

Review

A Review of Edible Wild Plants Recently Introduced into Cultivation in Spain and Their Health Benefits

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Abstract: Before the Bronze age, when agricultural practices spread throughout the Iberian Peninsula, the diet of the native people was based on hunting, fishing, and gathering wild plants. In spite of modern agriculture, the popular gathering of wild species for medical use, food, craftwork, etc., for centuries has left a detailed knowledge on the use of many of these species. Of the 6176 Angiosperms native to the Iberian Peninsula and the Balearic Islands, over 200 species were introduced into cultivation during the Neolithic period outside the Iberian Peninsula. The names of 30 of the progenitors still popularly used as food are listed in this paper, together with the names of their derived crops. This review focuses on five wild species collected as food from ancient times, namely *Borago officinalis* L., *Prunus spinosa* L., *Silene vulgaris* (Moench) Garke subsp. *vulgaris*, *Scolymus hispanicus* L., and *Asparagus acutifolius* L. In response to great demand, they have been recently introduced into cultivation in Spain and are now harvested and commercialized as new crops. Special attention is paid to their basic bioactive compounds and pharmacological properties. The limitation of this study is that the published information about the bioactive compounds of these five plants originates from different parts of the world where they grow wild or are cultivated. Therefore, further research is needed to trace the metabolomic dynamics of these plants regarding geographical and ecological principles, as well as wild versus cultivated origins.



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1. Introduction

The flora of the Iberian Peninsula, the Balearic Islands included, consists of 6176 vascular plant species [1], many of them with two or more subspecies. Over 200 of these species are progenitors of widely cultivated plants. Some were already introduced into cultivation in the Near East in the Neolithic period; this is the case, for instance, of *Linum bienne* Mill., the progenitor of flax (*L. usitatissimum* L.), and *Lathyrus cicera* L., the most likely progenitor of grass pea (*L. arvensis* L.). Some others were introduced into cultivation later, in the Bronze Age, also in the Near East, including some herbaceous crops, such as the fenugreek (*Trigonella foenum-graecum* L.) and the following three more characteristic Mediterranean woody crops: fig (*Ficus carica* L.), olive (*Olea europaea* L.), and grape vine (*Vitis vinifera* L.). Some crops have been cultivated since Greek and Roman times, for instance hazel (*Corylus avellana* L.), apple (*Malus pumila* Mill.), pear (*Pyrus communis* L. var. *communis*), laurel (*Laurus nobilis* L.), cabbage and cauliflower (*Brassica oleracea* L.), celery (*Apium graveolens* L.), chard (*Beta vulgaris* L.), and many others [2]. A few have been introduced into cultivation

in more recent times, such as sugar beet (*Beta vulgaris* L.), which was introduced into cultivation at the end of the 18th century [3,4].

Before the Bronze age, when agricultural practices spread throughout the Iberian Peninsula, the diet of the native people was based on hunting, fishing, and gathering wild plants, namely native species that grew and reproduce naturally in their natural habitats without being cultivated [5]. Remains of hazel (*Corylus avellana* L.), stony pine (*Pinus pinea* L.), wild olive (*Olea europaea* var. *sylvestris* (Mill.) Lehr), grape vine (*Vitis vinifera* L.), white beam (*Sorbus aria* L.), mastic (*Pistacia lentiscus* L.), and other plants have been found in Epipaleolithic, Mesolithic, and Neolithic archeological sites [6] (pp. 40–43). The presence of remains of acorns of *Quercus* is permanent in archeological sites. It may be said that the sweet fruits of these trees, particularly *Quercus ilex* subsp. *ballota* (Desf.) Samp., provided an important part of the diet of the native people of the Iberian Peninsula [7], at least until the introduction of the extensive cultivation of cereals (mainly tetraploid and hexaploid wheats) in Roman times.

Despite modern agriculture, centuries of collecting wild species as food, for medicinal purposes, for handicrafts, etc., have left a detailed knowledge of the uses of many of these species. Acorns of the green oak, for instance, are still part of the popular cuisine in the Iberian Peninsula, mainly in western Spain. These fruits, raw or roasted, are directly eaten or used to prepare stews. They are also ground to flour, which is used for baking bread, preparing cookies, or making soup [8], or macerated in spirit to produce an excellent “licor de bellota” (acorn liquor), a beverage very characteristic of the region of Extremadura.

Many of these wild plants are popular greens for preparing salads, like dandelion (*Taraxacum* spp.), native everywhere, or water cress (*Roripa nasturtium-aquaticum* (L.) Hayek), which grows along the streams and springs. The leaves, stems, or inflorescences of many other plants are used as pot vegetables, either cooked or stewed. Many aromatic plants are used as pot herbs, as is the case of rock tea (*Jasonia glutinosa* (L.) DC.), chamomile (*Chamaemelum nobile* (L.) All.), or penny royal (*Mentha pulegium* L.), or for seasoning olives (*Thymus mastichina* (L.) L., *T. albicans* Hoffmanns. & Link and *Thymbra capitata* (L.) Cav.). The fleshy fruits of several trees and shrubs are eaten or macerated in spirit to produce alcoholic beverages, like those of the strawberry tree (*Arbutus unedo* L.), the rowan (*Sorbus domestica* L.), or the sloe or blackthorn (*Prunus spinosa* L.) [9–11].

The consumption of several of these wild species is so deeply rooted, not only among the rural population, but also among city dwellers, that the amount of plant material of such sought-after plants, collected for personal use or to be sold in local markets, is not sufficient to cover the demand. Hence, the need for the introduction of these wild species into cultivation is widely demanded. Their introduction into cultivation facilitates easy access to these plants for any potential user. But, above all, their cultivation may contribute to the protection of wild populations. This was, in fact, the proposal made by Hernandez Bermejo et al. [12] (p. 63) to prevent the extinction of the chamomile of Sierra Nevada (*Artemisia granatensis* Boiss.), an endemic plant that was about to disappear due to excessive collection to be used as pot herb in bars and restaurants of Granada and other neighboring cities.

The introduction of a plant species into cultivation, even if it took place in the Neolithic period, is subsequent to its collection in the wild. This is traditional knowledge of the use of natural resources, since time immemorial. Nowadays, there are still people (particularly in rural areas) who collect wild progenitors because they prefer their taste to that of the derived cultivated plant.

Before dealing with the species recently introduced into cultivation in Spain, it is first necessary to make known which progenitors of Mediterranean cultivated plants are still collected in the Iberian Peninsula to be used as food. Spain is one of the European countries

with the highest number of scientific works devoted to ethnobotany; this is the dynamic relationship between plants and people [13]. They were compiled by Morales et al. [9] in a review in which 225 bibliography references are given, including PhD and graduation theses, books, and papers. Each of these sources gives information on the popular use of wild plants in one or more of the 17 autonomous communities into which Spain is divided, in one or more of the 50 provinces of the country, in a particular area, or in the natural areas around a particular city or village. Many of these resources deal with the popular uses of one or several species. According to this review, about 1200 wild species are used in folk medicine, and around 500 are used as food plants.

Tardío et al. [14] (p. 33) indicates that 490 species are collected from nature as food, which represents about 6% of the Iberian Peninsula's vascular flora. They can be separated into several groups. Green vegetables constitute the largest group, with 49% of the species used; 31% are plants used for beverages; 16% provide fruits and sweets; 6% are preservatives, and the remaining 5% are used for other purposes.

Many of these wild species are widespread in the Mediterranean area and are also traditionally used in other countries. This is why 318 wild edible plants, including pot-herbs, coincide in their use in Spain, Italy, and Greece [15].

Although agriculture has displaced the traditional use of wild plants, it is still a very deeply rooted custom in many areas of the Iberian Peninsula to collect wild plants in order to be consumed at home or to be sold at local markets, particularly in rural areas. There are even groups of friends and clubs who go out to the country together to collect edible plants, in order to prepare certain cooking recipes and to share the food.

Many of these currently collected plants are progenitors of cultivated plants, which were introduced into cultivation during the Neolithic period outside the Iberian Peninsula. The names of 30 of these progenitors are listed below, arranged by families. Their scientific names are followed by the name of the derived crop and, in bold type, the common name of the crop. These data are based on Heywood and Zohary [16] and Zohary and Hopf [2]; the nomenclature and taxonomy follow Castroviejo et al. [17]. An asterisk marks a potential relative when this is not clearly established.

Corylaceae

Corylus avellana L. (*C. avellana* L.; **hazel**)

Chenopodiaceae

Beta maritima L. (*B. vulgaris* L.; **sugar beet, chard**, etc.)

Capparidaceae

Capparis spinosa L. (*C. spinosa* L.; **caper**)

Brassicaceae

Brassica nigra (L.) W.D.J. Koch (*B. nigra* W.D.J. Koch; **black mustard**)

Brassica oleracea L. (*B. oleracea* L.; **cabbage, cauliflower**, etc.)

Eruca vesicaria (L.) Cav. subsp. *vesicaria* (*E. vesicaria* subsp. *sativa* (Mill.) Thell.; **rucola**)

Rhaphanus raphanistrum* L. (*R. sativus* L.; **radish)

Rorippa nasturtium-aquaticum (L.) Hayek (*R. nasturtium-aquaticum* (L.) Hayek; **green water-cress**)

Sinapis alba* subsp. *mairei* (H. Lindb. fil.) Maire (*S. alba* L. subsp. *alba*; **white mustard)

Rosaceae

Malus sylvestris (L.) Mill. (*M. pumila* Mill.; **apple**)

Prunus avium L. var. *avium* (*P. avium* var. *juliana* (L.) Thuill.; **sweet cherry**)

Pyrus communis var. *pyraster* L. (*P. communis* L. var. *communis*; **pear**)

Rubus idaeus L. (*R. idaeus* L.; **raspberry**)

Fabaceae

Ceratonia siliqua L. (*C. siliqua* L.; **carob**)

Glycyrrhiza glabra L. (*G. glabra* L.; **liquorice**)

Lathyrus cicera* L. (*L. sativus* L.; **green pea)

Pisum sativum subsp. *elatius* (M. Bieb.) Asch. & Graebn. (*P. sativum* L. subsp. *sativum*; **pea**)

Trigonella foenum-graecum L. (*T. foenum-graecum* L.; **fenugreek**)

Vitaceae

Vitis vinifera subsp. *sylvestris* (C.C. Gmel.) Berger & Hegi (*V. vinifera* L. subsp. *vinifera*; **grape vine**)

Apiaceae

Apium graveolens L. (*A. graveolens* L.; **celery**)

Carum carvi L. (*C. carvi* L.; **caraway**)

Daucus carota L. subsp. *carota* (*D. carota* subsp. *sativus* (Hoffm.) Schübl. & G. Martens; **carrot**)

Foeniculum vulgare subsp. *piperitum* (Ucria) Bég. (*F. vulgare* Mill. subsp. *vulgare*; **celery**)

Oleaceae

Olea europaea var. *sylvestris* (Mill.) Lehr (*O. europaea* L. var. *europaea*; **olive**)

Asteraceae

Cichorium endivia subsp. *divaricatum* (Schousb.) P.D. Sell (*C. endivia* L. subsp. *endivia*; **endive**)

Cichorium intybus L. var. *intybus* (*C. intybus* var. *sativum* DC.; **chicory**)

Cynara cardunculus subsp. *sylvestris* L. (*C. cardunculus* L. subsp. *cardunculus*, **cardo**; subsp. *scolymus* (L.) Hayek, **artichoke**)

Lactuca serriola* L. (*L. sativa* L.; **lettuce)

Liliaceae

Allium ampeloprasum* L. subsp. *ampeloprasum* (*A. porrum* L.; **leek)

Allium schoenoprasum L. (*A. schoenoprasum* L.; **chives**)

The aim of this paper is to give a detailed review of five species that have recently been introduced into cultivation in the Iberian Peninsula, with an emphasis on their cultivation practices, preparation methods, bioactive compounds, pharmacological properties, and safety.

2. Materials and Methods

To establish whether any wild progenitor of Mediterranean crops are still popularly collected to be used as food, a comparison is made between the information contained in the quite complete revision of the ethnobotanical use of Spanish native plants by Morales et al. [9] and the catalogue of wild relatives of cultivated plants native to Europe published by Heywood and Zohary [16]. The results of this comparative study are complemented mainly with the information provided by Zohary and Hopf [2] on the domestication of plants in the Old World.

A thorough revision of agronomic literature is carried out to try to find out whether attempts are currently being made in the Iberian Peninsula to introduce native plant species into cultivation. This allows us to know that four wild species have been recently introduced into cultivation in Spain. For a fifth one, cultivation has not yet been possible in the Iberian Peninsula, although it has been successful in Italy. References to other Mediterranean countries where these wild progenitors are also used as food are added.

For the phytochemical and pharmacological characterization of the five crops recently introduced into Iberian Peninsula, we accessed the Web of Science, Google Scholar,

PubMed, and ACS databases with the key words “*Borago officinalis*”, “*Prunus spinosa*”, “*Silene vulgaris*”, “*Scolymus hispanicus*”, “*Asparagus acutifolius*”, “phytochemistry”, “chemical composition”, “pharmacology”, “biological activity”, “metabolites”, etc. Following the PRISMA 2000 Guidelines, the publications were assessed for eligibility and the inappropriate ones (unreliable or with content deviating from the defined aim of this paper) were excluded.

3. Results

Some wild edible plants are so appreciated for their properties as food or for producing beverages that collecting them in the country is not sufficient to cover the demand. Consequently, attempts at the cultivation of five of them have been made in modern times in order to make them available at markets, supermarkets, and greengrocers. They are borage (*Borago officinalis* L.), sloe or blackthorn (*Prunus spinosa* L.), bladder campion (*Silene vulgaris* (Moench) Garke), golden thistle (*Scolymus hispanicus* L.), and wild asparagus (*Asparagus acutifolius* L.).

Borage (*Borago officinalis* L.)

Borago officinalis is an erect, setose-hispid annual Boraginaceae plant up to 70 cm high, with petiolate leaves with a petiole up to 15 cm and an ovate to elliptic blade up to 15 cm in length and 10 cm in width, blue flowers, sometimes white, and dark nutlets of 4–5 mm (Figure 1). It is a common weed in the Mediterranean and Macaronesian areas and Southwest Asia, and has been introduced and naturalized in most parts of Europe [18].



Figure 1. *Borago officinalis* L. (Photo by B. Valdés): flower (left); inflorescence (right).

Borage is collected from the wild in several Spanish provinces [15] and is much appreciated as food in some regions of northern Spain, particularly La Rioja, Navarra, and Aragón [19], where the petiole and midrib of the leaves are consumed raw in salads, but more frequently stewed or in soups, omelets, etc.

Since ancient times, borage has been cultivated in orchards to be used mainly medically as a diuretic, sudorific, anti-inflammatory, and sedative remedy, and in recent times, the oil obtained from the nutlets is used to control blood pressure and lower cholesterol [18] (p. 332). At the beginning of the 16th century, Herrera [20] said that borage “is very salutary, more than other vegetables”, but it was not appreciated because “it was not known”. Three centuries later, in an addition to the Agricultura General of Herrera,

Boutelou [21] (p. 60) said that “It is cultivated sometimes in the orchard, although it is considered rather as a medicinal plant than as a kind of vegetable”. This indicates that its introduction into agriculture as a new crop should have taken place in Spain throughout the 19th century. In 2018, the area devoted to the cultivation of borage covered 167 ha with a production of 6606 tons; its cultivation in greenhouses was initiated in the 1980s [19] (p. 27).

Outside Spain, *Borago officinalis* is cultivated commercially mainly as an oil crop, particularly in the United Kingdom, Canada, and New Zealand [22] to obtain γ -linolenic acid (GLA), an unusual fatty acid in plants, appreciated because of its nutritional, cosmetic, and medicinal value [23,24]. The plant also contains pyrrolizidine alkaloids, some of which are hepatotoxic, mutagenic, and carcinogenic [25]. An overview of its main constituents is shown in Table 1. Apart from the above-mentioned fatty acids and pyrrolizidine alkaloids, *Borago officinalis* also contains flavonoids, mucus compounds, tannins, mineral salts, organic acids, saponins, vitamins, and essential oil [26,27].

Table 1. Bioactive compounds of borage and their pharmacological activity.

Bioactive Compounds	Part of the Plant	Pharmacological Activity	References
Fatty acids: γ -linolenic acid, linoleic acid, α -linolenic acid, palmitic, stearic, oleic and elaidic acid	Flowers, leaves, seeds	Synthesis of eicosanoids, prevention of atherosclerosis	[27]
Pyrrolizidine alkaloids: likopsamine, supinidine, amabiline, intermedine	Flowers, leaves	Toxic to the liver parenchymal	[25]
Phenolic acids: vanillic acid, p-coumaric acid, p-hydroxybenzoic, gentisic acid, caffeic acid, rosmarinic acid, chlorogenic acid, sinapic acid	Leaves	Antioxidant	[28]
Flavonoids: quercetin, isoquercetin, isorhamnetin, kaempferol glycosides, vitexin and isovitexin	Leaves	Antioxidant	[29]
Essential oil: cumene, octanal, tetradecanal, hexadecanal, hexanal	Seeds, flowers, leaves		[26,27]

Borago officinalis possesses antispasmodic, bronchodilator, and cardiovascular inhibitory effects [30]. It is beneficial for patients with atopic dermatitis, psoriasis, and obsessive compulsive disorder [31]. Ramezani et al. reported antioxidant, antinociceptive, radioprotective, hepatoprotective, and memory improvement properties of borage [32]. Due to the fact that borage seed oil is rich in GLA, it is also used in the form of a food supplement [31].

Sloe or blackthorn (*Prunus spinosa* L.)

Prunus spinosa (Figure 2) is a deciduous intricately branched Rosaceae shrub up to 3–6 m high, native to most parts of Europe, North Africa, and West Asia, which forms part of the shrubby plant formations of most of the Iberian Peninsula and Balearic Islands [33] (p. 448).



Figure 2. *Prunus spinosa* L. fruit (Photo by E. Kozuharova).

The sub-globose 10–15 mm pruinose dark bluish-black drupes have an astringent taste due to their high tannin content. These fruits have traditionally been used in Navarra and the Basque Country (northern Spain) to produce, by maceration, a very popular beverage with 25–30 degrees of alcohol known as “pacharán” (sloe brandy), whose use is documented as early as the 15th century [34] (p. 6). To prepare pacharán, blackthorn fruits are harvested from the wild in September, although in the last decades fruits have also been imported from Eastern European countries.

To increase pacharán production and to lower sloe fruits’ importation, an agronomic program to introduce *Prunus spinosa* into cultivation was started in 1989 on the initiative of INTIA (Instituto Navarro de Tecnologías e Infraestructura Alimentarias, S.A.; Navarrese Institute for Food Technologies and Infrastructures, A.S), with the collaboration of the two Navarrese universities [34]. Cuttings collected from different wild populations throughout the province of Navarra were planted in the Experimental Field of Sartaguda (Stella, Navarra), where different cultivation and graft pattern methods were tested. The best results were obtained when cuttings were grafted in myrobalan plum (*Prunus cerasifera* Ehrh.). These plants are pruned to form trees with a trunk 80–90 cm high. Fruits are harvested mechanically by a vibrator system with an inverted canvas umbrella applied to gather the fruits, which are carried to a pallet by a conveyor belt [34] (p. 8).

In 2022, the area in Navarra dedicated to the monoculture production of *Prunus spinosa* covered 115 ha, with a fruit production of about 800 tons, allowing the production of over 3,3 million liters of pacharán [35], with this being about 90% of the total production of this liquor in the province of Navarra.

Today, it is a very successful new crop.

The phytochemical composition of the fruits of *Prunus spinosa* L. is shown in Table 2. The fruits are rich in antioxidants, polyphenols, anthocyanins, and beta-carotene, which help the body to reduce the harmful effect of the free radicals produced by reactive oxygen species [36].

This antioxidant activity is crucial in the prevention and treatment of many diseases. For example, it is beneficial to the wound healing process and may produce cytotoxic activity on some cancer cell lines and selective inhibitory effects on the growth of some strains

of potentially pathogenic bacteria [37]. Antioxidants in the fruits of *Prunus spinosa* could be beneficial in some neurodegenerative diseases (dementia, Alzheimer's, and Parkinson's disease) and also in the prevention of some cardiovascular diseases [38,39].

Table 2. Bioactive compounds of blackthorn and their pharmacological activity.

Bioactive Compounds	Part of the Plant	Pharmacological Activity	References
Vitamin C	Fruits	Antioxidant	[36]
Phenolic acids: protocatehuic acid, caffeoylquinic acid, coumarolquinic acid, feruloquinic acid, caffeoylshikimic acid	Fruits	Antioxidant	[38,39]
Anthocyanins: cyanidine, peonidine, pelargonidine and petunidin glycosides	Fruits	Antioxidant	[36,38]
Beta-carotene	Fruits	Antioxidant	[36]
Flavonols: quercetin glycosides, kaempferol glycosides, isorhamnetin glycoside	Fruits	Antioxidant	[38,39]

Prunus spinosa can be used to make processed products like marmalade, jam, and jelly, but the thermal processing of fresh blackthorn pulp leads to a significant decrease in phytochemicals and antioxidant activity [40].

Bladder campion (*Silene vulgaris* (Moench) Garke subsp. *vulgaris*)

This is a glabrous perennial herb of the family Caryophyllaceae, with several stems up to 80 cm, narrow elliptic-lanceolate to ovate leaves, and an open dichasial inflorescence with white flowers (Figure 3). Native to Europe and the Mediterranean area, it has been introduced and naturalized in North and South America. It grows in cultivated fields, on roadsides, and in general in anthropogenic areas [41] (p. 400).

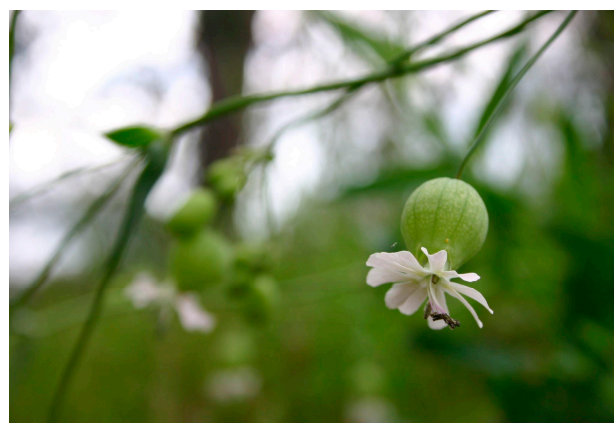


Figure 3. *Silene vulgaris* (Moench) Garke subsp. *vulgaris* (Photo by B. Valdés).

Its tender stems and leaves are eaten mainly in omelets, scrambled eggs, stews, or, more rarely, raw in salads, all around Spain [15] (p. 53) and in many Mediterranean countries, including Portugal [42] (p. 6), Morocco [43] (pp. 24, 35), France [44], Italy [45–47], Greece, Cyprus [47] (p. 398), and Turkey [48,49] (p. 335).

The habit of consuming this valuable plant in Spain means that collecting it within the country is insufficient. This is why the best way to turn bladder campion into a cultivated

crop is being investigated in several Spanish agronomic centers, particularly in the fields of “El Encín” (Alcalá de Henares, Madrid) of INIA (Instituto Madrileño de Investigación y Tecnología Agraria y Alimentaria; Institute of Agricultural Research and Technology of Madrid) (see, for instance, Alarcón Villora et al. [50] and García Gonzalo and Alarcón Villora [51]), in the experimental field “Finca Tomás Ferro” of the Polytechnical University of Cartagena (Murcia) (see, for instance, Conesa et al. [52] and Ortega Calzada [53]), and in the Agro-Environmental Research Center of Albacete [54].

The phytochemical composition of the fruits of *Silene vulgaris* is shown in Table 3. *Silene vulgaris* is rich in carbohydrates, proteins, and fibers and can be used to enrich the energy content of diets. It also contains triterpene saponins, flavonoids, tannins, phytoecosteroids, and essential oil. It contains low amounts of alkaloids and phytic acid (anti-nutrients), which could be decreased by boiling, soaking, and frying [55].

Table 3. Bioactive compounds of bladder campion and their pharmacological activity.

Bioactive Compounds	Part of the Plant	Pharmacological Activity	References
Triterpene saponins: silenosides A–C	Roots	Detergent properties Anti-inflammatory properties Lowering plasma lipid concentrations	[55,56]
Essential oils: longifolene, cyclo-hexane-methanol, camphor, elemol, thymol	Aerial parts	Antioxidant Anti-inflammatory Immunomodulatory	[57]
Organic acids: malic acid, p-coumaric acid, quinic acid	Aerial parts	Antifungal and anticholinesterase activity	[58]
Phytoecdysteroids	Leaves	Mimic insect molting hormones, the application of phytoecdysteroids is a promising alternative to the use of anabolic-androgenic steroids because of the apparent lack of adverse effects	[55]
Flavonoids: hyperoside, rutin, hesperidin	Aerial parts	Antioxidant	[55,58]
Tannins	Leaves	Antioxidant	[55]

The pharmacological profile of *Silene vulgaris* is poorly studied. A study comparing the composition and bioactive properties of six wild edible *Silene* species showed that *Silene vulgaris* possesses a relatively high enzyme inhibitory and lower antifungal, antimicrobial, and antioxidant capacity compared to the other *Silene* species [58].

Golden thistle (*Scolymus hispanicus* L.)

After bladder campion and wild asparagus, the most popular wild edible plant in the Iberian Peninsula is the golden thistle. It is a biennial herbaceous spiny Asteraceae plant, with a simple erect winged and leafy stem up to 150 (– 250 cm), with basal divided leaves forming a rosette and yellow flower heads (Figure 4). It is native to Central Europe, the Mediterranean region, and West Asia, where it grows mainly in uncultivated agricultural fields and on roadsides [59].



Figure 4. *Scolymus hispanicus* L. (Photos by B. Valdés): stem and flower heads (**left**); flower heads (**right**).

The petiole, midrib (i.e., the central leaf veins), and roots are eaten before the marginal spines develop [59], stewed, in scrambled eggs, in soups, rice dishes, omelets, or even raw in salads. Golden thistle is much appreciated as food all over Spain [15] (p. 49), particularly in the southern and western regions. But it is also consumed in many Mediterranean countries, such as Portugal [60,61] (p. 368), Morocco [43] (p. 617), [62] (pp. 23, 32), Italy [46,47], Greece [47,63], Cyprus [47], and Turkey [48] (p. 166), [49] (pp. 224, 338).

The diuretic sesquiterpene lactones of golden thistle give the food a very characteristic slightly bitter taste, which makes this vegetable particularly attractive. This property gives golden thistle the ability to stimulate appetite, enhance bile secretion, decrease flatulence, and aid digestion [64].

The demand for *Scolymus hispanicus* as a food is so high that attempts have been made to introduce it into cultivation [50]. But in Spain, the successful cultivation of this plant as a crop is owed to the initiative of farmers of the La Janda area in Cadiz province, particularly in the city of Conil, where some decades ago, farmers started to cultivate *Scolymus hispanicus* subsp. *occidentalis* F.W. Vázquez in their fields, with basal leaves up to 25 cm, which are distributed throughout the western half of the Mediterranean area [65]. Farmers formed a cooperative with a registered office in the city of Conil to market the vegetables produced in their fields. In this way, *Scolymus hispanicus* is available in spring in all local markets of the area. Currently, this cooperative comprises almost 500 farmers. Golden thistle is also collected from the wild and commercialized in many other Spanish areas.

Scolymus hispanicus contains triterpenes and sesquiterpenes, polyphenols, flavonoids, and tannins, as shown in Table 4. Due to its high content of dietary fiber, *Scolymus hispanicus* L. flour can be used in the preparation of low-fat, high-fiber dietetic products [64].

Scolymus hispanicus possesses antioxidant and antimicrobial pharmacological effects. Moreover, this plant is a good source of macro- and micro-nutrients (Table 4), which contribute to the fight against malnutrition [67]. A study by Berdja et al. [68] showed that *Scolymus hispanicus* possesses lipid-lowering, hypoglycemic, and anti-inflammatory activities. Özel Taşcı et al. [69] also reported cytotoxic activity.

Table 4. Bioactive compounds of golden thistle and their pharmacological activity.

Bioactive Compounds	Part of the Plant	Pharmacological Activity	References
Sesquiterpenes: iso-japonicolactone, guaianolide sesquiterpene	Flowering aerial parts	Anti-inflammatory Antioxidant	[66]
Triterpenes: lupeol, lupeol acetate	Flowering aerial parts	Anti-inflammatory Antioxidant	[66]
Phytosterols: stigmasterol	Flowering aerial parts	Antioxidant Local anti-inflammatory	[66]
Polyphenols	Aerial parts	Antioxidant, anti-aging, anti-inflammatory, and anti-proliferative	[67,68]
Flavonoids	Aerial parts	Antioxidant	[67,68]
Tannins	Aerial parts	Antioxidant	[67]

Wild asparagus (*Asparagus acutifolius* L.)

Like bladder campion and golden thistle, wild asparagus grows all around the Mediterranean and is collected for food practically in every country. It is a very thorny bush because its cladodes are lignified and transformed in sub-equal spines of up to 8 mm [70] (Figure 5).

**Figure 5.** *Asparagus acutifolius* L. (Photo by B. Valdés).

Young shoots are gathered before lignifying and are consumed boiled in omelets or stewed, rarely eaten raw in salads. Strongly diuretic, its slightly bitter taste is much appreciated. The shoots of the other not so common Mediterranean asparagus (*A. aphyllus* L., *A. horridus* L. and *A. albus* L.) are also collected and consumed in the same way [15] (p. 63).

Attempts have recently been made to introduce *A. acutifolius* into cultivation. These in Spain have, so far, been unsatisfactory. However, Rosatti et al. succeeded in cultivating this species in Italy (Umbria) [71].

The phytochemical composition of *Asparagus acutifolius* is shown in Table 5. A study by Hamdi et al. revealed that the stem of *A. acutifolius* contains high amounts of total flavonoids and simple phenolics [72]. Moreover, flavonoid glycosides were only found in the stems. The highest amount of saponins was found in the rhizome extract, followed

by pericarp, cladodes, and stem [73]. Kaska et al.'s study [74] showed that tannins are also present in water extracts of the fruit and cladodes from *A. acutifolius*. A study of the carotenoid content of wild edible species in Spain showed that the young shoots of *A. acutifolius* contain carotenoids (mainly lutein and neoxanthin, but also β -carotene and violaxanthin) [75].

Table 5. Bioactive compounds of wild asparagus and their pharmacological activity.

Bioactive Compounds	Part of the Plant	Pharmacological Activity	References
Phenolic acids: caffeic acid, ferulic acid, p-hydroxybenzoic, protocatechuic acid, vanillic acid	Cladodes, stem, pericarp, rhizome	Antioxidant	[72,75]
Flavonoids: rutin, narcissin, quercetin, naringenin, kaempferol	Cladodes, stem, pericarp, rhizome	Antioxidant	[72]
Steroidal saponins	Roots	Antifungal activity	[73]
Tannins	Cladodes, fruits	Antioxidant	[74]
Carotenoids: lutein, β -carotene, neoxanthin, violaxanthin	Young shoots	Antioxidant Anti-inflammatory	[75]

Asparagus acutifolius possesses antioxidant, cytotoxic, anti-inflammatory, antifungal, lipase inhibitory, and antimicrobial pharmacological effects [72–76].

4. Discussion

It is estimated that the world's flora comprises about 350,000 species [77]. A very high percentage of it cannot be consumed because of an unpleasant taste, toxicity, inability to be cultivated, etc. Only three of the world's edible plants (around 50,000)—rice, maize, and wheat—provide 60 percent of the world's food energy intake [78], and only 103 species contribute 90% of the national per capita supplies of food plants [77]. Most of these species were cultivated long ago, and their quality as crops and food has gradually adjusted to today's needs.

As science advances, more and more wild species are being studied. Phytochemical and pharmacological studies provide a basis to determine whether a plant can be used as a food source or for medicinal purposes, and botanical and agronomy studies show the possibilities for their introduction into cultivation. Four of the aforementioned species, *Borago officinalis*, *Prunus spinosa*, *Scolymus hispanicus*, and *Silene vulgaris*, were recently introduced into cultivation in Spain, while attempts to cultivate *Asparagus acutifolius* have not yet been satisfactory. Although some of these plants have a long history of consumption, special attention must be paid to their toxicological profile to ensure their safety.

Borago officinalis is predominantly used as an oilseed crop. Its properties as a food are famous not only in Spain, but also in Germany, Italy, Crete, France, and Great Britain [79]. It is known that the plant contains pyrrolizidine alkaloids that cause toxicity in the liver. In a systematic review and quality assessment of case reports on the adverse events of three plant species, containing pyrrolizidine alkaloids, no case reports referring to *Borago officinalis* were located [80]. However, their carcinogen activity based on their genotoxic mechanism of action has been shown in animal studies. Moreover, the consumption of borage is prohibited for pregnant women due to its adverse effects on fetus development [81]. While saturated pyrrolizidine alkaloids are considered to be nontoxic compounds, 1,2-unsaturated

ones are responsible for negative effects. The research results regarding cooking effects are still contradictory and insufficient [82]. Nevertheless, *Borago officinalis* became a new crop, despite the fact that it contains pyrrolizidine alkaloids which are hepatotoxic, mutagenic, and carcinogenic and may produce toxicity, particularly in people with liver disease. The Spanish production of this plant in 2018 reached 6606 tons, and this is more or less the annual production, which is consumed mainly in the La Rioja, Aragón, and Navarra regions (northern Spain), where borage is one of the typical dishes. But, in any case, its commercialization is controlled by Regulation (EU) 2023/915 and it is a challenge [83]. Borage's oil, which contains high amounts of γ -linolenic acid, does not contain pyrrolizidine alkaloids, or at least, if present, they are at levels lower than 200 ppt [81,84].

Prunus spinosa bluish-black fruits have astringent properties, and besides being used for making sloe brandy, they can also be used in the food industry as a natural colorant and preservative [85]. Studies on this species stress the antioxidant properties of these fruits, which are far too astringent for direct human consumption, but can be used as flavoring in liqueurs, wine, vinegar, jams, jellies, and preserves [86,87]. Information on toxicology of the sloe fruits is scarce.

Silene vulgaris stems and leaves can be consumed both fresh and cooked. The plant contains phytoecdysteroids, which possess adaptogenic, anabolic, antidiabetic, antitumor, antiosteoporosis, immunoprotective/immunostimulant, and hepatoprotective effects. Early pharmacological experiments have shown a low toxicity of ecdysteroids in mammals ($LD_{50} > 6$ g/kg) [88]. Another important group of secondary metabolites in *Silene vulgaris* comprises saponins. The hairy roots of *Silene vulgaris* can be even used as an alternative approach for the production of saponins [89]. Many plants used as foods contain saponins (e.g., chickpeas, soybeans, lentils, and lucerne), which, taken with the food, have the ability to lower the plasma lipid concentration. Toxicological studies show that the short-term consumption of saponins from soybeans, lucerne, or quillaia are safe at levels of below 50 mg/kg body weight—about 3 g/day [90].

Scolymus hispanicus midribs (i.e., the central leaf veins), petioles, and roots are usually consumed boiled, mashed, or baked, while the young tender leaves and the blanched leaf stalks are consumed fresh in salad, according to traditional Mediterranean cuisine [59,91]. Sergio et al. [91] studied how the cooking method of *Scolymus hispanicus* affected its phenolic content and composition, antioxidant activity, sugar and inorganic ion content, organoleptic characteristics, and microbial safety. They discovered that boiling caused a decrease in the values of these parameters, even though it was the most preferred way of cooking when it comes to taste. When prepared by steaming and 'sous vide', the antioxidant activity, total phenols, and chlorogenic acid content were preserved. Moreover, 'sous vide' resulted in the best cooking method also regarding microbial safety during shelf life. A study by Aboukhalaf et al. showed that the crude extract of *S. hispanicus* aerial parts is safe, with an LD_{50} higher than 5000 mg·kg⁻¹ [67].

Asparagus acutifolius shoots can be consumed boiled, stewed, and, rarely, raw. Although its safety profile is poorly studied, there are studies of its close edible relative *Asparagus officinalis*. Ito and co-authors [92] studied the acute and subchronic oral toxicity, as well as the genotoxicity, of an enzyme-treated *Asparagus officinalis* extract (a novel anti-stress functional material) in rats. This 90-day subchronic study (500, 1000, and 2000 mg/kg body weight, delivered by gavage) reported no significant adverse effects in food consumption, body weight, mortality, urinalysis, hematology, biochemistry, necropsy, organ weight, and histopathology, as well as observing no genotoxicity. In a double-blind and randomized controlled trial of a standardized extract of *Asparagus officinalis*, no severe side effects were observed [93].

As a wild edible plant, *Asparagus acutifolius* can be easily confused with some non-edibles by non-professionals. During 1995–2007, 31 patients presented clinical features of aconite poisoning following the ingestion of young shoots and leaves, which they assumed was “wild asparagus” [94]. Another plant, *Baptisia*, can also be confused with wild asparagus, and its consumption can cause generalized nicotinic agonist toxicity [95].

Obesity is a dramatic and multiple health hazard related to cardiovascular disease, hypertension, metabolic syndrome, etc., and WHO has declared it a global epidemic [96]. The Mediterranean diet is recognized as an efficient strategy for mitigating obesity rates and all related health problems [97]. Therefore, these five plants, traditionally consumed in the Iberian Peninsula and gathered from the wild, but recently introduced into cultivation, deserve attention due to their antioxidant, lipid-lowering, hypoglycemic, and anti-inflammatory activities.

5. Conclusions

In the Iberian Peninsula, around 500 wild plant species are popularly collected as food. As indicated above, thirty of these wild plants, widely distributed throughout the Mediterranean area, were introduced into cultivation, some already in the Neolithic period, but most of them in classical times, and they are currently important crops cultivated worldwide. But the traditional use of many other plants, not commercially available, has resulted in an attempt to introduce them into cultivation. The data included in this paper show that the introduction of borage [19], blackthorn [35], and golden thistle [65] has been successful, while attempts to cultivate bladder campion and wild asparagus are still in progress (see above). It is expected that new wild food and medicinal plants will be introduced into cultivation in the near future. A review of the phytochemistry and pharmacology of *Borago officinalis*, *Prunus spinosa*, *Silene vulgaris*, *Scolymus hispanicus* and *Asparagus acutifolius* provides a basic knowledge of their safety and beneficial properties, but further research should be carried out to determine their characteristics as food. The limitations of this study are due to the fact that the information about the bioactive compounds of these five plants is collected from the scientific literature from different parts of the world where they grow wild or are cultivated. Therefore, further research is needed to trace the metabolomic dynamics of these plants regarding geographical and ecological principles, as well as wild versus cultivated origins. Implications for further research should also be considered when looking at the effects of the cooking process on the pyrrolizidine alkaloids of *Borago officinalis*.

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