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Medicinal plants in the Mediterranean area: Synthesis of the results of the project Rubia

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Abstract

Aim of study: Within the scope of the European project RUBIA (ICA3-2002-10023), research has been performed on the traditional use and handling of plant species in several Mediterranean countries, Albania, Algeria, Cyprus, Egypt, Italy, Morocco, and Spain. This paper synthesises the chief results related to the medicinal utilization of those plants.
Material and methods: The information has been gathered by means of semi-structured interviews (1256) and techniques of participant observation with 803 informants. In each of the participating countries the study areas were selected by means of uniform criteria defined at the beginning of the study.
Results and conclusions: A total of 985 species have been catalogued, of which 406 have medicinal use.
This work constitutes the first comparative study performed with ethnobotanical data gathered by a coordinated methodology in the Mediterranean area. An exhaustive list is provided for the species catalogued, indicating the regions where each plant was mentioned.
Ethnopharmacological relevance: This information underlines the ethnobotanical richness of the region and the need to broaden this study to other areas of the Mediterranean. Furthermore, this constitutes a base for future phytochemical and pharmacological studies which could lead to new therapeutic products.

Keywords: Ethnobotany; Mediterranean; Medicinal plants

1. Introduction

The Mediterranean region, despite its location in a temperate zone far from the diversity hotspots popularized by the media, it is one of the areas with the greatest diversity on the planet, and thus it is considered that it should be maintained as a conservation sanctuary (Myers et al., 2000). Some 10% of the world's higher plants can be found in this area, which represents only 1.6% of the Earth's surface (Medail and Quézel, 1999). Around 25,000 species are found in the region,

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and a very high percentage of these are endemic (Heywood, 1999; Quézel, 1985; Greuter, 1991). Therefore, as indicated by Pineda et al. (2002a): "*El Mediterráneo es una zona histórica de ecotonía, refugio y cierto* '*fondo de saco*' *para la vida* ("*The Mediterranean is a historical area of ecotony, a refuge, and a certain baseline for life*"). For this reason, one of the priorities of the work groups dedicated to the study of the flora and vegetation of the Mediterranean region is to conserve diversity, including the uses made of plants by local inhabitants. The observation of the intimate and harmonious relationship of indigenous cultures with their environment, their accumulated knowledge of the biodynamics of the natural world, and their traditions of stewardship that sustain fragile ecological balance offers scientists, ethnobotanists, and others with insight into the management of land reserves, plant communities, and the biodiversity they sustain, so as to help maintain a balanced ecosystem for future generations (Plant Conservation Alliance and Medicinal Plant Working Group's *in* http://www.nps.gov/plants/medicinal/committees/ethnobotany.htm).

Although it may be a mechanistic argument, one of the many reasons for conserving biodiversity is the utilitarian value of natural resources (Pineda et al., 2002b). In this sense, our study seeks to evaluate ethnobotanical knowledge, focusing specifically on the medicinal use of plants as part of a series of works that compile other aspects of the overall study conducted within the framework of the European project RUBIA (ICA3-2002-10023).

Arguments such as species richness and uses, migration, cultural shift, or the disappearance of the communities are put forward to prioritize ethnobotanical studies in places such as the Amazon (Given and Harris, 1994). These same reasons continue to be valid in industrialized countries or emerging countries, such as those of the Mediterranean Basin, where the alteration of the physical and biological environment, rural depopulation, the new means of communication, etc. are causing an accelerated loss of traditional knowledge, making these types of studies perhaps even more urgent. As indicated by Pieroni (2000): "Systematic explorations of traditional pharmacopeias are urgent in southern Europe, especially in those areas which, for geographical and historical reasons, remain relatively isolated and where industrial development has not led to a complete decline of their traditions".

The current pharmacopeia of Western countries has its origin in the works of Classical authors, such as Theophrastus or Dioscorides, implying an ample fund of plants and medicinal uses in the Mediterranean basin. This ancient tradition of using medicinal plants has not been reflected in an ethnobotanical study line until relatively recent times, when researchers have realized the urgent need to collect this knowledge, which represents a rich heritage both for the exploration of new resources (drugs, food, etc.) as well as for constituting a irreplaceable part of the traditional culture of Mediterranean peoples.

In the Mediterranean area, many local works have been published (González-Tejero et al., 1995; Martínez Lirola et al., 1996; Agelet and Valles, 2001, 2003a,b; Pieroni, 2000; Camejo-Rodrigues et al., 2003; Merzouki et al., 2000; Said et al., 2002, etc.) but to date no previous study have involved the overall study with researchers working simultaneously and with the same methodology in different countries of the Mediterranean sphere, comparing the information and seeking to establish the existence or non-existence of a common typology in the use of plants.

RUBIA is a project that was undertaken from 2003 to 2005 and financed by the European Commission, in which countries related to the Mediterranean participated: Albania, Algeria, Cyprus, Egypt, Italy, Morocco, and Spain. The aim of the project was the coordinated collection of ethnographic data in areas previously selected by each of the participating countries to evaluate the species used as food, medicines, textiles, dyes, crafts materials, etc., as well as tools and technologies related to the use, identifying and evaluating the socio-economic and anthropological context in which these plants are used.

As an important part of this project, the information gathered was disseminated through texts, popular videos, a database that contains all the information compiled, ethnographic atlases, and, in some of the study area, special sections in local botanical gardens and anthropological museums.

The present paper synthesises the use of plants in traditional phytotherapy.

2. Materials and methods

To attain uniform scientific results, the project RUBIA, at the outset of its activity, defined a number of requirements for the study areas to fulfil in each of the participating countries. These requirements stipulate that:

- It should be a relatively isolated and more or less homogeneous zone, both in the physical as well as the biological sense in terms of socio-economic and cultural characteristics;
- it should currently maintain a rural way of life;
- it should be representative of the Mediterranean region;
- it should lack prior ethnobotanical studies.

On the basis of these requirements, the following localities were selected (Fig. 1):

- Albania: Upper Kelmend Province (northern Albanian Alps);
- Algeria: The Mitidja area (northern Algeria);
- Cyprus: Site 1, Paphos vine zone; Site 2; Larnaca mixed farming zone;
- Egypt: Site 1, Saint Catherine, located in Sinai Peninsula; Site 2, the Nile delta (Dakahlyia and Damietta) on the Egyptian Mediterranean coast;
- Morocco: Cercle de Ouezanne (northern Morocco);
- Italy: Site 1 Bagnacavallo, (Region Emilia-Romagna, north–eastern Italy); Site 2 District of Capannori in the province of Lucca (Tuscany);
- Spain: Sierra de Aracena y Picos de Aroche Natural Park (province of Huelva, south–western Spain).

The information was gathered by informal interviews and techniques of participative observation, following the habitual

Fig. 1. Location of the areas.

model in ethnobotanical work (Alexiades and Sheldon, 1996; Cotton, 1996). Whenever possible, the conversation was recorded on cassettes or, sometimes, in videos. A total of 1256 interviews were made with 803 interviewees (Table 1). Prior informed consent was verbally obtained before commencing any of interviews. As Pieroni et al. (2006) indicates in a complementary article derived also from RUBIA project: "the chosen methodology was purely ethnographic and not sociological in nature, the research teams at each of the sites used snowball techniques to select between 50 and 150 'knowledgeable' informants, without taking into consideration their gender or age ratios".

All the information on species were confirmed by taking samples from the plants mentioned in each interview. The voucher specimens corresponding to each study areas have been deposited in the institutions mentioned in Table 2. The plants were identified and labelled according to the criteria of the following guides:

- *Flora Europaea* (Tutin et al., 1964–1980); *Flora d'Italia* (Pignatti, 1982); *Flora de Andalucía Occidental* (Valdés et al., 1987); *Flora Ibérica* (Castroviejo, 1986–2005); *Flore de l'Albanie* (Paparisto and Qosja, 1988–2000); *Flora of Cyprus* (Meikle, 1977–1985); *Flore de l'Afrique du Nord* (Maire, 1952–1987); *Flora of Egypt* (Täckholm, 1974); *Nouvelle Flore de l'Algerie et des régions désertiques méridionales* (Quézel and Santa, 1962–1963); *Flore Pratique du Maroc* (Fennane et al., 1999).

Table 1
Synthesis of the results

	No. of interviews	No. of interviewees	No of total species	Species with medicinal use	No. of different medicinal uses
Albania	45	45	60	55	109
Algeria	225	225	125	101	66
Cyprus	315	93	183	119	73
Italy	119	95	179	76	167
Egypt	155	73	93	55	85
Morocco	87	72	100	28	36
Spain	310	200	245	122	109

Table 2
Herbarium

Countries	Herbarium
Algeria	USDB
Cyprus	National Herbarium of Cyprus (in the Agricultural Research Institute. (ARI)
Morocco	Herbarium of the National Institute of Medicinal and Aromatic Plants (Institut National des Plantes Médicinales et Aromatiques; INPMA)
Italy	MEP (Museo delle Erbe Palustri) MP (Museo della Piana di Lucca) I
Egypt	Medicinal Plant Project at EEAA (The Egyptian Environmental Affairs Agency)
Albania	Herbarium of the Laboratory of Pharmacognosy at the School of Life Sciences of the University of Bradford (BRAD)
Spain	Herbarium of the University of Granada (GDA)

All the information on the species and their uses have been included in a database which was prepared within the framework of the project RUBIA and which is located in MAICH (Mediterranean Agronomic Institute of Chania, Greece). This database is not accessible still to the readers.

For each of the species, in relation to the medicinal use, the following fields are included:

- Taxonomic Information (genus, species, sub-species, etc.); Herbarium Index and Specimen Number; Collector and Identifier; vernacular names. Interviewer and Interviewee.
- Perceived Abundance; Country, Area and Village; Occurrence; Habitat and Abundance, according to IUCN.
- Medicine: Organism; Disorder; Preparations; Common name of Disorder. Disorder Description; Administration Method and Dosage Frequency; Perceived Toxicity; Plant Part.
- Collected in; Traded in; Utilized in; Collectors; Cultivation Method; Collection Method; Storage Method and Preparation Technique.

3. Results and discussion

A total of 985 species of traditional use were censed, of which 406 species (the greatest use percentage) are employed medicinally in the localities studied. This result coincides with those found in most ethnobotanical studies made in the Mediterranean area (Martínez Lirola et al., 1996; Bonet et al., 1992; Scherrer et al., 2005; Guarrera et al., 2005, etc.), indicating the interest that traditional phytotherapy continues to have in this region.

The summary of the most relevant results from each locality studied is provided in Table 1, while Table 3 presents a catalogue of the species used and the main types of medicinal uses.

The characteristics of this work, in which zones of major cultural, social, and floristic differences were studied, made it difficult to draw conclusions from a simple analysis of the results. However, the breadth of the area evaluated and the methodological coordination with different work groups have provided noteworthy data on some concurring aspects in different areas, such as the best represented botanical families, the most used species, pathological groups, and diseases.

The comparison of the results was based mainly on the comparative analysis of the number of references for each item, and from this study we can highlight for the following points.

3.1. People interviewed

One of the most interesting aspects of this type of work is to know and characterize the informants, as this offers orientation on the current state of conservation of ethnobotanical knowledge. The interviewees were selected without taking into consideration their gender, age ratios or social status.

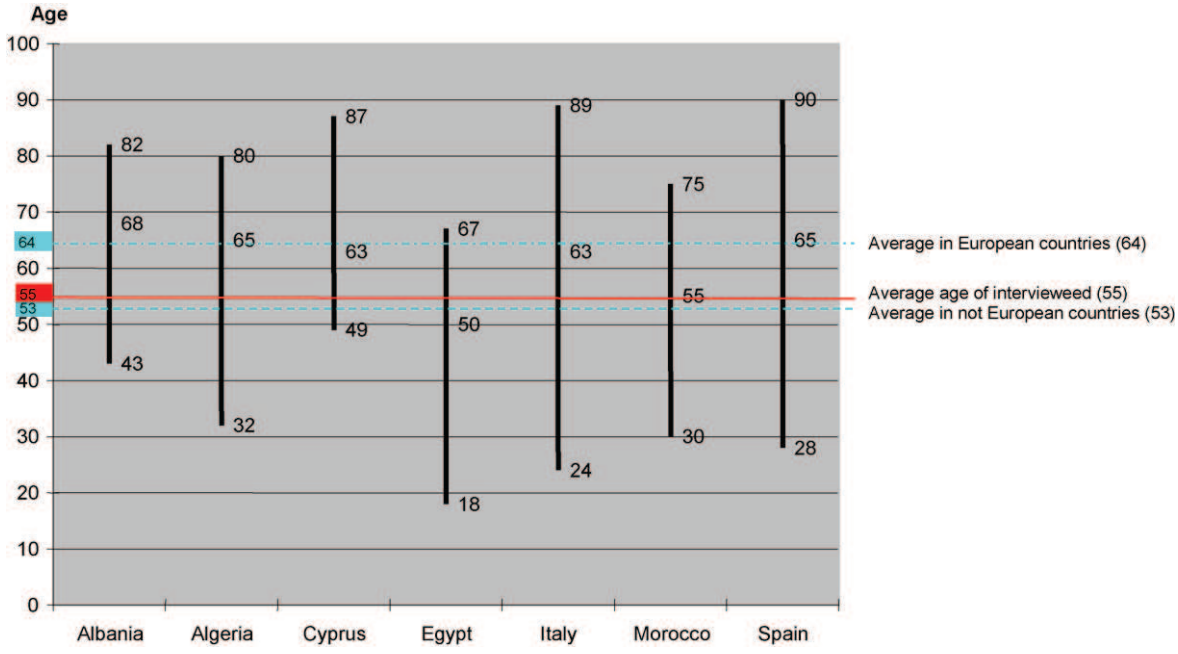

Fig. 2. Maximum, minimum and average age of intervieweed.

Table 3
Catalogue of species and pathological groups

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Acanthaceae							
Acanthus mollis L.		S					
Aceraceae							
Acer monspessulanum L.	D S O						
Adiantaceae							
Adiantum capillus-veneris L.		R S		D K			
Agavaceae							
Agave americana L.		D					
Amarillydaceae							
Pancratium maritimum L.			N				
Anacardiaceae							
Pistacia lentiscus L.		D	S			SE	
Pistacia terebinthus L.			S R				
Apiaceae							
Ammi majus L.				K O			
Ammi visnaga (L.) Lam.		K R		K C R			
Coriandrum sativum L.		D					
Cuminum cyminum L.		D					
Deverra triradiata Hochst. ex Boiss.				D			
Eryngium maritimum L.			R				
Eryngium campestre L.							M D
Foeniculum vulgare Miller		D ME N	K ME R D		D		
Foeniculum vulgare Miller subsp. *piperitum* (Ucria) Sweet							SE D
Meum athamanticum Jacq.	S						
Oenanthe pimpinelloides L.					D		
Petroselinum crispum L.			C N				D
Petroselinum sativum L.		K S			D		
Pimpinella anisum L.		N D			O		
Tordylium aegyptiacum (L.) Poir.			K				
Apocynaceae							
Nerium oleander L.		R				S R	O
Solenostemma argel (Del.) Hayne				R D K O			
Araceae							
Arisarum vulgare Targ. Tozz.			R D				
Arum hygrophyllum Boiss.			R D				
Arum italicum Miller					S K M		
Araliaceae							
Hedera helix L.					C S		S
Aristolochiaceae							
Aristolochia longa L.						S	
Asclepiadaceae							
Calotropis procera (Ait.) Ait.				R D			
Aspidiaceae							
Dryopteris filix-mas (L.) Schott.					NE		
Aspleniaceae							
Asplenium trichomanes L.	K						
Ceterach officinarum DC.							R
Phyllitis scolopendrium (L.) Newman.	R						
Asteraceae							
Achillea fragrantissima (Forssk.) Schultz Bip				D SE S			
Achillea millefolium L.					S		
Ambrosia maritima L.				K D			
Anthemis arvensis L.							O
Anthemis palestina (Reuter ex Kotschy) Boiss.			K				
Arctium lappa L.					C		
Artemisia absinthium L.		D O					
Artemisia herba alba Asso.		D O					

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Artemisia judaica L.				D			
Artemisia sp.				D			
Bellis perennis L.	SE						
Calendula arvensis L.			S				
Calendula officinalis L.					C		
Cardopatium corymbosum (L.) Pers.			D				
Carduus marianus L.				D			
Carlina sp.	N						
Centaurea alba L. subsp. *tartesiana* Talavera							S
Chamaemelum mixtum (L.) All.							SE D
Chamomilla recutita (L.) Rauschert	D	ME			D SE S R ME		D
Chrysanthemum balsamita L.					C D		
Chrysanthemum segetum L.			M R				
Cichorium intybus L.		S			D		
Conyza dioscoridis Desf.				D			
Dittrichia viscosa (L.) Greuter		M	S D				M D C
Erigeron annuus (L.) Pers.							D
Galactites tomentosa Moench							C
Helichrysum stoechas (L.) Moench							SE S
Hieracium pilosissimum Friv.	S						
Mantisalca salmantica (L.) Briq. et Cavillier							S
Matricaria recutita L. var. *coronata* (Gay ex Boiss.) Fertig			K R D				
Onopordum bracteatum Boiss. & Heldr.			K D				
Pallenis spinosa (L.) Cass.							M
Phagnalon saxatile (L.) Cass.							ME
Ptilostemon chamaepeuce (L.) Less. var. *cyprius* Greuter			M				
Pulicaria odora (L.) Reichemb.							S M
Scolymus hispanicus L.							D
Senecio jacobaea L.							S M
Senecio vulgaris L.			R K D				
Sonchus oleraceus L.		D					
Tanacetum santolinoides (DC.) Feinbr. & Fertig				S D O			
Taraxacum cyprium Lindberg			K D				
Taraxacum laevigatum DC.		M					
Taraxacum officinale Weber					K D N		
Tussilago farfara L.	R S M				R		
Urospermum delechampii (L.) Scop.					O		
Varthemia montana (Vahl) Boiss.				K D			
Bignoniaceae							
Parmentiera cerifera Seeman			X??				
Boraginaceae							
Anchusa azurea Miller							S R M
Ballota undulata Benth.				S D			
Borago officinalis L.		M	R				R
Cynoglossum officinale L.		S					
Echium plantagineum L.							M R
Heliotropium europaeum L.							O
Onosma fruticosa Sibth & Sm.			R				
Symphitum tuberosum L.					S		
Brassicaceae							
Anastatica hierochuntica L.				RE			
Brassica oleracea L.	N C	N D			D M		
Capsella bursa-pastoris (L.) Medic.		K O	S C D				
Diplotaxis tenuifolia (L.) DC.					D		
Erucaria hispanica (L.) Druce			R				
Globularia alypum L.		D					
Globularia arabica Jaub. & Spach				D N S			
Nasturtium officinale R.Brown		D N	ME		K		
Sinapis alba L.			M				
Sinapis arvensis L.			M				
Sisymbrium orientale L.			R				

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Burseraceae							
Commiphora opobalsamum L.				R S M K			
Cactaceae							
Opuntia ficus-indica (L.) Miller		D M N	K				R
Campanulaceae							
Campanula rapunculus L.							N
Capparaceae							
Capparis spinosa L.				R N C D		D N	
Cleome arabica L.subsp. *amblyocarpa* Barr. & Murb						S	
Cleome droserifolia (L.) Engl.				N O			
Caprifoliaceae							
Lonicera implexa Aiton							S
Sambucus nigra L.			SE R C		D S		S
Caryophyllaceae							
Bufonia multiceps Decne.				D			
Herniaria scabrida Boiss.							K
Paronychia argentea Lam.		K					C N K
Silene colorata Poiret							R
Spergularia rubra (L.) J. & C. Presl subsp. *longipes* (Lange) Briq							K
Spergularia rubra (L.) J. & C. Presl subsp. *rubra*						K	K
Chenopodiaceae							
Anabasis articulata (Forssk.) Moq.				S			
Beta vulgaris L. subsp. *maritima* (L.) Arcang.			D				
Chenopodium album L.	N						
Chenopodium bonus-henricus L.	N						
Salsola kali L.			C				
Salsola soda L.			C				
Cistaceae							
Cistus creticus L.			D C N				
Cistus crispus L.							D
Cistus ladanifer L.							R M
Cistus monspeliensis L.			D C N				D
Cistus populifolius L.							M S
Fumana thymifolia (L.) Spach.		RE					
Convolvulaceae							
Convolvulus arvensis L.							D
Ipomoea carnea Jacq.				S			
Cornaceae							
Cornus mas L.	N						
Crassulaceae							
Kalanchoe blossfeldiana Poelln.							S
Sedum telephium L.	S						
Sedum tenuifolium (Sibth. & Sm.) Strobl							D K
Sempervivum tectorum L.	SE						
Umbilicus rupestris (Salisb.) Dandy					S		S
Cucurbitaceae							
Bryonia dioica L.		M					
Citrullus colocynthis (L.) Schrad.				M R D RE			
Cucurbita pepo L.							D
Ecballium elaterium (L.) A. Rich.			ME				
Cupressaceae							
Cupressus sempervirens L.		D C			C S		
Juniperus communis L.	M C				C		
Juniperus oxycedrus L. subsp. *macrocarpa* (Sm.) Ball		R					
Juniperus phoenicea L.		R D	K S	D			
Juniperus thurifera L.						D	
Cyperaceae							
Cyperus rotundus L.				D RE ME K			

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Scirpus holoschoenus L.							O
Ephedraceae							
Ephedra aphylla Forssk.				S	NE		
Equisetaceae							
Equisetum arvense L.					K D		
Equisetum ramosissimum Desf.							K M
Ericaceae							
Arbutus andrachne L.			R RE D				
Arbutus unedo L.		D					
Erica arborea L.							R
Vaccinium myrtillus L.	D SE C						
Euphorbiaceae							
Euphorbia helioscopia L.		S					
Euphorbia hirsuta L.							S
Euphorbia thompsonii Holmboe			ME				
Ricinus communis L.			ME				
Fabaceae							
Acacia nilotica (L.) Willd. ex Delile				M SE			
Acacia tortilis (Forsk.) Hayne				M SE			
Anagyris foetida L.			D				
Anthyllis vulneraria L.		S					
Astracantha echinus (DC.) Podl.				ME			
Astragalus lusitanicus Lam.							S
Calicotome spinosa (L.) Link.		S					
Cassia lanceolata Forssk.				D			
Cassia obovata Collad.				D			
Ceratonia siliqua L.		N	D			D	
Chamaespartium tridentatum (L.) P. Gibbs							RE
Cicer arietinum L.						S	
Coronilla valentina L. subsp. *glauca* (L.) Batt.							C S M
Dorycnium rectum (L.) Ser.							M C D S
Glycyrrhiza glabra L.				R D RE			
Lens esculenta Moench		RE S					
Lotus angustissimus L.							C
Ononis spinosa L.		K					
Ornithopus compressus L.							S
Phaseolus vulgaris L.	S						
Retama raetam (Forssk.) Webb				D N			
Retama sphaerocarpa (L.) Boiss.							M
Scorpiurus muricatus L.							R
Tetragonolobus purpureus Moench			ME				
Trifolium repens L.		S					
Trifolium sp.	N						
Trifolium stellatum L.			M				
Trigonella foenum-graecum L.		N				D	
Vicia faba L.						D	
Fagaceae							
Quercus coccifera L.		D RE					
Quercus ilex L.		D					
Quercus rotundifolia Lam.							D
Quercus infectoria Oliv. subsp. *veneris* (A. Kern.) Meikle			D ME R				
Quercus pedunculata L.					C D R		
Fumariaceae							
Fumaria officinalis L.			D C				
Gentianaceae							
Centaurium erythraea Rafn.			S D				O
Centaurium spicatum (L.) Fritsch.				C K M ME N		R	
Centaurium umbellatum (Gibb.)Beck.		O					
Gentiana lutea L.	C						

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Geraniaceae							
Geranium tuberosum L.			C SE S				
Hippocastanaceae							
Aesculus hippocastanum L.					C R		
Hypericaceae							
Hypericum humifusum L.							S D
Hypericum maculatum Crantz	D R K S ME						
Hypericum perfoliatum L.							S
Hypericum perforatum L.			S		S RE		S C D M
Hypericum triquetrifolium Turra			S				
Juglandaceae							
Juglans regia L.	S M	S					S RE N
Lamiaceae							
Ajuga iva (L.) Schreb.		ME				S	
Ajuga reptans L.					C S		
Calamintha incana (Sm.) Boiss. ex Benth.			S				
Calamintha officinalis Moench						R	
Calamintha nepeta (L.) Savi		D					
Calamintha sylvatica Bromf.subsp. *ascendens* (Jordan) P.W. Ball							R D
Hyssopus officinalis L.			R				
Lamium amplexicaule L.			R K RE				
Lamium moschatum Mill.			R K RE				
Lavandula angustifolia Miller			R M C				
Lavandula dentata L.		D					
Lavandula stoechas L.		D	R M C				R S
Lavandula stoechas L. subsp. *luisieri* (Rozeira) Rozeira							R
Lavandula stoechas L. subsp. *sampaiana* Rozeira							R
Marrubium vulgare L.		D N	R				N C S
Melissa officinalis L.			ME C		ME		ME D
Mentha longifolia (L.) Hudson				D K			
Mentha longifolia L. subsp. *cyprica* (H. Braun) R. Harley			D				
Mentha pulegium L.		D	R			R	R RE
Mentha rotundifolia L.		ME				S	
Mentha spicata L.			D R				
Mentha x piperita L.		ME			R		D
Ocimum basilicum L.		SE ME C			S		
Origanum cordifolium (Aucher et Montbret ex Benth.) Vogel			R K RE				
Origanum dubium Boiss.			R ME D				
Origanum floribundum Munby.		R					
Origanum majorana L.		D O				D	
Origanum majorana var. tenuifolium Weston			D R RE				
Origanum syriacum L.				K			
Origanum vulgare L.	D K						
Origanum virens Hoffmanns. & Link							R
Rosmarinus officinalis L.		C	S M SE N RE		M	ME	C M
Rosmarinus tournefortii De Noe		D					
Salvia fruticosa Mill.			S C D ME R M				
Salvia microphylla Kunth							D C
Salvia multicaulis Vahl.				D R O			
Salvia officinalis L.	R D	D			D R ME		ME R D
Salvia pratensis L.					O		
Salvia sclarea L.						S	
Satureja montana L.	N						
Satureja vulgaris L.		D					
Sideritis perfoliata L.			D ME				
Stachys alpina L.	N						
Teucrium fruticans L.							O C ME
Teucrium micropodioides Rouy.			D ME				
Teucrium polium L.	D	D		N O			
Thymus capitatus (L.) Hoffs. & Link			S R D				
Thymus integer Griseb			S R D				

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Thymus mastichina (L.) L.							R D
Thymus serpyllum L.	D K				R		
Lauraceae							
Laurus nobilis L.		D	S D		R S		O D
Liliaceae							
Allium cepa L.	S	S SE	R		S K		R
Allium sativum L.	D O	S N D	C		R C N S SE	S	S
Allium triquetrum L.	N						
Asparagus acutifolius L.		D	K				
Asparagus stipularis Forssk.			K				
Asphodelus aestivus Brot.			S				S
Asphodelus microcarpa Salzm. & Viv.		D					
Lilium martagon L.	D						
Muscari comosum (L.) Mill.			C				
Urginea maritima L.		S M R	S				C S
Linaceae							
Linum usitatissimum L.					S R D		
Malvaceae							
Althaea officinalis L.					R		
Althaea rosea (L.) Cav.							D
Hibiscus sabdariffa L.				C			
Malva hispanica L.							C RE R S D
Malva parviflora L.			S D				
Malva sylvestris L.		S	S D		R S		
Moraceae							
Ficus carica L.	N	S N	R S		S D	S	
Moringaceae							
Moringa peregrina (Forssk.) Fiori				N D S M O			
Myrtaceae							
Eucalyptus camaldulensis Dehnh.			R S M		R		
Eucalyptus globulus Labill.		R				D	
Myrtus communis L.		D	S		D	R	
Oleaceae							
Fraxinus ornus L.					NE		
Fraxinus oxyphylla Bieb.		M					
Jasminum officinalis L.		D					SE
Olea europaea L.		S R C	M SE D C		S SE C D	D SE	C S
Orchidaceae							
Ophrys kotschyi H. Fleischm. et Soo			ME				
Orchis italica Poir.			ME				
Orchis sp. pl.	ME						
Serapias vomeracea (Burm.) Briq.			ME				
Oxalidaceae							
Oxalis pes-caprae L.			D R				
Paeoniaceae							
Paeonia broteri Boiss. & Reuter							D
Papaveraceae							
Chelidonium majus L.	D				S		S
Papaver rhoeas L.		R	D ME		ME		R
Phytolaccaceae							
Phytolacca americana L.					SE		
Pinaceae							
Pinus brutia Ten.			S				
Pinus halepensis Mill.		R					
Plantaginaceae							
Plantago albicans L.			K				
Plantago coronopus L.			K RE				

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Plantago lagopus L.							R
Plantago lanceolata L.		S	R S		R		S
Plantago major L.	S K				S		D M R ME
Poaceae							
Agropyrum repens (L.) Beauv.		D					
Cymbopogon schoenanthus (L.) Spreng.				D M O			
Cynodon dactylon (L.) Pers.			K		K D		
Hordeum vulgare L.		R K N			D		
Oryza sativa L.					D		
Poa pratensis L.					R		
Phragmites australis (Cav.) Trin. ex Steudel							N
Triticum aestivum L.					SE S		
Zea mays L.	K				S		K
Polygonaceae							
Atraphaxis spinosa L.				D			
Polygonum aviculare L.			D S		D		
Rumex acetosa L.	N				S D		
Rumex scutatus L. subsp. *induratus* (Boiss. & Reuter) Maire & Weiller							S
Portulacaceae							
Portulaca oleracea L.	M N		ME C				
Primulaceae							
Anagalis arvensis L.		SE S					
Primula boveana Decne.				C R O			
Primula veris L.	D R						
Punicaceae							
Punica granatum L.	D	D K					
Ranunculaceae							
Delphinium staphisagria L.						R	
Nigella arvensis L.		ME R					
Nigella damascaena L.		ME R					
Nigella sativa L.						D	
Resedaceae							
Sesamoides canescens (L.) O. Kuntze							M
Rhamnaceae							
Rhamnus alaternus L.		N D					C
Rhamnus alpinus L.	S						
Rhamnus oleoides L.			D				
Ziziphus lotus (L.) Lam.			D				
Ziziphus spina-christi (L.) Desf.				R C S RE D M			
Rosaceae							
Crataegus azarolus L.			C				
Crataegus monogyna Jacq.		ME D					C ME
Crataegus sinaica Boiss.				C			
Cydonia oblonga Mill.		C SE S					
Eriobotrya japonica (Thunb.) Lindley			C N				
Fragaria vesca L.	N						
Malus domestica (Borkh.) Borkh.							S
Potentilla reptans L.					D		
Prunus avium L.	K						
Prunus cerasus L.		K					
Prunus domestica L.	SE S O						
Prunus dulcis (Mill.) D.A Webb			R				
Prunus persica (L.) Batsch					O		
Rosa arabica Crep.				RE			
Rosa canina L.	D R M S				D		D SE
Rosa damascena Mill.			D				
Rosa pouzinii Tratt.							R
Rubus idaeus L.	N						
Rubus sanctus Schreb.			C N				
Rubus ulmifolius Schott.	S	N					N R

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Sanguisorba minor L.	O	D					
Sanguisorba minor Scop. subsp. *magnolii* (Spach) Briq.							O
Sarcopoterium spinosum (L.) Spach			K ME				
Rubiaceae							
Galium aparine L.			S				S
Rubia peregrina L.							
Rutaceae							
Citrus aurantium L.		ME			R		
Citrus limon L.		C					
Citrus sinensis (L.) Osbeck							R ME
Ruta angustifolia Pers.							SE RE
Ruta chalepensis L.		D	S				
Ruta graveolens L.					D R		
Salicaceae							
Salix alba L.			ME				
Salix sp.					S		
Populus alba L.		K					
Salvadoraceae							
Salvadora persica L.				D			
Sclerodermataceae							
Pisolithus tinctorius (Pers.) Coker & Couch							S
Scrofulariaceae							
Digitalis purpurea L.							S
Verbascum sinuatum L.			S				R C
Verbascum sp. pl.	S D						
Verbascum thapsus L.					R	SE	
Verbascum virgatum Stokes							R C
Sinopteridaceae							
Cheilanthes catanensis (Cosent.) H.P. Fuchs							R
Cheilantes guanchica C. Bolle							RE
Smilacaceae							
Smilax aspera L.			C ME				
Smilax aspera L. *var. altisima* Moris & De Not							N
Solanaceae							
Datura stramonium L.		SE ME O		R ME	ME		
Hyoscyamus albus L.							M
Hyoscyamus aureus L.			D				
Hyoscyamus muticus L.				D R			
Lycopersicon esculentum Mill.	N						
Mandragora officinarum L.			R S				
Nicotiana tabacum L.					S		
Solanum dulcamara L.		S					
Solanum nigrum L.			M	S RE D O			
Solanum tuberosum L.	O				S		
Solanum vilosum Mill.			D				
Styracaceae							
Styrax officinalis L.			ME				
Taxaceae							
Taxus baccata L.		RE					
Thymeleaceae							
Daphne gnidium L.							R D
Tiliaceae							
Tilia cordata Mill.	R						ME
Tilia plathyphyllos Scop					R D		
Ulmaceae							
Ulmus campestris L.		D					
Ulmus minor Miller					S		

Table 3 (*Continued*)

	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Ulmus sp.	S						
Urticaceae							
Parietaria difussa Mert. & Koch					D		K S
Parietaria judaica L.			S K				
Urtica dioica L.	N D S M RE	D			D S M D K		C
Urtica pilulifera L.			C N M ME S			R	
Urtica urens L.			C N M ME S				D N
Verbenaceae							
Lippia triphylla (L'Hér.) O. Kuntze					D		D
Verbena officinalis L.		N			M		S
Vitex agnus-castus L.			D R				
Violaceae							
Viola sp. pl.							S
Vitaceae							
Vitis vinifera L.		D	R D N M		R S		
Zygophyllaceae							
Balanites aegyptiaca (L.) Del. Savannah				M S D O			
Fagonia mollis Delile				S			
Peganum harmala L.		ME C		D			
Zygophyllum coccineum L.				M N R C D K S			

Pathological groups: C**:** cardiovascular; D**:** digestive; K**:** kydney; M**:** muscular-Skeletical; ME**:** mental-nervous; N**.** nutritional; R: respiratory;. RE**:** reproductive; S**:** skin; SE**:** sensory; O**:** others; NE**:**not specified.

In this regard, our study showed the average age of the interviewees to be 55 years old, indicating (as suspected) that one of the prime objectives of ethnobotanical investigation should be to rescue information which is gravely threatened by remaining only in the hands of people of middle age or beyond. Fig. 2 shows the average age to be slightly higher in the study areas situated in Europe, where the interviewees averaged 64 years of age (Cyprus, 63. Italy 63. Albania 68. Spain 65) as opposed to an average of 53 years old, in northern African populations (Algeria 65. Morocco 55. Egypt 50). These figures reflect the fragile condition of this knowledge in European countries. Nevertheless, the interest that the middle-aged population maintains for this type of knowledge enables a certain degree of optimism on the future conservation of ethnobotanical heritage.

3.2. Floristic features

In relation to the taxonomic analysis, although the floristic differences in each region hardly enable concordances at the taxonomic level of species, they indicate a trend to use, above all, plants of the families *Lamiaceae*, *Asteraceae*, and *Rosaceae*, coinciding with other works (Bonet et al., 1992; Scherrer et al., 2005; Guarrera et al., 2005; Novais et al., 2004; Camejo-Rodrigues et al., 2003). Also these families are well represented in Mediterranean flora. Fig. 3 shows the three best-represented families in each country.

Although, for the previous design of the work, we are conscious that the studied areas reflect only fragments of the territory and are not representative of the full potential of its medicinal flora, in accord with Moerman et al. (1999), we believe that the predominance of the families *Lamiaceae*, *Asteraceae*, and *Rosaceae* may represent a relative floristic homogeneity together with a possible cultural heritage favoured by the witness of the botanical and phytochemical characteristics, with plants that are easily recognizable for their striking flowers, intense aromas, and peculiar flavours.

Although in the catalogue of species most referred to the medicinal purposes (Table 4) the genera *Olea*, *Salvia*, *Origanum* or *Mentha*, habitual in Mediterranean flora, are repeated in several areas, we cannot draw conclusions concerning the homogeneity of the species used within the overall group of localities studied. It is noteworthy that there was a clear difference between the zones which are distinctly Mediterranean -in biogeographical terms- (Spain, Morocco, Algeria, and Cyprus) and those which are not (Albania, Italy and Egypt), as shown by the use of the Jaccard index.

This index allows the percentage of similarity to be calculated in each area. With this index, we can compare the samples two at a time according to species, bearing in mind only their presence or absence in the different samples. The formula to calculate this

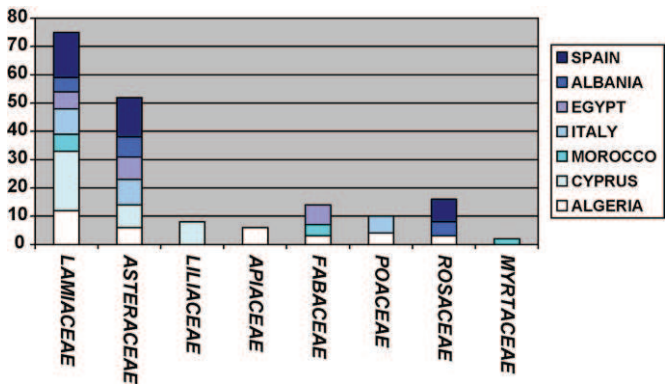

Fig. 3. Best represented botanical families.

	ITALY	SPAIN	ALGERIA	CYPRUS	MOROCCO	ALBANIA	EGYPT
ITALY		12,5	16	10	5	12	0.7
SPAIN	12,5		13	11	4	7	0
ALGERIA	16	13		13	12	8	4
CYPRUS	10	11	13		6,5	2	1
MOROCCO	5	4	12	6,5		2	2
ALBANIA	12	7	8	2	2		0.9
EGYPT	0,7	0	4	1	2	0,9	

Fig. 4. Index of Jaccard for specific level.

	CYPRUS	SPAIN	ITALY	ALGERIA	MOROCCO	ALBANIA	EGYPT
CYPRUS		27	25	31	14	15	8,5
SPAIN	27		22	23	10	14	6
ITALY	25	22		26	12	18	6
ALGERIA	31	23	26		19	15	11
MOROCCO	14	10	12	19		10	10
ALBANIA	15	14	18	15	10		6
EGYPT	9	6	6	11	10	6	

Fig. 5. Index of Jaccard for generic level.

index is:

$$\text{Index of Jaccard} = \left[\frac{C}{A + B - C}\right] \times 100$$

where A is the number of species of the sample A, B the number of species of the sample and C is the number of species common to A and B.

As shown in Fig. 4, the highest degree of similarity was found between Algeria, Italy, Cyprus, and Spain. In principle, the high degree of similarity between Italy and Algeria may be surprising, given the floristic differences, but this can be explained by the number of cultivated species used in both countries. Not surprisingly, Albania had the greatest number of species in common with Italy, and Morocco with Algeria. As might be expected, Egypt presented the lowest indices of similarity with the rest of the study areas, because of its position on the eastern edge of the Mediterranean together with its floristic and cultural differences.

The degree of affinity increased, as would be expected, when the genus level was used in the comparison (Fig. 5).

Table 4
Most cited species

Countries	Most cited species
Albania	*Origanum vulgare, Salvia officinalis, Vaccinium myrtillus, Hypericum maculatum, Lilium martagon*
Algeria	*Datura stramonium, Artemisia herba-alba, Olea europaea, Rosmarinus officinalis, Trigonella foenum-graecum*
Cyprus	*Salvia fruticosa, Dittrichia viscosa, Olea europaea, Sambucus nigra, Ceratonia siliqua*
Egypt	*Salvadora persica, Acacia nilotica, Ziziphus spina-christi, Mentha longifolia, Anastatica hierochuntica*
Italy	*Cichorium intybus, Taraxacum officinale, Urtica dioica, Thymus serpyllum, Oenanthe pimpinelloides*
Morocco	*Mentha pulegium, Origanum majorana, Olea europaea, Ceratonia siliqua, Trigonella foenum-graecum*
Spain	*Pulicaria odora, Dorycnium rectum, Mentha pulegium, Cistus ladanifer, Malva sylvestris*

As in the previous case, the highest levels of concordance were found between Algeria, Cyprus, Spain and Italy, the latter, as indicated above, for the number of cultivated species and wide distribution. The results for Italy and Albania also showed a high degree of concordance, corroborating our findings with respect to the species. Not surprisingly, 19 of the 27 genera catalogued in Morocco were common to Algeria. Finally, Egypt notably differed from the rest of the countries, though maintaining a certain affinity with Algeria and Morocco.

There were 30 genera that were cited in four or more countries. In general, all these were plants with an old medicinal tradition, notably *Salvia*, with an important diversity centre in the Mediterranean (Walker et al., 2004), where it is used in all the areas studied, primarily to treat disorders related to the skin, respiratory system, and digestive tract.

Similarly, 32 genera were found to be common to at least three of the areas studied, but mostly with different uses. Nevertheless, a closer relationship was found between Cyprus and Spain, where for example *Asphodelus* was collected for treating skin-related afflictions, *Lavandula* for respiratory ailments, and, finally, *Dittrichia viscosa* was used in both countries for similar uses, i.e. digestive ailments, wounds, and fungal infections. The antimycotic activity of this latter plant has been demonstrated by Maoz and Neeman (2000) on dermatophytes and *Candida albicans*. Khalil et al. (2007) have studied the scar forming activity in tests with mice. Finally, the effect on the digestive tract has been demonstrated by Alkofahi and Atta (1999), with rats, particularly in the treatment of gastric ulcers, a pathology for which it is habitually used in the Sierra de Aracena (Spain).

3.3. Medicinal use

It is worth quantifying the degree of diversity of uses that plants receive in each region, as this may *a priori* be indicative of the richness of ethnobotanical knowledge and could set the pattern for comparing very different sites. For this, we propose the diversity index of use, which can be calculated according

Table 5
Main used species in each pathological group

Disorders	Albania	Algeria	Cyprus	Egypt	Italy	Morocco	Spain
Digestive	*Origanum vulgare*	*Globularia alypum*	*Ceratonia siliqua*	*Achillea fragantissima*	*Cichorium intybus*	*Trigonella foenum graecum*	*Ditricchia viscosa*
Skin	*Phaseolus vulgaris*	*Euphorbia helioscopia*	*Dittrichia viscosa*	*Achillea fragantissima*	*Malva sylvestris*	*Nerium oleander*	*Hypericum perforatum*
Respiratory	*Phyllitis scolopendrium*	*Papaver rhoeas*	*Salvia fruticosa*	*Salvia multicaulis*	*Linum usitatissimum*	*Mentha pulegium*	*Mentha pulegium*
Cardiovascular	*Gentiana lutea*	*Citrus limon*	*Urtica urens*	*Crataegus sinaica*	*Allium sativum*		*Rhamnus alaternus*
Mental-nervous	*Hypericum maculatum*	*Citrus aurantium*	*Salvia fruticosa*	*Astracantha echinus*	*Chamomilla recutita*	*Rosmarinus officinalis*	*Crataegus monogyna*
Kidney	*Asplenium trichomanes*	*Petroselinum sativum*	*Plantago coronopus*	*Adiantum capillus-veneris*	*Cynodon dactylon*	*Spergularia rubra*	*Spergularia rubra*
Reproductive	*Urtica dioica*	*Fumana thymifolia*	*Origanum marjorana var. tenuifolium*	*Anastatica hierochuntica*			*Mentha pulegium*
Muscular-skeletical	*Tussilago farfara*	*Taraxacum laevigatum*	*Vitis vinifera*	*Acacia nilotica*	*Arum italicum*		*Pulicaria odora*
Nutritional		*Trigonella foenum-graecum*	*Rubus sanctus*	*Moringa peregrina*	*Allium sativum*	*Capparis spinosa*	*Rubus ulmifolius*
Sensory	*Sempervivum tectorum*	*Datura stramonium*	*Sambucus nigra*	*Acacia nilotica*	*Chamomilla recutita*	*Pistacia lentiscus*	*Rosa canina*

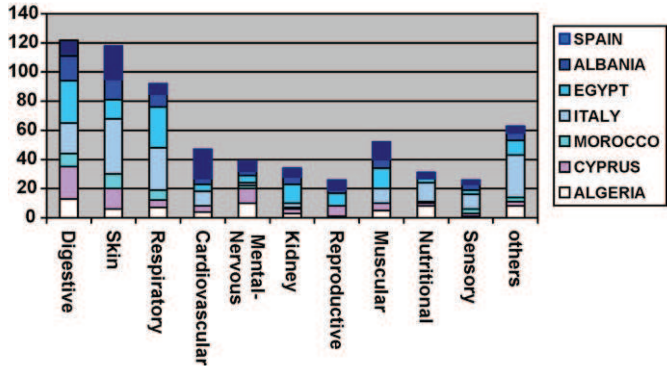

Fig. 6. Principal pathological groups treated with plants.

to the following equation: Diversity of use index (DU) = no. of uses/no. of species, estimating that values greater than 1 indicate high diversity while values lower than 1 signify low diversity. The data of our study reveal that in all localities except in Cyprus and Spain the number of species used was similar to or even lower than the uses recorded, implying that some species must have diverse medicinal uses (Table 1).

The disorders were divided into 10 pathological groups (Table 5), adding a final group (11) as a catch-all for symptoms or illnesses that, according to popular terminology were difficult to fit into any one category. For its specificity, this last group was not included in the comparison. According to the number of references, we established an ethnobotanical vicariance that provided orientation on the most important species for the treatment of the diseases of each pathological group in each country.

As might be expected, according to the Jaccard index, there was hardly any concordance at the species level between the medicinal flora used in the different countries. We found coincidences only in cases of geographic proximity, such as between Spain and Morocco, where *Mentha pulegium*, and *Spergularia rubra* were considered the most effective species for treating pathologies related to the respiratory and renal systems, respectively. Also, in the case of metabolic and nutritional pathologies, it is worth noting the use of the genus *Rubus* for hypoglycemia in Cyprus (*Rubus sanctus*) and Spain (*Rubus ulmifolius*). Different species of this genus have proven effective for treating hypoglycemia in experimental assays (Lemus et al., 1999; Jouad et al., 2002).

As reflected in Fig. 6, the pathologies of the respiratory system, digestive tract, and those related to the skin were the most

Table 6
Principal diseases treated with plants

Countries	Diseases
Albania	Stomach-ache, Rheumatism
Algeria	Stomach-ache, Sedative
Cyprus	Stomach-ache, Wounds
Egypt	Abdominal colic, Cough
Italy	Wounds, Depuratives for the stomach
Morocco	Stomach-ache, Dermatosis
Spain	Cough, Wounds

frequently mentioned and show the highest diversity of uses. This is reasonable, given that most of these disorders can be qualified as light, sometimes chronic, and they respond well to treatment with plants.

Table 6 presents the two illnesses most frequently mentioned in each of the countries; we confirmed that the affections treated with plants were related primarily to the respiratory and digestive system and the skin.

Finally, in all the countries, the preparation methods were simple, mostly boiling and infusion. These preparations were administrated mainly orally or externally in compresses.

4. Conclusions

As in previous work (Pieroni et al., 2006), the results of the present study do not demonstrate a common ethnobotanical heritage throughout the Mediterranean region.

Nevertheless, the project RUBIA does not have among its main objects the strict comparison of the results, and thus the localities studied were selected in a free way by each team without taking into account the parameters such as the floristic or bioclimatic characteristics, which surely would have offered more coincidences from the taxonomic standpoint. The few coincidences found suggest, more than a common ethnoflora, a set of similar practices in the preparation, administration of the medicinal preparations, or the ailments treated with plants, reflecting a fund of common heritage in the different regions studied.

It is important to highlight that this work constitutes the first comparative study performed with ethnobotanical data gathered by a coordinated methodology in the Mediterranean area. An exhaustive list is provided for the species catalogued, indicating the regions where each plant was mentioned This information underlines the ethnobotanical richness of the region and the need to broaden this study to other areas of the Mediterranean. Furthermore, this constitutes a base for future phytochemical and pharmacological studies which could lead to new therapeutic products.

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