

Review

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*Review*

# Wild Species from the Family Apiaceae, Traditionally Used as Food in Some Mediterranean Countries

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**Abstract:** Mediterranean countries are a cauldron of cultural exchange, with a strong emphasis on wild plants in cuisine traditions. Many of these plants belong to the family Apiaceae. The common climate determines the common range of distribution. While many plants have wide distribution, the range of distribution of others is restricted to Western Mediterranean or North Africa. This review investigates wild plants from the family Apiaceae traditionally used as food in 13 study sites - 11 countries in the Mediterranean and adjacent territories - the mainland and 3 islands. The aim is to trace patterns of native distribution versus consumption. As a result, 81 wild umbellifers are listed, traditionally used as food. Their consumption and distribution patterns are described and discussed. Interestingly in 8 of the 13 study sites (61.5%) are recorded 50 plants (66.7% of all wild umbellifers, traditionally used as food) which are consumed in only one particular country. These are as follows: 8 taxa in Morocco, 9 taxa in Spain, 2 taxa in Sicily, 3 taxa in Bulgaria 3 taxa in Crete, 8 taxa in Armenia, 14 taxa in Turkey, and 3 taxa in Jordan. However, these 50 restrictedly consumed plants are distributed in more than one country (except 15 taxa, which are endemics). Many of the plants that are used in certain countries are not consumed by the neighboring people. The results of the two statistical tests, namely Jaccard index and heatmap clustering (double dendrogram) are discussed. The presence of an outlier, such as Bulgaria, which shares borders, history, and culture with Greece and Turkey, emphasizes the importance of local climate on plant distribution and consumption over cultural interactions. The same was observed for some pairs of countries, such as Spain and Morocco and Turkey and Armenia, although they had the highest number of common plants, that are both distributed and consumed as food.

**Keywords:** consumed wild umbellifers; similarity; distribution; Jaccard index; heatmap clustering

## 1. Introduction

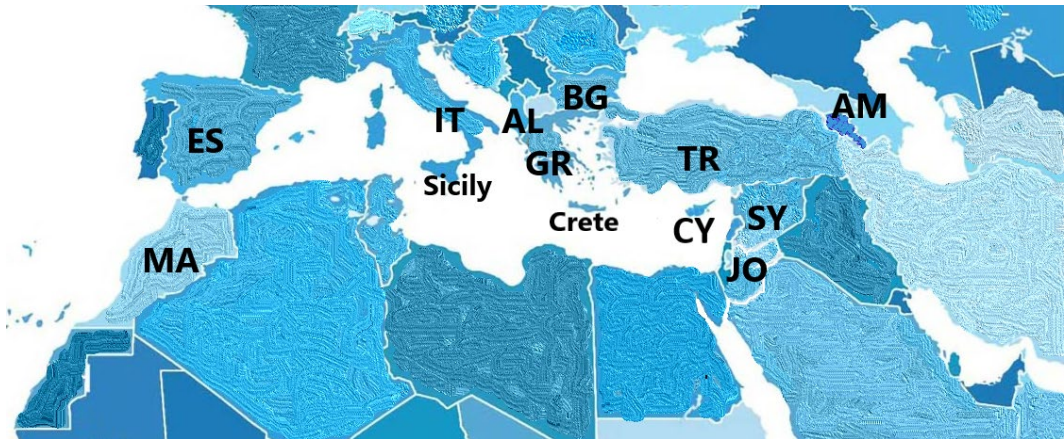
The use of wild edible plants is intimately linked to the cultural history of a certain region, but also to the local identity and traditions of the populations. The Mediterranean basin is a cauldron of different cultures, religious beliefs, which over the centuries have been mixed together due to great migrations of populations or to invasions and conquests. For instance, Muslim invaders conquered many European countries in the Middle Ages (10th and 11th centuries) [1]. Ottoman Empire expanded to the West and in 14th century on the Balkan peninsula and to Armenia [2]. Also, cultural relations can be expected between the eastern part of Spain and Sicily as the island was part of the Aragon Kingdom in 13th century. Moreover, Sicily was able to resist the demands of the maritime cities, namely Pisa and Genoa, and preserve a strong political core [3]. Cultural intersections are also known for Spain and Morocco in the Middle Ages [4].

The commercial trade across the Mediterranean Sea facilitated the exchange of knowledge between the different cultures that surrounded this area, including the use of wild plants as food. Thanks to Mediterranean traditions, a large number of them continue to be present in the food [5]. Native plants have been our most immediate source of food since ancient times. People all over the world experimented with and ate different parts of the plants they found growing locally. Many of these, were subjected to continuous selection and domestication processes over long periods of time, and as populations migrated to new territories, the plants also moved with them [6]. The result is a variety of eating styles with many common elements, but at the same time they differ in distinct local or regional traditions. The wild plants consumed by Mediterranean people have been the subject of interest since antiquity for their beneficial effects on human health. The relative longevity of these people is attributed to their diet. Indeed, the Mediterranean diet is considered a healthy and sustainable food model, combining respect for the biodiversity, creating a strong sense of cultural identity and continuity of these communities in the Mediterranean basin [7]. In Mediterranean countries, the traditional diet is usually based on the eating of a large number of plants collected from nature, including climbing plants with young edible sprouts, wild tubers and leafy vegetables, edible fruits of tree species, as well as aromatic plants used as spices [8,9]. There is increased interest in edible wild plants in recent years and the knowledge of their phytochemicals in the role of health care allows calling them “new functional foods” [10].

About 2300 different plants and fungi are collected from the nature as food in the Mediterranean region, many of these being umbellifers [11]. The *Apiaceae* family, consists of about 3780 species in 434 genera, most of which are native to the Mediterranean region and south-western Asia. It includes a large number of wild umbellifers used for different purposes from ancient times (food, traditional medicine) as well as in modern pharmaceutical and cosmetic industries [12,13].

The common Mediterranean climate determines common range of distribution of many plants. While plenty of them grow all over the territory, some occur restrictedly either to Western Mediterranean or to Eastern Mediterranean. Some plants grow only in North Africa while others do not reach so much to the South [14]. Thus, floristic specifics are the precondition for some plants to be used as food in some regions/countries and not in others.

The aim of this review is to study wild plants from family *Apiaceae* traditionally used as food in 13 study sites - 11 countries, including 3 islands in the Mediterranean and adjacent territories (Figure 1) in order to trace patterns of native distribution and cultural exchange. The hypothesis is that countries that are neighboring will have high similarity in the use as food of wild umbellifers.



**Figure 1.** Study sites. Legend: JO – Jordan and Palestina; IT – South Italy; MA – Morocco; Sicily; ES – Spain; SY – Syria; TR – Turkey; AL – Albania; AM – Armenia; BG – Bulgaria; Crete; CY – Cyprus; GR – Greece.

2. Results

2.1. Distribution of Wild Umbellifers, Traditionally Used as Food

As a result of our literature survey we come up with a list of 81 wild umbellifers, traditionally used as food in 13 study sites - the mainland and 3 islands of 11 countries in the Mediterranean and adjacent territories (Figure 1, Table 1).

The distribution of these 81 taxa is either all over the territory of the studied sites or restricted to certain parts (Table 1).

**Table 1.** Wild plants from family Apiaceae traditionally used as food and their distribution in 11 Mediterranean countries and adjacent territories. Legend: JO – Jordan and Palestina; IT – South Italy; MA – Morocco; Sicily; ES – Spain; SY – Syria; TR – Turkey; AL – Albania; AM – Armenia; BG – Bulgaria; Crete; CY – Cyprus; GR – Greece. Note: asterisk marks those species that are collected in the field and eaten only in one or two of the 50 Spanish provinces, while all other species listed for Spain are used in three or more provinces. Distribution of the taxa basically follows Euro+Med-Plantbase [14], double asterisk marks the synonym names used in the original publications.

| Taxon                                        | Presence in countries of the study area        | Used as food | Used part and modes of application                                               |
|----------------------------------------------|------------------------------------------------|--------------|----------------------------------------------------------------------------------|
| <i>Aegopodium podagraria</i> L.              | AL, BG, ES, GR, IT, TR                         | BG           | Sprouts, salad raw, soup,                                                        |
| <i>Ammi majus</i> L.                         | AL, Crete, CY, GR, ES, IT, JO, MA, Sicily, SY, | SY           | Inflorescence, added to yerba mate                                               |
|                                              |                                                | CY           | Aerial parts, salads                                                             |
|                                              |                                                | GR           | Aerial parts, sauté                                                              |
|                                              |                                                | IT           | Aerial parts boiled then on pasta, dressing with “pecorino” cheese and olive oil |
|                                              |                                                | MA           | Stems                                                                            |
| <i>Ammodaucus leucotricus</i> Coss. & Durieu | MA                                             | MA           | Seeds                                                                            |
| <i>Ammoides pusilla</i> (Brot.) Breister.    | AL, ES, GR, IT, MA, Sicily                     | MA           | Aereal parts                                                                     |



|                                                       |                                                                                                              |       |                                                                                              |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------|----------------------------------------------------------------------------------------------|
| <i>Anethum foeniculoides</i> Maire & Wilzek           | MA                                                                                                           | MA    | Aerial parts, seeds                                                                          |
| <i>Anethum graveolens</i> L.                          | native AL, BG, CY, ES, MA, TR, introduced to AM, Crete, GR, JO, SY;<br>naturalized in IT, casual to Sicily,; | TR    | Aboveground, salad, seasoning, raw, plant is with yogurt                                     |
|                                                       |                                                                                                              | JO    | Seed<br>Consumed cultivated in BG, as the plant is listed as Endangered in the Red Data Book |
| <i>Angelica sylvestris</i> L.                         | AL, AM, BG, ES, GR, IT, Sicily, SY, TR                                                                       | BG    | Sprouts, leaves, salad raw, soup,                                                            |
| <i>Angelica tatiana</i> Bordz.                        | AM                                                                                                           | AM    | Petiole, stem                                                                                |
| <i>Anthriscus cerefolium</i> (L.) Hoffm.              | native AM, AL, BG, CY, GR, Sicily, TR<br>introduced to MA, IT, naturalised to ES                             | BG    | Leaves, shoots, salad raw, soup, spice                                                       |
|                                                       |                                                                                                              | GR    | Young aerial parts, boiled                                                                   |
| <i>Anthriscus sylvestris</i> (L.) Hoffm.              | AL, AM, BG, ES, GR, IT, JO, MA, Sicily, SY TR                                                                | AM    | Stems, leaves                                                                                |
|                                                       |                                                                                                              | BG    | Roots, leaves, shoots, salad raw, soup, pastry                                               |
|                                                       |                                                                                                              | Crete | Young aerial parts, fried in mixtures as a filling for pies                                  |
| <i>Apium graveolens</i> L.                            | native AL, AM, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR                                             | JO    | Petiole, leaves                                                                              |
|                                                       |                                                                                                              | AM    | Leaves, roots                                                                                |
|                                                       |                                                                                                              | *ES   | Leaves, raw in salads or stewed                                                              |
| <i>Astrodaucus orientalis</i> (L.) Drude              | AM, JO, SY, TR                                                                                               | AM    | Stems                                                                                        |
| <i>Berula erecta</i> (Huds.) Coville                  | AL, AM, BG, Crete, ES, GR, IT, JO, MA, SY, TR                                                                | AM    | Leaves, fruits                                                                               |
| <i>Bunium balearicum</i> (Sennen) Mateo & López Udías | ES                                                                                                           | *ES   | Tubers, raw as a snack                                                                       |
| <i>Bunium macuca</i> Boiss.                           | ES, MA, Sicily                                                                                               | ES    | Tubers, raw as a snack (they taste chestnut)                                                 |
| <i>Bunium pachypodum</i> P.W. Ball                    | ES, MA                                                                                                       | *ES   | Tubers, raw as a snack                                                                       |
| <i>Bupleurum fruticosum</i> L.                        | ES, GR, IT, MA, Sicily                                                                                       | *ES   | Aerial parts, for hardening olives                                                           |
| <i>Bupleurum gibraltaricum</i> Lam.                   | ES, MA                                                                                                       | *ES   | Aerial parts for hardening olives                                                            |

|                                                                                                                      |                                                                                                                        |     |                                                                                           |
|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------|
| <i>Cachrys microcarpa</i> M. Bieb.<br>(syn. ** <i>Bilacunaria microcarpa</i><br>(M. Bieb.) Pimenov & V.N.<br>Tikhom. | AM, JO, SY, TR                                                                                                         | AM  | Stems, leaves                                                                             |
| <i>Carum carvi</i> L.                                                                                                | AL, AM, BG, ES, IT, TR                                                                                                 | AM  | Stems, leaves, seeds                                                                      |
|                                                                                                                      |                                                                                                                        | BG  | Fruits, spice                                                                             |
|                                                                                                                      |                                                                                                                        | *ES | Fruits                                                                                    |
| <i>Centella asiatica</i> (L.) Urb.                                                                                   | native in Georgia and tropical<br>and subtropical Asia and<br>Africa                                                   | JO  | Above ground organs                                                                       |
| <i>Chaerophyllum aureum</i> L.                                                                                       | AL, AM, BG, ES, GR, IT, TR                                                                                             | AM  | Stems, leaves                                                                             |
| <i>Chaerophyllum bulbosum</i> L.                                                                                     | AM, BG, GR, IT, TR                                                                                                     | AM  | Stems, leaves, roots                                                                      |
|                                                                                                                      |                                                                                                                        | BG  | Young shoots, corms, salad<br>raw and stew                                                |
| <i>Chaerophyllum macropodium</i><br>Boiss.                                                                           | TR                                                                                                                     | TR  | Eaten fresh                                                                               |
| <i>Chaerophyllum macrospermum</i><br>(Spengel) Fisch. & C. A. Mey.                                                   | AM, TR                                                                                                                 | TR  | Cooked as a stew or egg-<br>vegetable dish; used in cheese<br>production                  |
| <i>Conopodium majus</i> (Gouan)<br>Loret                                                                             | ES, IT, Sicily                                                                                                         | ES  | Tubers, raw as a snack (they<br>taste chestnut)                                           |
| <i>Conopodium marianum</i> Lange                                                                                     | ES, MA                                                                                                                 | ES  | Tubers, raw as a snack                                                                    |
| <i>Conopodium pyrenaeanum</i><br>(Loisel.) Miégev                                                                    | ES, MA                                                                                                                 | ES  | Tubers, raw as a snack                                                                    |
| <i>Conopodium subcarneum</i><br>(Boiss. & Reut.) Boiss. & Reut.                                                      | ES                                                                                                                     | *ES | Tubers, raw as a snack                                                                    |
| <i>Conopodium thalictrifolium</i><br>(Boiss.) Calest.                                                                | ES                                                                                                                     | *ES | Tubers, raw as a snack                                                                    |
| <i>Coriandrum sativum</i> L.                                                                                         | native to JO, SY,<br>naturalized to IT, MA, casual<br>to ES, Sicily;<br>introduced to AL, AM, BG,<br>GR, Crete, CY, TR | AM  | Stems, fruits                                                                             |
|                                                                                                                      |                                                                                                                        | TR  | Cooked as a stew or rice-<br>vegetable dish; pie is made<br>from its seeds                |
| <i>Crithmum maritimum</i> L.                                                                                         | BG, Crete, CY, ES, GR, IT, JO,<br>MA, Sicily, SY, TR                                                                   | IT  | Young leaves, shoots boiled<br>and dressed with vinegar (or<br>lemon juice) and olive oil |
|                                                                                                                      |                                                                                                                        | MA  | Aerial parts                                                                              |
|                                                                                                                      |                                                                                                                        | *ES | Leaves, for seasoning olives;<br>raw in salads; roots, raw as a<br>snack                  |

|                                                                                                                       |                                                           |        |                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|--------|----------------------------------------------------------------------------------------------|
|                                                                                                                       |                                                           | CY     | Young aerial parts, boiled, then pickled                                                     |
|                                                                                                                       |                                                           | GR     | Young aerial parts, boiled, then pickled                                                     |
| <i>Cuminum cyminum</i> L.                                                                                             | AM, ES, JO, casual to Sicily and MA                       | JO     | Seed                                                                                         |
| <i>Daucus carota</i> L.                                                                                               | AL, AM, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR | CY     | Young aerial parts, boiled                                                                   |
|                                                                                                                       |                                                           | GR     | Young aerial parts, boiled                                                                   |
|                                                                                                                       |                                                           | IT     | Root, roasted, boiled, fried                                                                 |
|                                                                                                                       |                                                           | TR     | Shoot and leaf meal, pancake, stew                                                           |
|                                                                                                                       |                                                           | Crete  | Young aerial parts, boiled in mixtures                                                       |
| <i>Daucus carota</i> L. subsp. <i>maximus</i> (Desf.) Ball                                                            | AL, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR     | JO     | Fleshy roots, eaten raw                                                                      |
|                                                                                                                       |                                                           | *ES    | Roots, as a snack, young leaves stewed                                                       |
| <i>Daucus carota</i> L. subsp. <i>carota</i>                                                                          | AL, BG, Crete, CY, ES, GR, IT, MA, Sicily, TR             | Sicily | Tender basal leaves and roots, raw in salads or stewed.                                      |
| <i>Deverra scoparia</i> Coss. & Durieu                                                                                | MA                                                        | MA     | Shoots, core of roots, aerial parts                                                          |
| <i>Devera denudata</i> (Viv.) Pfisterer & Podlech                                                                     | MA                                                        | MA     | Shoots, core of roots                                                                        |
| <i>Deverra tortuosa</i> (Desf.) DC.                                                                                   | JO                                                        | JO     | Leaf and flower                                                                              |
| <i>Diplotaenia turcica</i> Pimenov & Kljuykov (syn. ** <i>Diplotaenia cachrydifolia</i> sensu P. H. Davis, non Boiss) | TR                                                        | TR     | Cooked as a stew or egg-vegetable dish; used in brine and cheese production                  |
| <i>Echinophora tenuifolia</i> L.                                                                                      | AM, BG, Crete, CY, GR, IT, Sicily, TR                     | TR     | Shoot, flower, leaf soup, seasoning, drinking                                                |
| <i>Eleoselinum asclepium</i> (L.) Bertol.                                                                             | AL, Crete, GR, ES, IT, MA, Sicily, TR                     | MA     | Aereal parts                                                                                 |
| <i>Eryngium billardieri</i> F. Delaroche.                                                                             | TR, AM, SY                                                | TR     | Eaten fresh                                                                                  |
| <i>Eryngium campestre</i> L.                                                                                          | AL, AM, BG, Crete, ES, GR, IT, MA, Sicily, SY, TR         | AM     | Leaves, roots                                                                                |
|                                                                                                                       |                                                           | Sicily | Sprouts, raw in salads.                                                                      |
|                                                                                                                       |                                                           | TR     | Shoot and leaf pie, stew                                                                     |
| <i>Eryngium creticum</i> Lam.                                                                                         | AL, BG, Crete, CY, GR, JO, SY, TR, casual to IT           | JO     | Vegetables leaves and stems, eaten raw as salad with garlic and yoghurt, or cooked as pastry |

|                                                                                                       |                                                         |        |                                                                                                           |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------|
|                                                                                                       |                                                         | SY     | Young aerial part, salad; steamed.                                                                        |
|                                                                                                       |                                                         | Crete, | Young aerial part, salad                                                                                  |
| <i>Eryngium glomeratum</i> Lam.                                                                       | Crete, GR, JO, SY, TR                                   | JO     | Young aerial part, salad                                                                                  |
|                                                                                                       |                                                         | Crete, | Young aerial part, salad                                                                                  |
| <i>Falcaria vulgaris</i> Bernh.                                                                       | AL, AM, BG, ES, GR, IT, JO, SY TR,                      | TR     | Aerial parts cooked as vegetable; leaves eaten in salads                                                  |
|                                                                                                       |                                                         | AM     | Stems                                                                                                     |
| <i>Ferula assa-foetida</i> L.                                                                         | native to Libya                                         | JO     | Root                                                                                                      |
| <i>Ferula communis</i> L.                                                                             | AL, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR       | IT     | Inflorescences deep fried                                                                                 |
|                                                                                                       |                                                         | MA     | Unopen inflorescence                                                                                      |
|                                                                                                       |                                                         | JO     | Vegetables inflorescence, eaten cooked                                                                    |
| <i>Ferula orientalis</i> L.                                                                           | AM, BG, TR                                              | TR     | Cooked plant is with yogurt; used in brine and cheese production                                          |
| <i>Ferulago angulata</i> (Schlecht.) Boiss. subsp. <i>angulata</i>                                    | TR                                                      | TR     | Used in cheese production                                                                                 |
| <i>Ferulago angulata</i> (Schlecht.) Boiss. subsp. <i>carduchorum</i> (Boiss. & Hausskn.) Chamberlain | TR                                                      | TR     | Used in cheese production                                                                                 |
| <i>Ferulago setifolia</i> K. Koch                                                                     | AM, TR                                                  | AM     | Leaves, stems                                                                                             |
| <i>Ferulago stellata</i> Boiss.                                                                       | TR                                                      | TR     | Cooked as a stew or egg-vegetable dish; used in brine and cheese production                               |
| <i>Foeniculum vulgare</i> Mill.                                                                       | AL,AM, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY TR | AM     | Stems, fruits                                                                                             |
|                                                                                                       |                                                         | BG     | Leaves, mericarps, spice                                                                                  |
|                                                                                                       |                                                         | CY     | Leaves and tender stems, raw as a snack or in salads, or stewed and cooked, seasoning (especially snails) |
|                                                                                                       |                                                         | ES     | Leaves and tender stems, raw as a snack or in salads, or stewed                                           |
|                                                                                                       |                                                         | GR     | Leaves and tender stems, raw as a snack or in salads, or stewed, fried,saute                              |



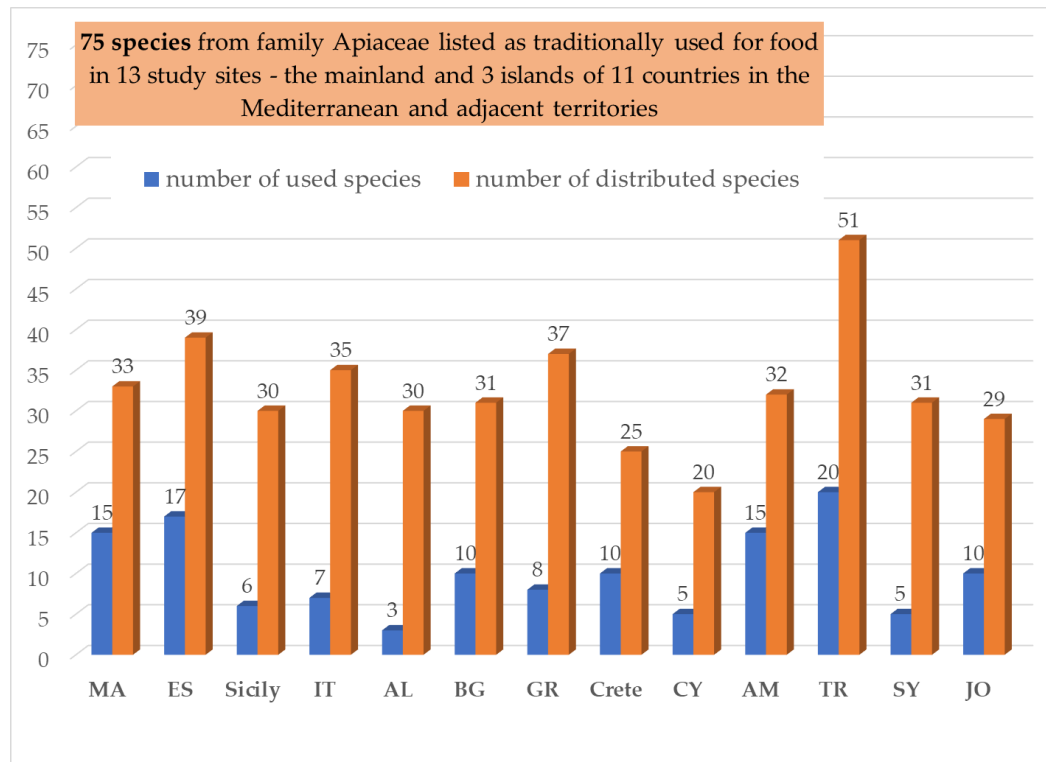
|                                                                                             |                                                       |        |                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------|-------------------------------------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                             |                                                       | MA     | Tender stems, tender leaves, roots after being peeled, seeds                                                                                                                                                        |
|                                                                                             |                                                       | TR     | Aboveground meal, roasted, pilaf, as spice                                                                                                                                                                          |
|                                                                                             |                                                       | JO     | Seeds, as herbal tea seeds, boiled and added to bread leaves, dried and added to pickles, fruits foliage, eaten raw foliage, dried and added to cake as a condiment, foliage, eaten raw as salad, or cooked as soup |
|                                                                                             |                                                       | Sicily | Leaves and tender shoots, raw as a snack or in salads, or stewed; seeds as a condiment and for the herbal teas and digestive liquors preparation.                                                                   |
|                                                                                             |                                                       | Crete  | Leaves, fried in mixtures as a filling for pies or seasoning stewed potatoes and tomatoes                                                                                                                           |
|                                                                                             |                                                       | SY     | Aerial part, spice added to zaatar and soups; fried with: eggs/ meat/potato                                                                                                                                         |
| <i>Foeniculum vulgare</i> subsp. <i>piperitum</i> (C. Presl.) Bég.                          |                                                       | AL     | Young aerial parts and fruits boiled, then on pasta or in mixed vegetables young leaves, shoots boiled and dressed with vinegar (or lemon juice) and olive oil                                                      |
|                                                                                             |                                                       | IT     | Young aerial parts and fruits boiled, then on pasta or in mixed vegetables young leaves, shoots boiled and dressed with vinegar (or lemon juice) and olive oil                                                      |
| <i>Grammosciadium platycarpum</i> Boiss. & Hausskn.                                         | TR, AL                                                | TR     | Eaten fresh                                                                                                                                                                                                         |
| <i>Heliosciadium nodiflorum</i> (L.) W.D.J. Koch (**syn. <i>Apium nodiflorum</i> (L.) Lag.) | AL, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR | AL     | Aerial parts raw in salads; seasoning soups                                                                                                                                                                         |
|                                                                                             |                                                       | IT     | Aerial parts raw in salads; seasoning soups                                                                                                                                                                         |

|                                                                             |                                                                                                                        |        |                                                              |
|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|--------|--------------------------------------------------------------|
|                                                                             |                                                                                                                        | ES     | Tender leaves and stems, raw in salads.                      |
|                                                                             |                                                                                                                        | Sicily | Tender leaves and stems, raw in salads or stewed.            |
|                                                                             |                                                                                                                        | SY     | Young aerial part, appetizer                                 |
|                                                                             |                                                                                                                        | MA     | Aerial parts                                                 |
| <i>Heracleum antasiaticum</i> Manden.                                       | AM, TR                                                                                                                 | AM     | Stems                                                        |
| <i>Heracleum persicum</i> Fisch.                                            | TR                                                                                                                     | TR     | Used in cheese production                                    |
| <i>Heracleum sibiricum</i> L.                                               | BG, IT, Sicily                                                                                                         | BG     | Leaves, shoots, salad raw, soup, spice                       |
| <i>Heracleum trachyloma</i> Fisch. & C.A. Mey.                              | TR, AM                                                                                                                 | TR     | Leaves stffed, stems as spice, eaten raw afer bark is peeled |
| <i>Kundmannia sicula</i> (L.) DC.                                           | Crete, ES, GR, IT, MA, Sicily,                                                                                         | Sicily | Basal leaves, stewed.                                        |
| <i>Levisticum officinale</i> W. D. J. Koch                                  | native to JO; introduced to BG, ES; casual to AL. naturalized in IT                                                    | JO     | Leaves                                                       |
| <i>Oenanthe pimpinelloides</i> L.                                           | AL, BG, Crete, ES, GR, IT, JO, MA, Sicily, SY, TR                                                                      | Crete  | Young aerial parts, fried in mixtures in pies                |
| <i>Orlaya daucoides</i> (L.) Greuter (syn. ** <i>Caucalis daucoides</i> L.) | AL, AM, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR                                                              | AM     | Stems                                                        |
| <i>Pastinaca sativa</i> L.                                                  | AL, AM, BG, ES, GR, IT, Sicily, TR                                                                                     | JO     | Leaves, root                                                 |
| <i>Petroselinum crispum</i> (Mill.) Fuss                                    | native to JO, MA casual to Sicily; doubtfully native to AL, introduced to AM, BG, GR, Crete, CY, TR; naturalized to ES | JO     | Petiole, root, stem, leaves                                  |
| <i>Pimpinella kotschyana</i> Boiss.                                         | SY, TR,                                                                                                                | TR     | Used in rennet production                                    |
| <i>Pimpinella saxifraga</i> L.                                              | AL, AM, BG, GR, ES, IT, JO, SY, TR                                                                                     | AM     | Seeds                                                        |
|                                                                             |                                                                                                                        | BG     | Root, leaves, fruits, salad raw, spice                       |
| <i>Pimpinella cretica</i> Poir.                                             | Crete, CY, GR, JO, SY, TR                                                                                              | Crete  | Young aerial parts, in mixtures for pies                     |
| <i>Pimpinella peregrina</i> L.                                              | AL, AM, BG, Crete, CY, GR, IT, JO, Sicily, SY, TR                                                                      | Crete  | Young aerial parts, in mixtures for pies                     |
| <i>Prangos ferulacea</i> (L.) Lindl.                                        | AL, AM, BG, GR, IT, JO, Sicily, SY, TR,                                                                                | AM     | Leaves                                                       |

|                                                                                                                      |                                                           |        |                                                              |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|--------|--------------------------------------------------------------|
| <i>Pseudopimpinella anthriscoides</i> (Boiss.) F. Ghahrem. & al.<br>(syn. ** <i>Pimpinella anthriscoides</i> Boiss.) | AM, SY, TR                                                | TR     | As spice; cooked as a stew or egg vegetable dish             |
| <i>Ridolfia segetum</i> (Guss.) Moris                                                                                | AL, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR         | MA     | Stems                                                        |
| <i>Scandix pecten-veneris</i> L.                                                                                     | AL, AM, BG, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR | *ES    | Young basal leaves, stewed                                   |
|                                                                                                                      |                                                           | MA     | Basal leaves                                                 |
|                                                                                                                      |                                                           | GR     | Young leaves, soups                                          |
|                                                                                                                      |                                                           | SY     | Young aerial part, steamed with sleeq.                       |
|                                                                                                                      |                                                           | Crete  | Young aerial parts, fried in mixtures, as a filling for pies |
| <i>Sium sisarum</i> var. <i>lancifolium</i> (M. Bieb.) Thell.                                                        | native AM, BG, GR, SY TR, casual to ES, IT                | TR     | Used in cheese production                                    |
| <i>Smyrniolum olusatrum</i> L.                                                                                       | AL, Crete, CY, ES, GR, IT, JO, MA, Sicily, SY, TR         | TR     | Eaten fresh                                                  |
|                                                                                                                      |                                                           | ES     | Tender leaves and stems, raw in salads or stewed             |
|                                                                                                                      |                                                           | MA     | Stems, young shoots                                          |
|                                                                                                                      |                                                           | GR     | Young shoots, boiled, pastery                                |
|                                                                                                                      |                                                           | IT     | Young shoots, boiled, pastery                                |
| <i>Smyrniolum perfoliatum</i> L.                                                                                     | AL, AM, BG, CY, Crete, ES, GR, JO, IT, MA, Sicily, TR     | Sicily | Tender leaves and stems, pickled in vinegar.                 |
|                                                                                                                      |                                                           | BG     | Root, leaves, spice, soup                                    |
| <i>Smyrniolum rotundifolium</i> Mill.                                                                                | AL, BG, Crete, CY, GR, IT, Sicily, TR                     | Sicily | Tender leaves and stems, pickled in vinegar.                 |
| <i>Thapsia villosa</i> L.                                                                                            | ES, MA                                                    | MA     | Peeled roots                                                 |
| <i>Tordylium apulum</i> L.                                                                                           | AL, BG, CY, Crete, GR, ES, IT, JO, Sicily, SY, TR         | AL     | Aereal part, boiled                                          |
|                                                                                                                      |                                                           | CY     | Young aerial parts, seasoning                                |
|                                                                                                                      |                                                           | Crete  | Young aerial parts, in mixtures for pies                     |
|                                                                                                                      |                                                           | GR     | Basal rosettes, boiled and pastery                           |

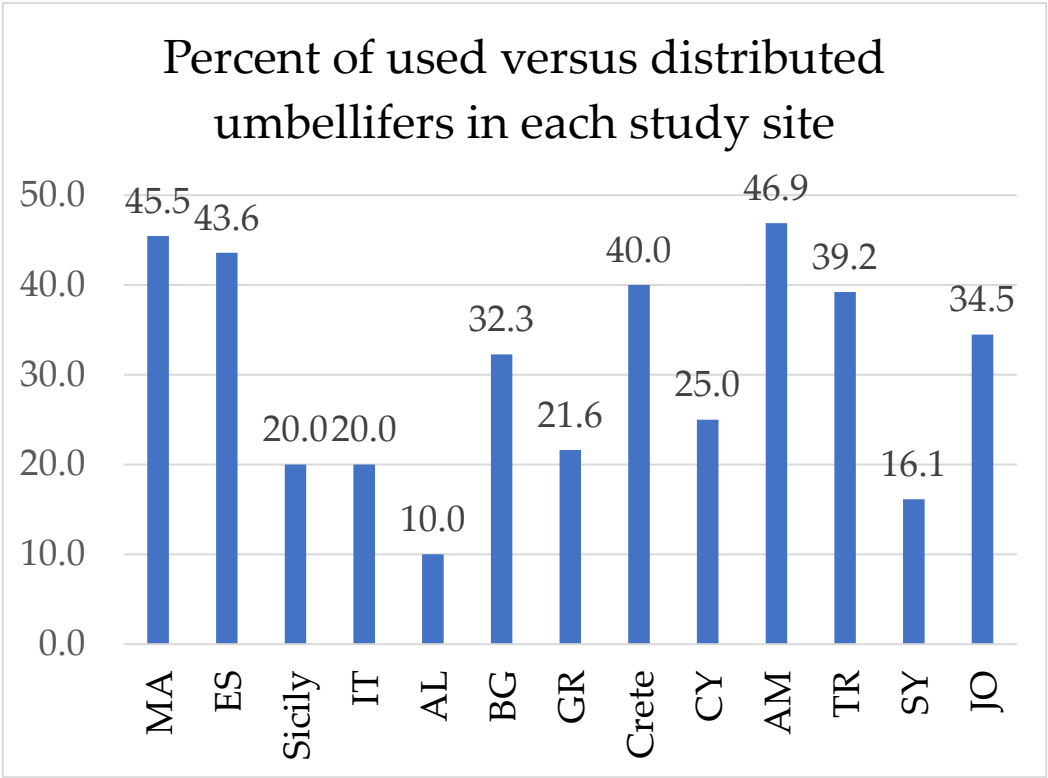
The listed 81 wild umbellifers, traditionally used as food (Table 1) are reduced to 75 taxa suitable for statistically analyses (as explained in Material and methods section). These 75 taxa are distributed as follows: 15 taxa in Morocco [15–22], 17 taxa in Spain [23–25], 6 taxa in Sicily [26–29], 7 taxa in South Italy [30–34], 3 taxa in Albania [32,34,35], 8 taxa in Greece [37,38], 10 taxa in Crete [37,39,40], 5 taxa in Cyprus [37,40], 20 taxa in Turkey [41–44], 10 taxa in Bulgaria [42,45–49], 15 taxa in Armenia [50–56], 5 taxa in Syria [57], 10 taxa in Jordan and Palestina [58–61] (Figure 2).

The highest number of edible wild umbellifers are reported for Turkey, followed by Spain, Armenia and Morocco (Figure 2). Similar pattern is seen in the distribution - Turkey, followed by Spain, Morocco and Armenia (Figure 2).

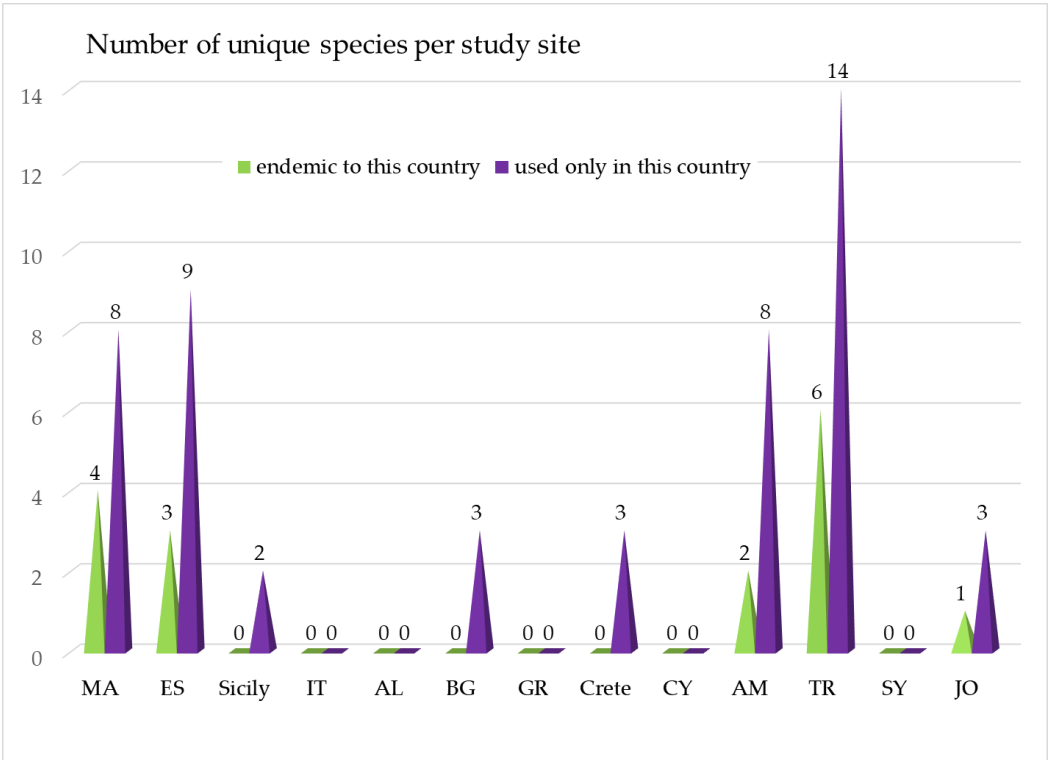


**Figure 2.** Number of wild plants taxa from family Apiaceae used as food and distributed in each of the study sites.

It is also shown that only about half or even less of the distributed edible umbellifers are consumed traditionally in each country (Figure 3). This indicates that the knowledge does not cross the borders that much as expected, because many of the plants that are used in certain country are not used by the neighbors. Armenia holds the record of utilization of wild edible umbellifers distributed on its territory (46.9%), followed by Morocco (45.5%), Spain (43.6%), Crete (40.0%) and Turkey (39.2%). Interestingly on the territory of Turkey are distributed the highest number (51 taxa) of the recognized as edible umbellifers (68%), but only 39.2% of them are used as food. Additionally, 14 taxa (70%) of these umbellifers are not consumed elsewhere and 6 of them are endemic plants (Figure 4). The lowest use of wild edible umbellifers distributed on its territory is observed in Albania (10.0%).



**Figure 3.** Percent of traditionally consumed wild umbellifers versus distributed edible taxa in each country.



**Figure 4.** Number of wild plants from family Apiaceae restrictedly used as food and distributed in each of the study sites.

Some of the wild umbellifers, traditionally used as food have restricted distribution. In 8 of the 13 study sites (61.5%) are recorded 50 plants used as food only in one particular country (66.7% of all



wild umbellifers, traditionally used as food). The distribution is as follows: 8 taxa in Morocco, 9 taxa in Spain, 2 taxa in Sicily, 3 taxa Bulgaria 3 taxa Crete, 8 taxa in Armenia, 14 taxa in Turkey and 3 taxa in Jordan (Figure 4). Of these 50 restrictedly consumed plants only 15 taxa (20 % of all documented umbellifers used as food) are distributed in only one country (Figure 4), namely 5 taxa endemic to Turkey - *Diplotaenia turcica* Pimenov & Kljuykov (syn. *D. cachrydifolia* non Boiss.), *Chaerophyllum macropodium* Boiss., *Ferulago angulata* (Schlecht.) Boiss., *F. stellata* Boiss. and 1 taxon endemic to Turkey and Armenia - *Grammosciadium platycarpum* Boiss. & Hausskn.; 4 taxa in Spain, 3 of them endemic to that country - *Bunium balearicum* (Sennen) Mateo & López Udías, *Conopodium subcarneum* (Boiss. & Reut.) Boiss. & Reut., and *C. thalictrifolium* (Boiss. & Reut.) Boiss. & Reut.; 1 taxon endemic to Morocco *Anethum foeniculoides* Maire & Wilzek, 1 taxon in Armenia *Angelica tatianae* Bordz, endemic to North Caucasus, Georgia and Azerbaijan; 1 taxon distributed in Jordan and few neighbor countries - *Deverra tortuosa* (Desf.) DC. (Table 1).

Additionally, the range of *Conopodium marianum* Lange, *C. pyrenaicum* (Loisel.) Miégev, *Bunium pachypodium* P.W. Ball etc., (Table 1). is restricted to Western Mediterranean. Plants growing only in North Africa are *Deverra scoparia* Coss. & Durieu, *D. denudata* (Viv.) Pfisterer & Podlech, etc.

2.2. Statistical Analyses of the Distribution of Wild Umbellifers, Traditionally Used as Food

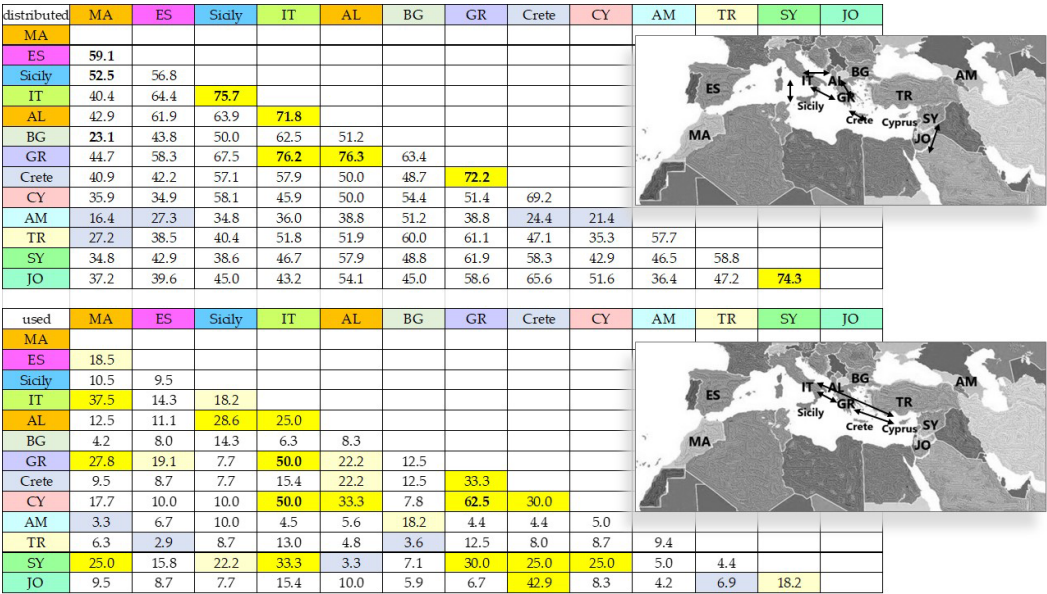
2.2.1. Jaccard Index

Jaccard index (JI) revealed that the level of similarity between pairs of countries in traditional use of wild umbellifers as food, is rather different regarding the distribution pattern of edible wild umbellifers in same pairs of countries there.

The highest similarity regarding the distribution pattern of edible wild umbellifers is between Albania and Greece immediately followed by Italy and Greece, Sicily and Italy, Syria and Jordan, Greece and Crete, Italy and Albania (Figure 5).

While the highest similarity regarding the use pattern of wild umbellifers is between Greece and Cyprus, followed by South Italy and Greece, South Italy and Cyprus, Crete and Jordan, Morocco and South Italy, Greece and Crete, Greece and Syria, Crete and Cyprus etc. (Figure 5). Surprisingly on the contrary of expected high similarity in use pattern between Bulgaria and Turkey – both neighbouring countries and parts of Ottoman Empire, the Jaccard index is low. Also, low JI is calculated for the pair Turkey and Greece, both neighbouring countries and parts of Ottoman Empire. Additionally the use pattern similarity between Morocco and Spain is not high on the contrary of the expected (Figure 5).

In all cases the similarity regarding the use as food is marked by much lower indexes compared to the distribution pattern.

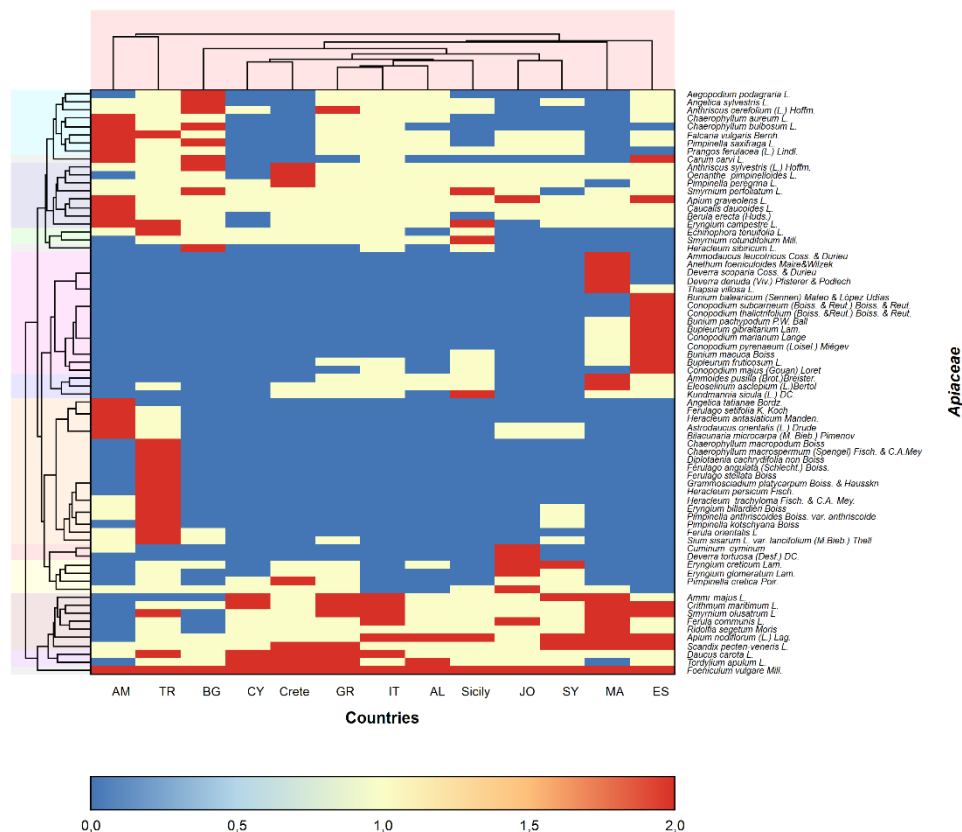


**Figure 5.** Similarity between pairs of countries in both traditional use of wild umbellifers as food, and distribution of edible wild umbellifers, expressed as JI %.

### 2.2.1. Heatmap Clustering

The heatmap (double dendrogram) highlights the similarities between all of the plants and countries studied in terms of Apiaceae wild plant distribution/food consumption patterns (Figure 5). The patterns are divided into three categories: not distributed and not used as food, distributed, but not used as food, and both distributed and used as food. The columns of the heatmap depict the similarities between patterns per country, while the rows represent the plants.

Countries cluster together according to their geographical proximity. Thus, Armenia is linked with Turkey, whereas Morocco is associated with Spain. (Figure 6). The remaining countries are clustered together as follows: the islands of Crete and Cyprus; Greece and Italy, as well as the more distant members Albania and Sicily; Jordan and Syria. Bulgaria is something of an outlier, despite having common borders with Turkey and Greece. In the pattern where plants are both distributed and consumed as food, the greatest parallels can be seen between Morocco and Spain, Greece and Italy, Crete and Cyprus, and Armenia and Turkey (Figure 6).



**Figure 6.** Heatmap and dendrogram showing clustering of wild-growing Apiaceae plants with similar distribution and eaten pattern across the studied countries and clustering of countries with similar distribution and eaten pattern of the same plants. The colors used refer to specific patterns as follows: blue – not distributed and not used as food, yellow – distributed, but not used as food, and red – distributed and used as food.

Plants cluster that deserves attention comprises *Angelica tatianae* Bordz., *Ferulago setifolia* K. Koch, *Heracleum antasiaticum* Manden., *Astrodaucus orientalis* (L.) Drude, *Cachrys microcarpa* M. Bieb. (syn. *Bilacunaria microcarpa* (M. Bieb.) Pimenov) and *Chaerophyllum macropodum* Boiss., *Chaerophyllum macrospermum* (Spengel) Fisch. & C. A. Mey., *Diplotaenia turcica* Pimenov & Kljuykov (syn. *D. cachrydifolia* sensu P.H. Davis, non Boiss.), *Ferulago angulata* (Schlecht.) Boiss., *Ferulago stellata* Boiss.,

*Grammosciadium platycarpum* Boiss. & Hausskn., *Heracleum persicum* Fisch., *Heracleum trachyloma* Fisch. & C.A. Mey. *Eryngium billardieri* F. Delaroche, *Pimpinella anthriscoides* Boiss., *Pimpinella kotschyana* Boiss., *Ferula orientalis* L., *Sium sisarum* L., respectively used either only in Armenia or only in Turkey (Figure 6).

Next cluster of plants groups those used in Morocco (*Ammodaucus leucotricus* Coss. & Durieu, *Deverra scoparia* Coss. & Durieu, *D. denudata* (Viv.) Pfisterer & Podlech, *Thapsia villosa* L.) and associated with Spain (*Bunium balearicum* (Sennen) Mateo & López Udías *B. macuca* Boiss., *B. pachypodum* P.W. Ball, *Bupleurum fruticosum* L., *B. gibraltarium* Lam., *Conopodium marianum* Lange, *C. pyrenaicum* (Loisel.) Miégev, *Conopodium majus* (Gouan) Loret) (Figure 6).

*Scandix pecten-veneris* L., *Daucus carota* L. and *Tordylium apulum* L. group in cluster which is related to the consumption of these plants in Greece, Crete and Cyprus, but also in some other countries (Figure 6).

### 3. Discussion

The consumption of wild umbellifers is basically well documented in all studied countries (Table 1).

The only plant that is reported “consumed wild” in all countries is *Foeniculum vulgare* L. Additionally it is important commercial vegetable for its swollen, bulb-like stem base and varieties are cultivated widely [62,63].

Some interesting cases that deserve special comments are *Anethum graveolens* L., *Petroselinum crispum* (Mill.) Fuss, *Cuminum cyminum* L. and *Apium graveolens* L. (Table 1, Figure 6). These are respectively dill, parsley, cumin and celery which are quite popular spices [64]. The dill, *Anethum graveolens* which is reported among the wild umbellifers used as food in Turkey and Jordan is native to Turkey and Jordan, but also to Albania, Bulgaria, Cyprus, Syria Morocco and Spain [14] (in the Jaccard Index are taken into account only study sites where the plant is native). This plant is introduced to Armenia Crete, Greece and Jordan. Interestingly it appears in reports of wild used umbellifers in Jordan (Table 1, [67]. The dill is naturalized in Italy, and casual to Sicily and Spain [14]. The dill is widely used in all countries being very popular spice, which is vastly cultivated. For example, is very popular food plant, cultivated commercially and in kitchen gardens in Bulgaria. It is not reported among the wild umbellifers used as food in this country. *A. graveolens* is wild but rare plant there (category “Endangered” according to the Red Data Book [65]. The well-known and widely used parsley, *Petroselinum crispum* (Mill.) Fuss is reported consumed from wild in Jordan. It is a native plant there, as well as in Morocco and Albania. Parsley is casual to Sicily and introduced to Armenia, Bulgaria, Greece, Turkey, Crete, Cyprus and naturalized to Spain [14]. Commercially grown and widely used cumin *Cuminum cyminum* L., is native to Irano-Turanian Region [66], including Jordan and Armenia (Table 1). It is consumed wild in Jordan [67]. The commercially cultivated celery, *Apium graveolens* L., which is native Albania, Bulgaria, Crete, Cyprus, Greece, Jordan, Italy, Morocco, Sicily, Spain, Syria and Turkey is consumed wild in Jordan and some provinces of Spain. Interestingly it is mentioned as used as food from the wild in Armenia, but it is introduced to this country (therefore this particular record was eliminated from the statistical analysis). The reported consumption of popular and commercially cultivated spices from wild in Jordan indicate this part of the world as a center of domestication of dill, parsley and cumin, and quite an ancient one [66].

*Ferula* is a key symbolic plant, known from antiquity and even before that. Levey, M. (1958) [68]. *Ferula* is associated to the production of perfume in Minoan civilization [69]. Unidentified *Ferula* (*Ferula assa-foetida* L., or *F. orientalis* L.) images are found on ancient Greek coins [70]. *F. communis* L. is important plant in Sicily during the antiquity [71]. Different species of the genus are used as food only in Jordan, Turkey, Morocco and South Italy (Table 1) although particularly *F. communis* L. is distributed not only in these countries, but also in Crete, Cyprus, and Greece.

### 4. Materials and Methods

The object of our study is the wild plant form family Apiaceae, traditionally used as food on the territory of 12 countries (mainland and 3 islands, Figure 1) in the Mediterranean and adjacent

territories. We followed the principles for historical unity (e.g., Roman Empire, Byzant Empire, Visigothic Kingdom, Ostgothic Kingdom, Umayyad Caliphate Ottoman Empire, Aragon Kingdom, The Kingdom of Sicily etc.) [72], and the potential for cultural exchange, territorial neighborhood, phytoclimatic and floristic relationships.

We accessed Google Scholar, Web of Science, and PubMed to identify publications for the period 1990-2022 using the search string: "Spain", "Morocco", "Sicily", "Italy", "Albania", "Greece", "Crete", "Cyprus", "Turkey", "Bulgaria", "Armenia", "Egypt", "Syria", "Jordan and Palestine", "Kosovo", North Macedonia" as well as "traditionally" "wild", "food", "plants", "ethnobotany", etc. These countries were selected according to the territorial neighborhoods but also historical cultural influences.

Following the PRISMA 2000 guidelines [73], the records were assessed for eligibility. Totally 452 papers were excluded either because 1) the information was not in accordance to the topic of this research; 2) the data on the traditional use was only about medicinal purposes; 3) the studies analyzed traditional food habits of the local populations but did not provide information about wild plants; 4) the records were for consumption of plants that were cultivated.

#### 4.1. Distribution of Wild Umbellifers, Traditionally Used as Food

From the selected publications we extracted the information about the wild plants from family Apiaceae traditionally used as food in Spain [23–25], "Morocco [16–22], Sicily [26–29], Italy [30–34], Albania [32,34,35], Greece [37,38], Crete [37,39,40], Cyprus [37,40], Turkey [41–44], Bulgaria [42,45–49], Armenia [50–56], Syria [57], Jordan and Palestine [58–61]. We found that there are not enough studies and publications on the wild plants traditionally used as food in Egypt, Kosovo and North Macedonia providing sufficient data for the aim of this investigation.

#### 4.2. Data Set Preparation and Analyses

We organized the reported data for each country in Excel tables. The range of distribution of each plant taxon on the territories of the studied countries was added in the tables following [14]. Some incorrections of the published data were noticed and eliminated in the Tables and analyses. For example, *Oenanthe javanica* (Blume) DC., *Ostericum sieboldii* (Miq.) Nakai and *Ferula sinkiangensis* K.M. Shen reported for Jordan and Palestina [67] are plant taxa distributed in the Far East but not in the Near East. Therefore, they are not included in Table 1, and the analysis. Also, *Pimpinella anisum* L. is not included in Table 1, and the analysis. This plant is reported among the umbellifers used form the wild in Jordan and Palestina [60]. However, it is cultivated, introduced, naturalized or casual in all studied countries but nowhere wild [14]. Additionally, *Bunium macuca* Boiss. reported to be used in Jordan and Palestina is not distrusted in this country because it is a west Mediterranean taxon. It is considered only for Spain in Table 1 and in the analyses of the use, but not for Jordan. Particular taxa are casual (alien species that do not form self-sustaining populations in the invaded region) or naturalized plants in some countries and these cases are discussed in the text with caution. For example, this is the case with lovage, *Levisticum officinale* W.D.J. Koch, which is often grown in herb gardens. It is native to Iran and Afghanistan [14] but not to Jordan, although it is reported to be consumed wild in this country. This taxon is excluded from the statistical analysis. The records about 6 wild umbellifers, traditionally used as food in our study sites are found to have peculiarities. *Coriandrum sativum* L. which is reported among the wild umbellifers used as food in Armenia and Turkey is native only to Jordan and Syria but introduced to Armenia, Turkey, Bulgaria, Albania, Greece, Crete and Cyprus. This worldwide popular spice is also naturalized to Italy, Morocco, and casual to Sicily and Spain. In the analyses wild carrot was considered to a species level, although it was specified that in Spain and Jordan it was *Daucus carota* L. subsp. *maximus* (Desf.) Ball Jazar Barri, while in Sicily it was the typical subspecies but in the other countries the subspecies level is not mentioned. *Ferula assa-foetida* L. is reported to be consumed as a wild plant in Jordan, but it is native only to Libya [14]. Same wild consumption is reported about *Centella asiatica* (L.) Urb. in Jordan which however, is native only to Georgia. *Pastinaca sativa* L. is a popular commercially cultivated vegetable in Europe. It is native to Albania, Bulgaria, Greece, Italy, Sicily, Spain Turkey and Armenia. However,



there are no reports for gathering from the wild in these countries nowadays. At the same time such use is reported about Jordan, where this plant is not distributed (Table 1). These peculiarities of the records made them not suitable for the statistical analyses and we excluded them from the calculations.

We marked which part of the plant was used as well as the way of consumption. Ethnobotanists, sometimes provided synonyms in the published original sources and a replacement with the accepted names was done following [14]. They were used to perform basic descriptive statistics.

#### 4.2.1. Jaccard Similarity Coefficient or Jaccard Index JI

Jaccard similarity coefficient or JI is used when the level of similarity between two groups of elements should be identified [74]. We used JI to evaluate the similarity of use and similarity of distribution respectively comparing countries by pairs. JI is calculated using the following formula:

$$JI [\%] = N_{AB} * 100 / (N_A + N_B - N_{AB})$$

Where

$N_A$  is the number of elements in study site A (country/ mainland or island)

$N_B$  is the number of elements in study site B (country/ mainland or island)

$N_{AB}$  is the number of elements available in both study sites (country/ mainland or island)

#### 4.2.1. Heatmap Clustering

The clustered heatmap (double dendrogram) was created using Group Average (Unweighted Pair-Group) Clustering Method and Euclidian distance in NCSS Statistical Software [75].

## 5. Conclusions

This work, focused on the wild plants of the *Apiaceae* family traditionally used as food in some Mediterranean countries, has provided an overview of the most commonly consumed umbellifers, highlighting similarities and differences between the territories of reference. In particular, this survey revealed 81 specific and infraspecific taxa from *Apiaceae* family used traditionally as food in 11 Mediterranean countries and 3 islands. This also makes it possible to pass on to future generations traditional knowledge about wild edible plants, which in the particular context of the Mediterranean diet is of considerable relevance. The working statement that neighboring countries have high similarity in the use of wild umbellifers as food is confirmed with heatmap clustering statistical model. Similarities of consumption of umbellifers are found on geographical pattern based on plants' range of distribution and cultural exchange.

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