/g FW [41] 0.15 mg/g FW [42]

¹ GAE: Gallic acid equivalents.

1.3. *Salicornia* spp.

Salicornia spp. (Figure 3) is a group of edible halophytes able to grow in high salt soil conditions, commonly named glasswort, pickle-weed, or sea asparagus [43]. *Salicornia* spp. can be found as a wild species in transition zones between permanently flooded muds and perennial vegetation, characterized by a winter flooding period and dry summer. The geographical distribution of the wild species is very wide, since it can be found in USA, Mexico, Canada, Europe (e.g., Britain, Ireland, France, Spain, Italy), India, Iran, Korea, and some Africa regions [43].



<i>Salicornia</i> spp. (L.) Parl.	
Origin	Probably originating between the Mediterranean and Central Asia during Miocene
Environmental conditions required for growth	Saline environments, coastlines, tidal floodways, salt lakes
Resistance to adverse environment	Salt-tolerant
Edible tissues or part of the plant	Stems, leaves
Ethnobotanical usages	Glass and soap making; livestock feeding; human consumption in local dishes
Nutritional/nutraceutical properties	Rich in minerals, vitamins, fatty acids, phenolic compounds; antioxidant, anti-inflammatory, immunomodulatory, hypolipidemic and hypoglycemic properties

Figure 3. Scheme of the main features of *Salicornia* spp. (Source photo: biodiversitàpuglia.it [35]).

Apart from the historic usage as a source of sodium carbonate for glass making and an additive for soap production [43], some *Salicornia* spp. are utilized for culinary purposes.

The natural adaptation to saline environments, as well as the salt tolerant traits and the contextual content of bioactive compounds, makes *Salicornia* spp. interesting for many landscapes due to its cultivation in adverse, harsh environments and its contribution to human nutrition. In fact, *Salicornia* cultivation could represent a valid option in the context of global warming, in which edible plants with high salt tolerance are needed. *Salicornia* spp. can be also good candidates for reclamation of barren lands, salt flats, and seashores [43]. Its use has also been proposed in heavy metal removal and phytoremediation, but these applications are not compatible with nutritional purposes, as they can be a source of toxic metal ions and antinutrients. In fact, it is important to keep in mind that some species can accumulate high contents of oxalic acid and iatrogenic iodine and excessive content of salt, heavy metals, and saponines (as in the case of *S. bigelovii*) [44].

In the Apulia region, wild *Salicornia* spp. gathering is quite common, linked to ancient culinary uses, even though some cultivation practices (as in the case of *Salicornia patula*, belonging to the *S. europea* group) are also consolidated, especially in the northern area of Gargano, close to the areas of the Lesina and Varano salt lakes [44,45]. The first attempts of *Salicornia* cultivation have been reported along the Lesina lagoon, which occupies an area of about 51 km², with a length of 22 km, an average width of 2.4 km, and a depth of about 0.7 m [45]. Other scattered coastal sites suitable for *Salicornia* spp. growth and gathering are present in the southern parts of the Apulia region, such as “Torre Guaceto” coastal lagoon (province of Brindisi), “Le Cesine” (province of Lecce), and “Salina dei monaci” (province of Taranto).

S. patula can be generally cultivated from February–March to August–September in a soil that is typically black, sandy, acidic, and very rich in organic matter. The harvest of fresh and tender parts can be repeated depending on the level of development of the plant, with a final yield that can reach 10–15 tons per hectare [44]. The propagation can be carried out by gametic or agamic techniques, and in the case of gametic techniques, seeds need strategies for dormancy under hypersaline conditions and germination at low salt levels. Furthermore, germination is affected either by the type of salt or its concentration [45].

Regarding the nutritional value, *Salicornia* spp. L. contains essential amino acids, vitamins (mainly vitamins A and C), dietary fibers, and, as expected, a large diversity of

minerals, including sodium, potassium, calcium, magnesium, iron, and iodine [46]. Going deeper into the phytochemistry of *Salicornia* spp., some studies have also evidenced the presence of: (i) saponins (in *S. europea* and *S. bigelovii*); (ii) lipids, with a prevalence of palmitic acid (e.g., in *S. ramosissima*) or α -linolenic acid (e.g., in *S. europea*) [46]; (iii) steroid compounds, such as spinasterol and stigmasterol (in *S. europea*, *S. herbacea*, *S. fruticosa*, and *S. bigelovii*); (iv) alkaloid derivatives, saliherbine, and salicornin [47]; (v) flavonoids (mainly flavanones and flavone derivatives) and phenolic acids in methanolic extracts from *S. europea* [47]. Due to the presence of sterols, triterpenoids saponins, and polyphenolic compounds, beneficial properties have been associated with *Salicornia* extracts, such as antioxidant, anti-inflammatory, immunomodulatory, hypolipidemic, and hypoglycemic effects [46–50].

Phytochemical analyses on *S. patula* have focused on fatty acids content, with a percentage of saturated fatty acids reaching 80% and phenolic content ranging from 2.989 to 4.209 mg GAE/g DW, with the major components represented by salicylic and transcinamic acids [51] (Table 3).


Table 3. Some examples of polyphenol and fatty acid content in *Salicornia* spp.

<i>Salicornia</i> spp.	Polyphenol Content	Fatty Acid Content
<i>Salicornia</i> (two ecotypes from Israel)	1.05–1.53 mg GAE ¹ /g FW [52]	2.24–2.41 mg/g FW (Total FAs ²) [52]
<i>Salicornia herbacea</i>	0.78 mg/g FW [53]	
<i>Salicornia patula</i>	2.989–4.209 mg GAE/g DW [51]	80% total FAs 2–3% MUFAs ³ 6–13% PUFAs ⁴ [51]
<i>Salicornia ambigua</i>	0.813–0.1252 mg/g FW [54]	1.2–1.6 mg/g FW 60–61% ⁵ SFAs 4–4.5% MUFAs 17–18% PUFAs [54]

¹ GAE: Gallic acid equivalents; ² FAs: fatty acids; ³ MUFAs: monounsaturated fatty acids; ⁴ PUFAs: polyunsaturated fatty acids; ⁵ SFA: saturated fatty acid.

1.4. Purslane

Purslane (*Portulaca oleracea* L.) (Figure 4) is a very common spontaneous plant in gardens, lawns, vineyards, cultivated fields, eroded slopes, and bluffs, where it is considered one of the most common weeds. It is a very common plant in the temperate and subtropical regions, but it also grows in the tropics and at higher latitudes [55]. *P. oleracea* is a synanthropic species that can tolerate mechanical disturbance and can be derived from anthropic activities. It has fleshy, succulent, and very branched leaves and stems. The origin of *P. oleracea* is uncertain, but it has been suggested that it comes from India, even though it was also found in America in pre-Columbian times [56]. Purslane has a broad physiological adaptability and high morphological variability (highly polymorphic); therefore, the taxonomy of *P. oleracea* is still under debate [56]. This is quite important because the Italian peninsula and adjacent islands provide fragmentary information on the infraspecific diversity of *P. oleracea*. However, a recent elucidation about the distribution of various *P. oleracea* morphotypes has been provided [56,57]. Thus, in the *P. oleracea* complex, the *P. trituberculata* morphotype has been identified in the Apulia region. This morphotype is one of the most common in continental Italy since the Roman period [57].



Purslane (<i>Portulaca oleracea</i> L.)	
Origin	Uncertain
Environmental conditions required for growth	Temperate, subtropical and tropical areas
Resistance to adverse environment	Synanthropic species
Edible tissues or part of the plant	Stems, leaves
Ethnobotanical usages	Consumption of fresh or cooked leaves in local dishes
Nutritional/nutraceutical properties	Rich in minerals, phenolics, omega-3 fatty acids, tocopherol and Vitamin C; antioxidant activities

Figure 4. Scheme of the main features of *P. oleracea* (Source photo: biodiversitàpuglia.it [35]).

In the Apulia region, purslane has always been traditionally harvested, and recently, it has been officially recognized as a traditional food product [58]. Due to its sour and salty taste, similar to fresh spinach, purslane is generally served raw in salads to give flavor and freshness or cooked to prepare soups. In the past, it was used as a medicinal herb due to its purifying, diuretic, and anti-diabetic properties. Purslane is a good source of omega-3 fatty acids, tocopherols, and vitamin C (Table 4) and contains minerals, such as magnesium, manganese, potassium, iron, and calcium. Flavonoids and polyphenols have also been extracted from purslane leaves, particularly with oleracein A and C, found as major components in leaves, reaching 8.2–103.0 mg and 21.2–143 mg/100 g dried weight [59]. Concerning the biological activities, purslane has shown antioxidant and lipid oxidation inhibiting capacities [60–63] and provides protection against DNA damage in in vitro studies [61]. Di Cagno et al. [64] have also tested purslane juice obtained by lactic acid bacteria fermentation, finding that the fermented juice strongly decreased the levels of pro-inflammatory mediators and reactive oxygen species in the CaCo₂-cell line.

Table 4. Some examples of polyphenol, vitamin C, tocopherol, and fatty acid content in purslane.


<i>P. oleracea</i>	Polyphenols	Vitamin C	Tocopherols	Fatty Acids
	0.96–9.12 mg GAE/g DW [63]			
<i>P. oleracea</i> accessions	3.6 mg GAE/g DW [60]			Total SFA ² (% of total FA ¹): 27–55%
	Oleracein A: 8–1.03 mg/g DW [59]	2.40–9.73 µg/g FW [65]	3.02–4.81 µg/g FW [59]	MUFA ³ (% of total FA): 5–12%
	Oleracein C: 21–1.43 mg/g DW [62]			PUFA ⁴ (% of total FA): 38–66% [59]
Raw purslane juice	85 mg GAE/100 mL [64]	22 mg/100 mL [64]	2.5 mg/100 mL [64]	

¹ FA: fatty acids; ² SFA: saturated fatty acid; ³ MUFAs: monounsaturated fatty acids; ⁴ PUFAs: polyunsaturated fatty acids.

1.5. *Leopoldia comosa* L.

Leopoldia comosa (L.) Parl., (Figure 5), previously named *Muscari comosum* (L.) Mill, is a perennial bulb, belonging to the Hyacinthaceae family and originating from South-East Europe, Turkey, and Iran, naturalized elsewhere and eaten in some Mediterranean countries. It is called the tassel of hyacinth or tassel grape hyacinth. It is a wild species, but it can also be properly cultivated. The wild specimens can be found in rocky ground or

cultivated lands, cornfields, or vineyards. The cut bulbs transude mucilages, sugars, latex, tannins, salts, triterpenes, homoisoflavones, and muscarosides [66].



<i>Leopoldia comosa</i> (L.) Parl.	
Origin	Turkey and Mediterranean area
Environmental conditions required for growth	Temperate areas, rocky grounds
Resistance to adverse environment	Resistant to cold
Edible tissues or part of the plant	Bulbs
Ethnobotanical usages	Consumption of bulbs in local dishes
Nutritional/nutraceutical properties	Bulbs are rich in flavonoids, phenolic acids and fatty acids; antioxidant and hypoglycemic properties, prevention of obesity-related disorders

Figure 5. Scheme of the main features of *L. comosa*. (Source photo: biodiversitàpuglia.it [35]).

The bulbs of *L. comosa* are characterized by a typical strong sour and bitter taste and, in the culinary uses of the Apulia region, are traditionally boiled and consumed with olive oil, vinegar, and salt, or they can be fried. Additionally, they can be part of the preparation of other traditional local dishes [67]. Other popular usages of *L. comosa* bulbs include the cure of toothache and skin spots [68].

L. comosa bulbs are rich in several classes of phytochemicals, including flavonoids, phenolic acids, and fatty acids [69] (Table 4). Among the fatty acid fraction, palmitic acid has been reported as the major component, followed by linoleic, linolenic, and stearic acids [69] (Table 5).

Phytochemicals in *Leopoldia comosa* bulbs have shown metal chelating, antioxidant properties, pancreatic lipase inhibitory activity, and hypoglycemic activity via the inhibition of carbohydrate digestive enzymes, such as α -amylase and α -glucosidase [70]. Furthermore, enzyme-inhibitory effects and in vitro antitumoral activities in breast adenocarcinoma cells have also been reported [71].

In a comparative study of extracts deriving from wild and cultivated bulbs of *L. comosa*, Marrelli et al. [69] have shown higher radical scavenging activity and good in vitro pancreatic lipase inhibitory activity from the wild bulb extracts compared to the cultivated bulb extracts. In light of these data, the extracts from wild *L. comosa* bulbs have been suggested to be considered for subsequent in vivo studies and the activity could be attributed to phenolic compounds [69]. Accordingly, Casacchia et al. added *L. comosa* extracts (20 or 60 mg/die) to a high-fat diet in rats fed for 2 weeks. Following these conditions, *L. comosa* extracts inhibited lipase and pancreatic amylase activities, counteracting abdominal obesity, dyslipidemia, liver steatosis, and improving glucose tolerance, suggesting an important effect of prevention of obesity-dependent metabolic disorders [72]. In another study, Casacchia et al. [71] used raw bulbs or bulbs cooked with two different methods (boiled or steam-cooked), confirming higher antioxidant activities and inhibition of pancreatic lipase and α -amylase, especially in the raw bulbs, relating these in vitro activities mainly to the phenolic compounds and suggesting that the traditional cooking methods can partially deplete the observed biological activities.

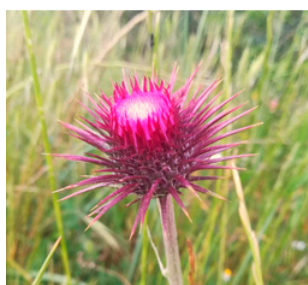
Table 5. Some examples of polyphenol and fatty acid content in *L. comosa*.

<i>Leopoldia comosa</i>	Total Polyphenols	Total Flavonoids	Total Fatty Acids
Wild raw bulbs	264.33 mg/g FW [69]	10.40 mg/g FW [69]	Palmitic acid 16.2 mg/g of fatty acids fraction [69]
	92.47 mg CAE ¹ /g FW [71]	4.57 mg QE ² /g FW [71]	
	56.6 mg CAE/g extract [70]	23.4 mg QE/g extract [70]	Palmitic acid 15.5% of fatty acid composition [70]
	102.89 mg CAE/g of FW [72]	28.07 mg QE/g of FW [72]	
Cultivated raw bulbs	42 mg/g FW [69]	5.74 mg/g FW [69]	Palmitic acid 17.5 mg/g of fatty acids fraction [69]
Boiled bulbs	39.53 mg CAE/g FW [71]	0.64 mg QE/g FW [71]	
Steam-cooked bulbs	49.80 mg CAE/g FW [71]	1.63 mg QE/g FW [71]	

¹ CAE: Chlorogenic acid equivalents; ² QE quercetin equivalents.

1.6. Milk Thistle

Milk thistle (*Silybum marianum* L.) (Figure 6) is a member of the Asteraceae family and is native to the Mediterranean basin, although it is widespread in Northern Africa, Asia, North and South America, and South Australia [73,74]. It can be cultivated as an ornamental plant, but it often grows widely as a proper weed in yields and roadsides, in warm environments and dry soils. Flowering season is between July and August. It is also considered a heavy metals tolerant species [73]. Milk thistle fruits, sometimes confused as seeds, have been used for medical purposes since ancient Greek civilization, especially for the treating of liver diseases for its hepatoprotective activities. A recent study has evidenced that wild accessions of *S. marianum* in Italy can be identified in three different stable chemotypes, based on the biochemical profile of these accessions. Two of these chemotypes have been reported from different Italian regions, including Apulia, with no clear correlation between the chemical profile and geographic features [75].



Milk thistle (<i>Silybum marianum</i> L.)	
Origin	Mediterranean basin, then widespread over the world
Environmental conditions required for growth	Warm environment, dry soils
Resistance to adverse environment	Tolerant to dry soils or polluted with heavy metals
Edible tissues or part of the plant	Stems, leaves, fruits
Ethnobotanical usages	Oils and tea from fruits; consumption of cooked leaves and stems in local dishes
Nutritional/nutraceutical properties	Rich in flavolignans (the most abundant is silybin), flavonoids, tocopherol; antioxidant, anti-inflammatory and hepatoprotective activities

Figure 6. Scheme of the main features of *S. marianum*.

Apulian traditional culinary usages included the leaves and the tender stems of the milk thistle, together with other well-known and appreciated species, *Cynara cardunculus* L. and *Scolymus hispanicus* L. (golden thistle). However, the main problem that has greatly limited its uses in recent years is represented by the first cleaning phase, which consists of eliminating leaf blade, which is exceedingly spiny. However, once cooked the milk thistles can be used to prepare very tasty dishes rich in beneficial compounds.

The most important biological activities of milk thistle are related to silymarin, a mixture of flavonoid complexes and flavolignans. In silymarin, many compounds have been reported, among which are silybin, isosilybin, silychristin, isosilychristin, syldianin, and silimonin [76–78]. Apart these compounds, some flavonoids (quercetin, kaempferol, apigenin, naringenin, eriodyctiol, and taxifolin), tocopherol, sterols, sugars, and proteins have been reported [76], even though silybin is the most abundant compound in the extracts [74] (Table 6).

Milk thistle extracts, from the heads, leaves, and stems, have shown several biological properties [79], including strong antioxidant and anti-inflammatory properties and anti-tumoral activities [79–81]. In an experimental model of nonalcoholic steatohepatitis, the administration of *S. marianum* extract reduced the severity of steatohepatitis and the levels of alanine amino transferase and aspartate amino transferase and improved the levels of glutathione [82]. The hepatoprotective activities were also observed in human hepatocytes and human liver microsomes by inhibiting cytochrome-P450 isoenzymatic activities [83].

Table 6. Some examples of bioactive compounds in *S. marianum*.

Milk Thistle Organs	Polyphenols	Flavonoids	Silybin
Leaves	14–17 mg GAE ¹ /g DW [73]	~11 mg GAE/g DW [73]	
Heads	11–12 mg GAE/g DW [73]	~5 mg GAE/g DW [73]	
Seeds (fruits)	24–35 mg GAE/g [84]	16–29 mg QE ² /g [84]	3–311 mg/g [85]

¹ GAE: Gallic acid equivalents; ² QE quercetin equivalents.

2. Conclusions

In this review, we focused on some examples of NUS from the Apulia region that are worthy of being enhanced, with the intent to preserve the living heritage and biodiversity. The major staple crops, intensively cultivated because they ensure the standards of global market requirements, are preferred to NUS, thus hiding their great potentials to contribute to the process of adaptation to changing climates. Indeed, most of NUS are characterized by a high resilience to harsh and adverse environments and a rich source of nutrients. Further efforts need to address:

1. The molecular basis and genetic traits linked to the adaptation to harsh environmental conditions (with a special look at tolerance to heat/salt/heavy metals stresses);
2. The characterization of main nutrient classes and their biosynthesis pathways;
3. The quantification and characterization of the main antimetabolic factors/antinutrients;
4. A better knowledge of the biological activities in the prevention of human diseases.

Expanding our knowledge on these issues will increase awareness of the importance of NUS and the activities related to their recovery and enhancement. Investing in research on NUS, an inter/multi-disciplinary approach and shared scientific and traditional knowledge will help to fully realize the benefits of these crops.

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