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# TRADITIONAL KNOWLEDGE OF MEDICINAL PLANTS IN THE SERRA DE MARIOLA NATURAL PARK, SOUTH-EASTERN SPAIN

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**Abstract**

The present study aims to inventory and analyse the ethnobotanical knowledge about medicinal plants in the Serra de Mariola Natural Park. In respect to traditional uses, 93 species reported by local informants were therapeutic, 27 food, 4 natural dyes and 13 handcrafts. We developed a methodology that allowed the location of individuals or vegetation communities with a specific popular use. We prepared a geographic information system (GIS) that included gender, family, scientific nomenclature and common names in Spanish and Catalan for each species. We also made a classification of 39 medicinal uses from ATC (Anatomical, Therapeutic, Chemical classification system). Labiatae (n=19), Compositae (n=9) and Leguminosae (n=6) were the families most represented among the plants used to different purposes in humans. Species with the most elevated cultural importance index (CI) values were *Thymus vulgaris* (CI=1.431), *Rosmarinus officinalis* (CI=1.415), *Eryngium campestre* (CI=1.325), *Verbascum sinuatum* (CI=1.106) and *Sideritis angustifolia* (CI=1.041). Thus, the collected plants with more therapeutic uses were: *Lippia triphylla* (12), *Thymus vulgaris* and *Allium roseum* (9) and *Erygium campestre* (8). The most repeated ATC uses were: G04 (urological use), D03 (treatment of wounds and ulcers) and R02 (throat diseases). These results were in a geographic map where each point represented an individual of any species. A database was created with the corresponding therapeutic uses. This application is useful for the identification of individuals and the selection of species for specific medicinal properties. In the end, knowledge of these useful plants may be interesting to revive the local economy and in some cases promote their cultivation.

**Keywords:** ATC classification, Cultural importance index (CI), medicinal plants, Serra de Mariola, Geographic information system (GIS).

## Introduction

Throughout the ages, mankind has used plants, particularly those that are accessible, for various purposes (Agelet et al., 2000). The worldwide consumption of herbal medicines today is enormous (Hamilton, 2004), so that, in terms of population exposure alone, it is essential to identify the risks associated with their use. Safety of herbal medicines is therefore an important public health issue (Shetti et al., 2011). Thus, in the Iberian Peninsula there are studies on medicinal plants (Raja et al., 1997; Bonet et al., 1999; Agelet and Vallès, 2001, 2003; Camejo-Rodrigues et al., 2003; Belda et al., 2004; Rivera et al., 2005; Akerreta et al., 2007; Benitez, 2007; Tardío and Pardo-de-Santayana, 2008; Gonzalez et al., 2010; Cavero et al., 2011) and edible flora (Bonet and Vallès, 2002; Tardío et al., 2005; Rivera et al., 2007; Parada et al., 2011), but also some general ethnobotanical studies (Mulet, 1991; Gil-Pinilla, 1995; Verde et al., 2000; Molina, 2001; Carvalho, 2005) and other about the importance of home gardens and cultivated areas in the evolution of useful flora (Agelet et al., 2000). In the literature, there are several studies related to the properties of plants and botanical of the Serra de Mariola Natural Park (Belda et al., 2009). The plants of this study area are represented in herbariums of the most important botanical institutions in Europe. Serra de Mariola is a unique space for research and there are several studies that evaluated different ethnobotanical aspects in cultivated and non-cultivated areas (Rios and Martinez, 2003, Belda et al., 2004; Belda and Bellod, 2006).

The plant species in Serra de Mariola include sclerophyllous shrubs and trees, which are adapted to Mediterranean stress conditions. Local flora, consisting of evergreen, coriaceous, glabrous, and aromatic plants, is adapted to conserve water for much of the year. Some qualities are common to many of these plants, including resistance to drought, adaptations to heat, and low tolerance to low temperatures. These bioclimatic and biogeographical conditions favour the development of rare, endemic, and endangered species (Serra, 2001, 2007). Considering the bioclimatic and biogeographical conditions, the climax vegetation is the evergreen oak forest (*Hedero helicis-Quercetum rotundifoliae* subas. *ulicerosum parviflorae*) (Belda and Bellod, 2006).

The process of oral transmission has broken down and most traditional knowledge is only to be found in the memories of elderly people, and of course it is being progressively lost as such people pass away (Gonzalez et al., 2010). The registration of the traditional ecological knowledge is useful, but its collection has unresolved methodological problems such as the inadequate research in the traditional uses, the lack of cooperation and sharing of knowledge among diverse disciplines have further hampered the research and development (Reyes-García et al., 2009; Meetei et al., 2012). Only through a rigorous design of this type of research can optimize the significance and relevance of the data (Davis and Wagner, 2003). One of the most important aspects are tools used to identify local experts, that provide research data which are based on local ecological knowledge. Global Positioning Systems (GPS) and Geographic Information System (GIS) facilitate localization of taxa. These studies are very difficult to perform due to the thoroughness of the field work. The use of GPS allows detailed and accurate chorological studies to inventory ranges, dynamics and evolution studies of populations, monitoring and control of the most interesting species (Marco et al., 2002; Giménez et al., 2010).

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The objectives of this study are the development of a GIS database to distinguish the therapeutic uses of plant species in a Mediterranean protected natural area and evaluate the use of the ATC classification (Anatomical Therapeutical Chemical) for the standardization of results and compare with other regions (Miller, 1995). In this case, it is useful to compare medicinal properties in international electronic databases, such as MEDLINE, EMBASE, AMED, NeMedPlant, NAPALERT, TCM-ID, CMKb and CINALH (Hung et al., 2011; Meetei et al., 2012). Thus, this paper documents the cross-cultural plant uses for human link to folk therapies, in order to preserve the ethnological knowledge on traditional health medicine. At the end, we want to contribute to the dissemination of results within the scientific community in order to open a door to research in other disciplines.

## Materials and methods

### Study area

Serra de Mariola Natural Park is located in the southeast region of Spain, in the northern Alicante province and south of the province of Valencia. It is geographically located between the coordinates UTM 702000N- 4288000E (Figure 1). The total area occupied by the protected area is 17,500 hectares. 7 localities distributed in three districts: *l´Alcoià*, *Vall d´Albaida* and *Comtat*. The study area has a very mountainous and rugged relief, except for some river valleys. Due to its geographical location, Serra de Mariola has a typical Mediterranean climate with mild temperatures. Thus, the average temperature is 5.3 ºC in the coldest month (January) and 25.4 °C in the hottest month (August), with average annual temperature of 14.5 ºC. The average annual rainfall is 638 mm, which is concentrated in the spring and autumn and there is a prominent dry period in the summer. It should be noted that the resources provided by this river system (Serpis-Clariano-Vinalopó), supply most of the required water resources for this area (Belda and Bellod, 2006).
According to the land uses, the most abundant is the natural matrix that occupies 67% of the total area of the park, followed by the dry matrix (24%), urban (5%), abandonment (3%) and irrigation (1%). However, in some areas of the Natural Park there have been some considerable episodes of change in land use, especially for the transformation of urban use in natural. This natural area has a high level of plant and animal biodiversity. Thus, the Serra de Mariola is an area of great diversity of flora and ethnobotanical value. Mariola floristic popularity is due to the abundance and diversity of plants that are used by human with different uses (Belda and Bellod, 2006; Belda et al., 2009).

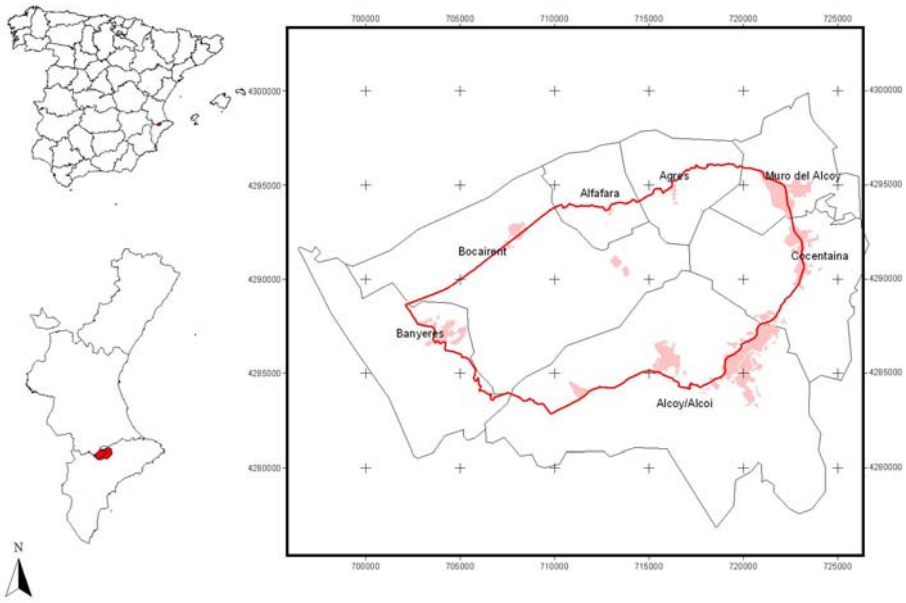


**Figure 1. Map showing the location of the P.N. Serra de Mariola (Spain).**

### Ethnobotanical interviews

A total of 7 localities were prospected with oral interviews in all regions of the Serra de Mariola (*El Comptat*, *L'Alcoià* and *Vall d'Albaida*) during 2002-2009 (Figure 1). Vernacular names of plant species traditionally used were obtained in the field by interviews with the local population. Ethnobotanical information was primarily based on semi-structured interviews, in which we gathered information such as the different plant species used to cure illnesses and other interesting uses (edible flora, dyes, fibber extraction, etc.). The information gathered in interviews was further verified by field observations with the stakeholders. This kind of investigation, in sociological terms, is called "participant observation" (Guasch, 1997; Trujillo and García, 2001; Belda et al., 2010). In this process, informants were observed while preparing plants to cure illness, and their recreational activities were documented.

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People with a specific profile were selected in order to obtain high quality and reliable information. Interviewed people are 26 to 92 year-old volunteers living in a rural environment and from a variety of socioeconomical strata, who had used medicinal plants throughout their life. We wanted to emphasize the ethnobotanical importance of local variations of plant names and the different applications of these species. We conducted 123 oral interviews; 64.22% (n = 79) of the informants were men and 35.38% (n = 44) women, and the mean age was 62.4 years. In all municipalities, inhabitants speak Valencian (variant of Catalan) and Castillian (standard of Spanish).

A digital sound recorder was used to register interviews and to create an audio pool of the information with a total of 85 hours. In addition, a photographical archive, with photographs of each of the species referred to by the informants, was constructed and deposited in the Ecology Department Archive of Alicante University. Plants were collected from various parts of the study area and were identified in the laboratory, using a detailed regional dichotomous key (Mateo and Crespo, 2003) and registered into ABH (Herbarium of Alicante University). We used Excel ® 2003 to perform a simple statistical analysis of the collected data; specifically, we calculated the relative frequency of citation (RFC) at which each species of plant was used for its medicinal properties. Moreover, we calculated a cultural importance index (CI) where each addend is a measure of the relative importance of each plant (Tardío and Pardo-de-Santayana, 2008).

**Field work with GPS**

Individuals of each species mentioned have been georeferenced, defining its existence in physical space (Hill, 2006). A highly accurate GPS (Trimble ® GeoXT) have been used to carry out the fieldwork. This work was performed during 25 field days, locating at least five individuals of each species of interest. The fieldwork was completed in the cabinet with differential correction and export of records to the GIS database. Differential correction was carried out using the GPS Pathfinder Office® software. Next, with reference to the ethnobotanical interviews, data were introduced concerning family, scientific name, common name in Castilian, common name in Catalan, plant part used, administration way and ATC therapeutic uses. These variables were the most representative in the ethnobotanic study. Finally, from this database, different location maps have completed as support to future field trips.

**Use of the ATC code**

The next step georeferencing is the classification of plants according to their therapeutic applications, identified by a code ATC (Miller and Britt, 1995). Use of a standardized classification and identification for transmitting reports is desirable. Coding of adverse events/adverse reactions to herbal medicines should be compatible with that for other medicines. For the therapeutic classification of herbal products, anatomic–therapeutic–chemical (ATC) classification was used for chemical substances in medicine (Shetti et al., 2011). Each code is an indicator of drug substances and drugs, organized by therapeutic groups. The therapeutic classification system was established by the World Health Organization (WHO) and has been adopted in Europe (De Smet, 1993). The code registers the system on serving the active ingredient, pharmacological, therapeutic indications and chemical structure of the drug. This classification system is divided into five levels: 1) (anatomy): organ or system in which the drug acts, with 14 groups in total, 2) therapeutic, identified by a two-digit number, 3) therapeutic or pharmacological identified by a letter of the alphabet, 4) therapeutic, pharmacological or chemical, identified by a letter of the alphabet, 5) name of the active drug or association, identified by a two-digit number.

## Results and discussion

93 species of plants were collected, belonging to 41 botanical families, which are used for different purposes. We present the scientific names of these plant species, voucher register, the family to which they belong, relative frequency of citation, cultural importance, whether wild or cultivated types were used, and their properties for humans (Table 1).

In figure 2a, 464 individuals were located of the total 93 species in the study area. Moreover, a cut image of the area which recorded the highest abundance of medicinal plants has been presented. Each taxon can have different uses ATC, so a different mapping, for each of the 37 identified uses, has been developed (Figure 2b).

With respect to the gathering of the different useful plants, the majority are collected from scrublands or forests (45.16%). Thus, 23.60% of the species reported are associated with nearby homes, footpaths, homegardens, etc. and 12.90% with urban or periurban zones. 9.68% of the species are collected from cultivated areas respectively, while 5.38% and 3.23% are gathered from rocky places and aquatic environments. The best season for gathering wild plants is spring, when the majority of the species are available.

*Labiatae* (n=19), *Compositae* (n=9) and *Leguminoseae* (n=6) are the families most represented among the plants used to different purposes in humans. In this study, the majority of species are wild (n=66) and the others are cultivated (n=27) in farmlands and cottages, there are significant differences between both types (p=0.015) (Table 1). The most important plant species used by informants are *Foeniculum vulgare, Chiliadenus saxatilis, Sideritis angustifolia, Salvia blancoana, Rosmarinus officinalis* and *Thymus vulgaris*, representing more than 80% of relative citation frequency (RFC). Among the species with the greatest cultural importance, five species with values higher than 1 for the CI index are striking: *Thymus vulgaris* (CI=1.431), *Rosmarinus officinalis* (CI=1.415), *Eryngium campestre* (CI=1.325), *Verbascum sinuatum* (CI=1.106) and *Sideritis angustifolia* (CI=1.041). In contrast, the lowest CI are in: *Saxifraga longifolia* (CI=0.057), *Daucus carota* (CI=0.089), *Allium sativum* and *Crocus salzmanii* (CI=0.098). However, there is no correlation between the type (wild or cultivated) and RFC and CI indexes (p> 0.05) (Table 1).

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**Table 1:** Plant species in the study area and their traditional uses in humans. Medicinal uses according to the ATC classification. Type: W, wild; C, cultivated. RFC: relative frequency of citation. CI: cultural importance index. Mar 01, 02, 03 and 04 are the register number of photographs deposited in the Ecology Department Archive of Alicante University. Plant part used: leaves (L), flowers (F), seeds (S), fruits (Fr), branches (B), roots (R) and whole plant (P).

| Scientific name | Herbarium Voucher (ABH) | Family | Spanish name | Catalan name | Medicinal uses | Administration way | Plant part used | RFC | CI | Type |
|---|---|---|---|---|---|---|---|---|---|---|
| *Adiantum capillus-veneris* L. | 51475 | *Pteridaceae* | culantrillo de pozo | falzia | R03, N02, N06 | Oral | L | 20.33 | 0.276 | W |
| *Aesculus hippocastanum* L. | 43255 | *Hipocastanaceae* | castaño de indias | castanyer bord | G04, G02, D03, C05, B06 | External, oral | Fr, S | 39.84 | 0.504 | C |
| *Allium cepa* L. | mar-01 | *Alliaceae* | cebolla | ceba | G04, D11, D10, M01, C02, A13, H04 | External, oral | P | 8.94 | 0.260 | C |
| *Allium roseum* L. | 43307 | *Alliaceae* | ajo de culebra | all bord | D11, M01, R02, C02, A13, A03, H04, N06 | External, oral | P | 29.27 | 0.382 | W |
| *Allium sativum* L. | mar-02 | *Alliaceae* | ajo | all cultivat | M01, R02, A03 | External, oral | P | 37.40 | 0.545 | C |
| *Asparagus acutifolius* L. | 37509 | *Asparagaceae* | espárrago | esparreguera | G04, D11, A06 | External, oral | L, B | 9.76 | 0.138 | W |
| *Calamintha nepeta* (L.) Savi | 14908 | *Labiatae* | calamento | poliol de bosc | G02, A13 | Oral | L, B, F | 31.71 | 0.382 | C |
| *Centaurea aspera* L. subsp. *stenophylla* | 30636 | *Compositae* | tamaladro | bracera | D08, M01, A13, A10, A05 | External, oral | L, B, F | 13.82 | 0.171 | W |
| *Chiliadenus saxatilis* (Lam.) S. Brullo | 21590 | *Compositae* | árnica | àrnica | D08, R02, A07, D03, A06, A09 | External, oral | L, B, F | 81.30 | 0.959 | W |
| *Cichorium intybus* L. | 37547 | *Compositae* | achicoria silvestre | cama-roja | G04, A13, A06 | Oral | R, L, F | 22.76 | 0.285 | W |
| *Cistus albidus* L. | 43248 | *Cistaceae* | jara blanca | estepa | D08, R02, D03, A01, R05 | External, oral | L, B, F | 13.01 | 0.252 | W |
| *Cistus clusii* Dunal | 33909 | *Cistaceae* | romero macho | matagall | D08, M01, D03, R05 | External, oral | L, B, F | 30.89 | 0.333 | W |
| *Coris monspeliensis* L. | 47746 | *Primulaceae* | hierba pincel | sapito reial | G04, R02, D03, A13 | Oral | L, B, F | 17.07 | 0.220 | W |
| *Crataegus monogyna* Jacq. | 43322 | *Rosaceae* | espino blanco | espinal blanc | C02, N01, C01 | Oral | F, Fr | 24.39 | 0.537 | W |
| *Crocus salzmanii* Gay | 44757 | *Iridaceae* | azafrán silvestre | safrà | G02, A01, A09, N06 | Oral | P | 8.13 | 0.098 | W |
| *Cupressus sempervirens* L. | 43314 | *Cupressaceae* | ciprés común | ciprer | G04, G02, A07, R05, C05 | External, oral | Fr | 13.82 | 0.163 | C |
| *Cuscuta epithymum* (L.) L. | 38056 | *Convolvulaceae* | cuscuta | cabellera d´àngel | A05, A06 | Oral | P | 20.33 | 0.236 | W |
| *Cynara cardunculus* L. | 35991 | *Compositae* | cardo de comer | penca | D11, G02, A15, A05, D05, H04 | Oral | L, B, F | 22.76 | 0.431 | C |
| *Cynodon dactylon* (L.) Pers. | 39944 | *Gramineae* | grama común | gram | G04 | Oral | R, L | 19.51 | 0.195 | C |
| *Cynoglossum cheirifolium* L. | 33566 | *Borangineae* | lengua de perro | besneula | D10, A07, D03 | External, oral | L, B, F | 7.32 | 0.154 | W |
| *Daphne gnidium* L. | 10830 | *Thymeleaceae* | torvisco | matapoll | D11, R02 | External | L, B, F | 8.94 | 0.114 | W |
| *Daucus carota* L. | 33104 | *Umbelliferae* | zanahoria silvestre | pastanaga | G04, D11, A15, A13 | Oral | R, L | 6.50 | 0.089 | W |
| *Dictamnus hispanicus* Webb ex Willk. | 22828 | *Rutaceae* | fresnillo | timó reial | G02, A13, A03 | Oral | L | 34.15 | 0.398 | W |
| *Digitalis obscura* L. | 55429 | *Scrophulariaceae* | digital negra | clavelliner a borda | G04, M05, D03, A01, C01 | External, oral | L, B, F | 15.45 | 0.171 | W |
| *Dittrichia viscosa* (L.) Greuter | 39371 | *Compositae* | olivarda | jolivarda | A07, D03, R05, A03 | External, oral | L, B, F | 9.76 | 0.244 | W |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Dorycnium hirsutum* (L.) Ser. | 18892 | *Leguminosae* | coronela | coronel.la | G04, P02, C02, C05 | External, oral | L, B, F | 5.69 | 0.130 | W |
| *Equisetum telmateia* Ehrh. | 23613 | *Equisetaceae* | cola de caballo | cua de cavall | G04, M05, B02, D11 | External, oral | B | 31.71 | 0.398 | W |
| *Eryngium campestre* L. | 11155 | *Umbelliferae* | cardo corredor | panical | G04, D11, D10, M01, D03, A01, H04, C05 | External, oral | R, B | 82.93 | 1.325 | W |
| *Ficus carica* L. | 47519 | *Moraceae* | higuera común | figuera | D11, M01, D03, A06 | External, oral | L, Fr | 13.82 | 0.179 | C |
| *Foeniculum vulgare* Mill. | 23129 | *Umbelliferae* | hinojo | fenoll | G04, R02, A06, A09, S01 | Oral | L, B, S | 80.49 | 0.837 | W |
| *Glycyrrhiza glabra* L. | 11289 | *Leguminosae* | regaliz | regalissia | R02, A06 | Oral | R | 47.97 | 0.545 | W |
| *Helianthemum cinereum* (Cav.) Pers. | 43289 | *Cistaceae* | jarilla | setge | G02, D03, A01 | External, oral | L, B, F | 60.98 | 0.805 | W |
| *Helichrysum stoechas* (L.) Moench | 49268 | *Compositae* | siempreviva | sempreviva herba | D03, A03, D05 | External, oral | L, B, F | 25.20 | 0.301 | W |
| *Heliotropium europaeum* L. | 14672 | *Boraginaceae* | heliotropo | paixarellera | D11, D03 | External | L, B, F | 22.76 | 0.293 | W |
| *Hypericum ericoides* L. | 58604 | *Guttiferae* | pinillo de oro | cor de roca | G04, A15 | Oral | L, B, F | 16.26 | 0.211 | W |
| *Hypericum perforatum* L. subsp. *angustifolium* (DC.) A. Fröhl | 44852 | *Guttiferae* | hipérico | hipèric | M01, R02, D03 | External, oral | L, B, F | 63.41 | 0.813 | W |
| *Juglans regia* L. | 32699 | *Junglandaceae* | nogal | noguera | G04, D11, G02, A07, A10, A09 | External, oral | L, S | 34.15 | 0.626 | C |
| *Juniperus oxycedrus* L. subsp. *oxycedrus* | 34967 | *Cupressaceae* | enebro | ginebre | G04, D10, P02, D08, M01, R02 | External, oral | Fr | 29.27 | 0.341 | W |
| *Juniperus phoenicea* L. subsp. *phoenicea* | 34968 | *Cupressaceae* | sabina negral | savina | G02, A07, A01 | External, oral | Fr | 15.45 | 0.203 | W |
| *Laurus nobilis* L. | 43242 | *Lauraceae* | laurel | llorer | R03, A15, A09, A02 | External, oral | L | 13.01 | 0.260 | C |
| *Lavandula latifolia* Medik. | 20246 | *Labiatae* | espliego | espigol | M01, A09, A03 | External, oral | F | 43.90 | 0.504 | W |
| *Lavatera arborea* L. | 8334 | *Malvaceae* | malva arbórea | malva vera | M01, D03, A06, R05 | External, oral | F | 47.15 | 0.545 | C |
| *Leuzea conifera* (L.) DC. | 50237 | *Compositae* | cuchara de pastor | carxofetes | M01, D03, H04, C05 | External, oral | F | 38.21 | 0.618 | W |
| *Linum narbonense* L. | 22671 | *Linaceae* | lino | llinós | R03, M01, A06, N01 | External, oral | S | 11.38 | 0.187 | C |
| *Lippia triphylla* (l'Her) O. Kuntze | mar-03 | *Verbenaceae* | hierba luisa | marialluïsa | G04, R03, D08, R02, C02, A15, A01, A10, R05, A09, D05, N01 | External, oral | L, B, F | 26.83 | 0.829 | C |
| *Malva sylvestris* L. | 37062 | *Malvaceae* | malva común | malva | D10, M01, A06, R05 | External, oral | F | 71.54 | 0.837 | C |
| *Marrubium vulgare* L. | 43048 | *Labiatae* | marrubio blanco | manrubi | R03, R02, A15, A13, R05 | Oral | L, B, F | 12.20 | 0.317 | W |
| *Melissa officinalis* L. | 35305 | *Labiatae* | melisa | melissa | G02, D01 | Oral | L, B, F | 30.89 | 0.415 | C |
| *Mentha spicata* L. | 22151 | *Labiatae* | hierbabuena | herba-sana | D11, R03, A13, D01, N01 | External, oral | L, B, F | 20.33 | 0.276 | C |
| *Mentha suaveolens* Ehrh. | 42392 | *Labiatae* | mentastro | mentastre | A09, A03 | Oral | L, B, F | 15.45 | 0.195 | W |
| *Mercurialis tomentosa* L. | 16775 | *Euphorbiaceae* | mercurial blanca | orelleta de rata | G04, M01, G02, A05, A06 | External, oral | L, B, F | 24.39 | 0.260 | W |
| *Ocimum basilicum* L. | 23959 | *Labiatae* | albahaca | alfàbega | R02, A06, A03 | Oral | L | 40.65 | 0.634 | C |
| *Olea europaea* L. | 17212 | *Olaceae* | olivo | olivera | D11, M01, C02, A05, A06 | External, oral | L, Fr | 33.33 | 0.642 | C |
| *Ononis aragonensis* Asso | 22574 | *Leguminosae* | anonis de hoja | nona | G04 | Oral | L, B | 26.02 | 0.260 | W |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Ononis viscosa* L. subsp. *breviflora* (DC.) Nyman | 10285 | *Leguminosae* | gorromino | gorromino | G04, A07, A09 | Oral | L, B, F | 14.63 | 0.187 | W |
| *Origanum vulgare* L. | 22140 | *Labiatae* | orégano | orenga | G04, R03, A13 | Oral | L, B, F | 23.58 | 0.301 | C |
| *Papaver rhoeas* L. | 37589 | *Papaveraceae* | amapola | rosella | G04, R03, R02, A01, N01 | Oral | L, F, Fr | 30.08 | 0.537 | W |
| *Paronychia argentea* Lam. | 13044 | *Caryophyllaceae* | sanguinaria | herbeta de la sang | G04, D03, C02 | Oral | L, B, F | 13.82 | 0.228 | W |
| *Petroselinum crispum* (Mill.) A. W. Hill | 31693 | *Umbelliferae* | perejil | jolivert | G04, D11, G02, A15, A06, B03 | External, oral | L, S | 17.07 | 0.325 | C |
| *Phlomis lychnitis* L. | 49256 | *Labiatae* | oreja de liebre | orellleta de llebre | G04, A07, D03, C05 | External, oral | L, B, F | 15.45 | 0.220 | W |
| *Pinus halepensis* Mill. | 37506 | *Pinaceae* | pino carrasco | pi blanc | R03, M01 | External, oral | L, Fr | 27.64 | 0.293 | W |
| *Prunus dulcis* (Mill.) D. A. Webb | 55044 | *Rosaceae* | almendro | ametler | M05, D11, R02, C02, A06, D05, N01 | External, oral | L, S | 34.96 | 0.528 | C |
| *Quercus ilex* L. subsp. *rotundifolia* (Lam) Schwartz ex T. Morais | 20160 | *Fagaceae* | carrasca | carrasca | B02, R02, A07, D03, C02, A01, R05 | External, oral | F, S | 12.20 | 0.333 | W |
| *Retama sphaerocarpa* (L.)Boiss. | 39459 | *Leguminosae* | retama | ginesta | G04, D11, R03 | Oral | L, B, F | 25.20 | 0.285 | W |
| *Rhamnus alaternus* L. | 7260 | *Rhamnaceae* | aladierno | aladern | R02, C02, A13 | Oral | L, B | 28.46 | 0.390 | W |
| *Rosa agrestis* Savi | 51473 | *Rosaceae* | rosal silvestre | roser bord | G04, M01, D03, N05 | Oral | F, Fr | 15.45 | 0.228 | W |
| *Rosmarinus officinalis* L. | 37512 | *Labiatae* | romero común | romer | G04, D03, A13, A05 | External, oral | L, B, F | 85.37 | 1.415 | W |
| *Rubia peregrina* L. | 22764 | *Rubiaceae* | tintorera | rapallengua | G04, A07 | Oral | R | 18.70 | 0.268 | W |
| *Rubus ulmifolius* Schott | 40230 | *Rosaceae* | zarzamora | esbarzer | D03, A01, H04, G01 | Oral | L, B, F, Fr | 21.14 | 0.293 | W |
| *Ruscus aculeatus* L. | 37448 | *Ruscaceae* | rusco | rusc | G04 | Oral | B | 14.63 | 0.146 | C |
| *Ruta angustifolia* Pers. | 47924 | *Rutaceae* | ruda | ruda | M01, G02 | Oral | L, B, F | 21.95 | 0.236 | W |
| *Salvia blancoana* Webb & Heldr. subsp. *mariolensis* Figuerola | 4663 | *Labiatae* | salvia de mariola | sàlvia de mariola | G04, R02, G02, C02, A03, D01 | Oral | L, B, F | 83.74 | 0.878 | W |
| *Salvia microphylla* Humb. & al. | 43610 | *Labiatae* | hierba de mirto | sogra i nora | R02, G02, A07, A09 | Oral | L, B, F | 13.01 | 0.228 | C |
| *Salvia verbenaca* L. | 56137 | *Labiatae* | verbenaca | tàrrec | D03, A09, S01 | External, oral | L, B, F, S | 10.57 | 0.154 | W |
| *Santolina chamaecyparissus* L. subsp. *squarrosa* (DC.) Nyman | 982 | *Compositae* | abrótano hembra | camamirla de riba | C02, A13, A09, A03, S01, N02 | External, oral | F | 74.80 | 0.821 | W |
| *Satureja intricata* Lange subsp. *gracilis* Rivas Mart. ex G. López | 30276 | *Labiatae* | ajedrea | sajolida | R02, A13 | Oral | L, B, F | 63.41 | 0.715 | W |
| *Saxifraga longifolia* Lapeyr. | 22860 | *Saxifragaceae* | tamaladro | corona de rei | G02 | Oral | L | 5.69 | 0.057 | W |
| *Scirpus holoschoenus* L. subsp. *holoschoenus* | 23224 | *Cyperaceae* | juncos | juncs | D11 | Oral | L | 26.83 | 0.268 | W |
| *Sedum sediforme* ( Jacq.) Pau subsp. *sediforme* | 15304 | *Crassulaceae* | uva de pastor | raïm de pastor | D11, D03, A05, A02 | Oral | L, B, F | 45.53 | 0.602 | W |
| *Sideritis angustifolia* Lag. | 14909 | *Labiatae* | rabo de gato | rabet de gat | G04, D03, A13 | External, oral | L, B, F | 82.11 | 1.041 | W |
| *Sideritis hirsuta* L. | 54468 | *Labiatae* | zahareña | rabet de gat ver | G04, D03, S01 | External, oral | L, B, F | 72.36 | 0.821 | W |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Silene vulgaris* (Moench) Garcke subsp. *vulgaris* | 20083 | *Caryophyllaceae* | collejas | conillets | A15, A13 | Oral | L | 54.47 | 0.67 | W |
| *Silybum marianum* (L.) Gaertn. | 32020 | *Compositae* | cardo mariano | card marià | D11, G02, A05, D05, H04 | External, oral | L, B, F | 47.97 | 0.91 | W |
| *Stachys heraclea* All. | 57491 | *Labiatae* | santónica | santònica | D03, A13, A03 | External, oral | L, B, F | 58.54 | 0.72 | W |
| *Thymus piperella* L. | 35959 | *Labiatae* | piperella | pebrella | R03, D03 | Oral | L, B, F | 44.72 | 0.45 | W |
| *Thymus vulgaris* L. | 39381 | *Labiatae* | tomillo | timó | G04, D11, R03, M01, R02, D03, A15, A01, A09 | External, oral | L, B, F | 92.68 | 1.431 | W |
| *Tilia platyphyllos* Scop. | 41462 | *Tiliaceae* | tilo | til.ler | A06, A02, N01, N05 | Oral | F | 52.03 | 0.659 | C |
| *Triticum aestivum* L. | 9453 | *Gramineae* | trigo | forment | M05, D11, R02, A06, R05 | External, oral | S | 36.59 | 0.455 | C |
| *Umbilicus rupestris* (Salisbury) Dandy | 7723 | *Crassulaceae* | ombligo de venus | trencapedres | G04, D03 | External, oral | L | 29.27 | 0.309 | W |
| *Urtica urens* L. | 33640 | *Urticaceae* | ortiga menor | ortiga menor | G04, D11, C02, R05, B03 | Oral | L, B, F | 41.46 | 0.634 | W |
| *Verbascum sinuatum* L. | 48380 | *Scrophulariaceae* | gordolobo macho | gordolobo | R03, R02, A07, D03, C05 | External, oral | L, B, F | 79.67 | 1.106 | W |
| *Vicia faba* L. | mar-04 | *Leguminosae* | haba | favera a la planta | G04 | Oral | S | 27.64 | 0.276 | C |
| *Zea mays* L. | 14049 | *Gramineae* | maíz | panís | G04, A03, H04, N02, C01, B06 | Oral | F, S | 38.21 | 0.504 | C |

Subsequently, there are the uses identified under the ATC code referring to the application of the plant and give the number of plants used for each of these medicinal uses (Table 2). Among the many considerations that can be drawn from this record, it is interesting to note two: (1) the number of plants available in the study area for each use ATC and (2) those plants with greater diversity of uses ATC. First, the most frequent use ATC is G04, with 38 species known to have healing properties for various urological affections. Secondly, the plants belonging to the group D03 (with 31 species) have been employed in the treatment of wounds and ulcers. The third most important group is R02 with a total of 23 species. On the other hand, *Lippia triphylla* (12), *Thymus vulgaris* (9), *Allium roseum* and *Eryngium campestre* (8) are the species with greater therapeutic uses. Most of the remedies are related to the treatment of unimportant ailments, referring to disorders of the skin, and the respiratory and digestive systems. Thus, some of the species studied in this project are in the group of the top vascular plants in traditional phytotherapy in other regions, such as *Allium sativum* (antiotalgic, antihelmintic, anti-inflammatory/antialgic, antiverrucose, and antibronchitic), *Foeniculum vulgare (*carminative, cold, intestinal anti-inflammatory, laxative, gastralgia, diuretic and antihalitosic), *Olea europaea* (antihypertensive, hyperglucemia, hernia, food poisoning, heartburn, warts, cough, erysipelas, sores, psoriasis, burns, hoarseness, baldness, rheumatism, antipyretic, antiseptic, laxative and antiotalgic) (Parada et al., 2009; Benitez et al., 2012). In other Spanish studies, the results are similar, such as *Ditricchia viscosa* which is used for this digestive pathologies, *Hypericum perforatum* to skin problems, *Rhamnus alaternus* to cardiovascular system, *Crataegus monogyna* to mental-nervous affections, *Rubus ulmifolius* to nutritional uses and *Rosa canina* to sensory properties (Gonzalez-Tejero et al., 2008; Gonzalez et al., 2011). Moreover, in South-Eastern Spain, *Helichrysum stoechas*, *Dorycnium pentaphyllum*, *Mercurialis tomentosa* and *Retama sphaerocarpa* extracts have used due to their potential anti-inflammatory effects targeting nuclear factors and other pro-inflammatory mediators (Bremner et al., 2009).

The cultural importance index corresponds with an interest in detailing the specific uses of plants that better reflect the cultural aspects of plant utilization. In fact, ethno botanical publications usually present plant uses in tables or catalogues, where the information is grouped by species, indicating their particular uses, and, commonly, the number of informants who mentioned them. This way of grouping is much more reasonable for evaluating the importance of each plant species by its cultural consensus (Tardío and Pardo-de-Santayana, 2008). Thus, two species of this study are the most important taxa, within the Spanish food traditions, are *Rubus ulmifolius* and *Foeniculum vulgare*. Both plants are cited for more than two food-categories and their cultural importance of elm-leaved bramble (CI = 2.08) is due to its fruits and young shoots are eaten; same fruits are also used for the elaboration of beverages. In turn, the wild fennel reaches a CI value of 1.34, because its young shoots are sucked as a sweet; its aerial part is used for making liqueurs, and its seeds for preparing herbal tea. Its aerial parts are also used for seasoning olives and its tender leaves and stems are eaten in salads (Gonzalez et al., 2011). In respect to medical properties, in one study of the Arribes del Duero (western Spain), the most elevated CI values are to *Hypericum perforatum* (CI =0.71), *Malva sylvestris* (CI =0.54) and *Rosmarinus officinalis* (CI =0.46) (Gonzalez et al., 2010). In Campoo the folk species of *Quercus* sp. Pl., is the most culturally significant according to the CI index (0.60), and other species such as *Crataegus monogyna* (CI=0.52), *Origanum vulgare* and *Rubus ulmifolius* (CI=0.42), *Urtica dioica* (CI=0.41), *Rosa* sp. pl. (CI=0.40), *Prunus spinosa* (CI=0.39), *Malva sylvestris* and *Equisetum* sp. pl. (CI=0.26),have been studied too.(Tardío and Pardo-de-Santayana, 2008)

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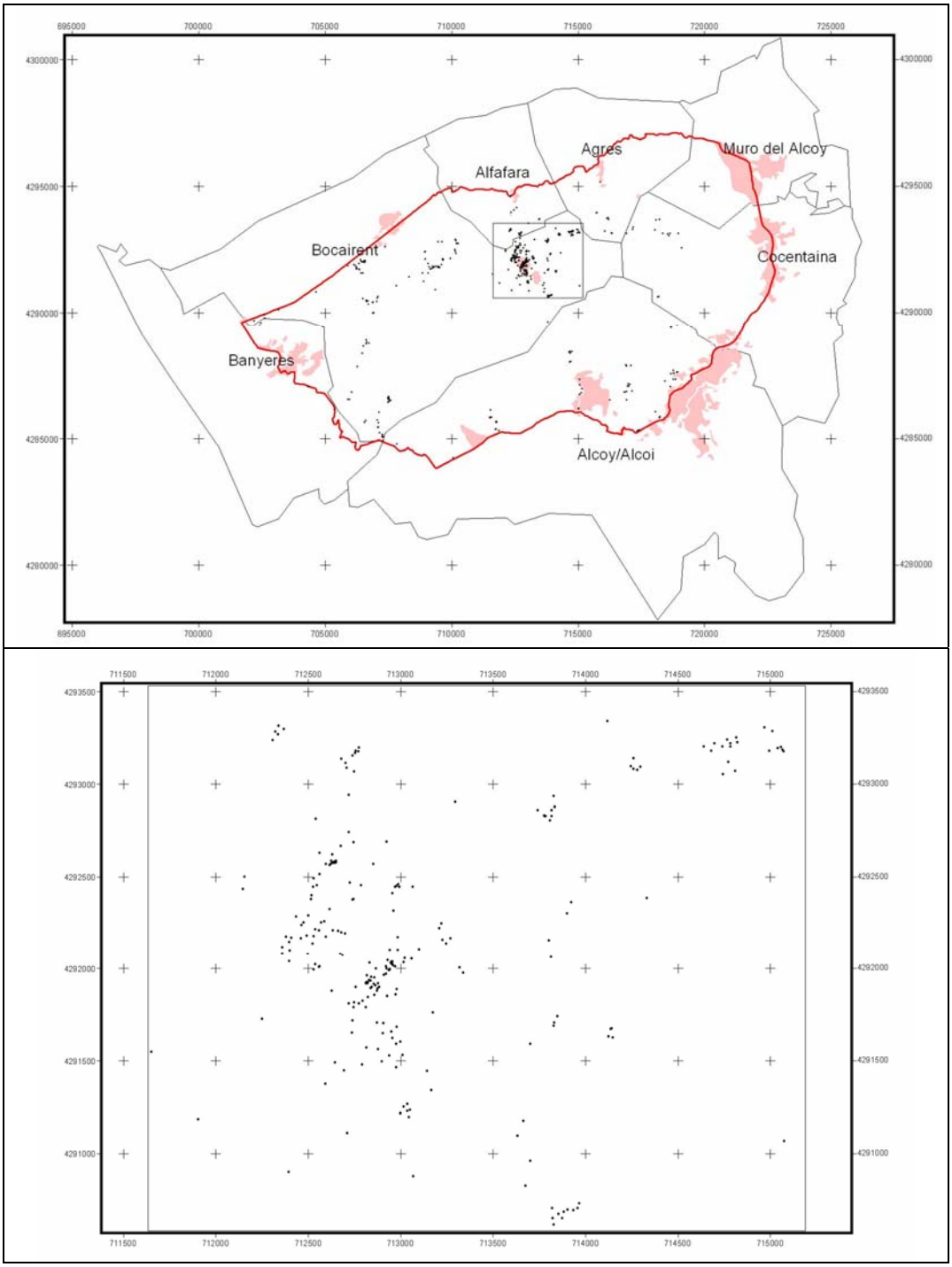


**Figure 2.** Location of individuals harvested for medicinal purposes in the Natural Park of Serra de Mariola. a) all individuals in the area, b) the location of each individual in the area with the greatest abundance of medicinal plants.

ATC groups best represented are those whose illnesses and diseases are more common and for which treatment is most evident. Thus, respondents have a heightened awareness for the treatment of general ailments. It is also interesting to note that there are certain plants which have identified several potential applications are considered by many informants as plants panacea. However, this popular perception does not meet the needs of the pharmaceutical industry, where they can also be very interesting species with less diversity of uses but more effectively. It must bear in mind the global WHO database to identify/detect signals of new adverse reactions from the cumulative data and to communicate risk assessments back to the national pharmacovigilance centers and to others concerned with drug safety (Shetti et al., 2011).. Using bioinformatics approaches, we made an attempt to systematically record information on rich heritage of the medicinal plants. We gathered traditional, scientific and medicinal information from local sources and peer-reviewed literature, and compiled it into a comprehensive knowledgebase (Meetei et al., 2012).

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**Table 2:** Medicinal uses according to the ATC classification and number of species that have therapeutic properties.

| ATC Code | Use | Nº of species | Frecuency |
|---|---|---|---|
| G04 | Urinary | 38 | 40.86 |
| M05 | Bones and joins | 4 | 4.30 |
| B02 | Haemorrhages | 2 | 2.15 |
| D11 | Skin and subcutaneous tissues | 22 | 23.66 |
| R03 | Respiratory problems | 13 | 13.98 |
| D10 | Acne | 5 | 5.38 |
| P02 | Helminthiasis | 2 | 2.15 |
| D08 | Bacteria and microbes | 6 | 6.45 |
| M01 | Rheumatism and inflammations | 20 | 21.51 |
| R02 | Throat | 23 | 24.73 |
| G02 | Gynaecological | 17 | 18.28 |
| A07 | Diarrhoea | 12 | 12.90 |
| D03 | Injury and ulcer | 31 | 33.33 |
| C02 | Alteration of blood pressure | 13 | 13.98 |
| A15 | Loss of appetite | 9 | 9.68 |
| A13 | Tonic | 18 | 19.35 |
| A01 | Toothache | 11 | 11.83 |
| A10 | Hyperglycaemia | 3 | 3.23 |
| A05 | Ischocholia | 8 | 8.60 |
| A06 | Constipation | 17 | 18.28 |
| R05 | Cough | 11 | 11.83 |
| A09 | Indigestion | 13 | 13.98 |
| A03 | Stomach and intestine problems | 12 | 12.90 |
| D05 | Psoriasis | 5 | 5.38 |
| S01 | Eye infection | 4 | 4.30 |
| A02 | Heartburn | 3 | 3.23 |
| N01 | Anaesthetics | 3 | 3.23 |
| D01 | Skin fungus | 7 | 7.53 |
| H04 | Pancreatic problems | 8 | 8.60 |
| N02 | Fever | 3 | 3.23 |
| C05 | Haemorrhoids | 7 | 7.53 |
| N05 | Stress and insomnia | 2 | 2.15 |
| N06 | Stimulant | 3 | 3.23 |
| C01 | Heart problems | 3 | 3.23 |
| G01 | Gynecological anti-invectives | 1 | 1.08 |
| B03 | Anaemia | 2 | 2.15 |
| B06 | Hematological agents | 2 | 2.15 |

In this study we consider only species mentioned by the informants in the study area. Thus, there are more species with medicinal properties in this Mediterranean region (Mulet, 1991; Gonzalez-Tejero et al., 2008; Bremner et al., 2009). However, this line of work opens the door to future research, in which this database can be reviewed and extended. This information can be used as a guide for other ethnobotanists when preparing studies in their areas.

## Conclusion

In conclusion, data obtained in this research are scarcely known at local scale and show many details of plants related to human medicine, facilitating access to interesting and novel information. This allows recovery of forgotten uses and traditions, highlighting the utilization of different species to cure common illnesses, resulting in a very interesting contribution to ethnobotanical bibliography. Thus, knowledge of these useful plants may be interesting to revive the local economy and in some cases promote the cultivation of them. Working with GPS and GIS can be located quickly and easily the position of individuals and taxa studied. Thus, it is very useful presentation of results by mapping. Once the field work with GPS and the integration of GIS information, the user can type queries multitude of spatial and thematic, which serve to save sampling effort in other ethnobotanical research.

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The information provided through personal interviews is valuable because it allows a very detailed knowledge of medicinal plants in the area. This information can be properly normalized within a database, thus facilitating the development of pharmacological and ethnobotanical heritage conservation. Thus, the combined use of GIS with ATC classification code is a good management tool that allows rapid location of species, depending on the therapeutic needs and facilitates the collection of them.

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