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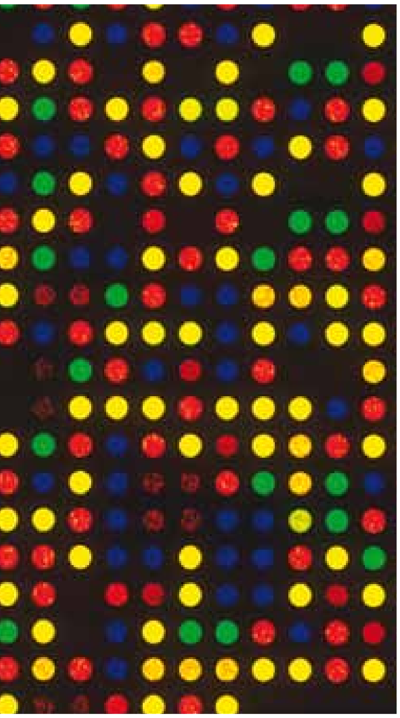
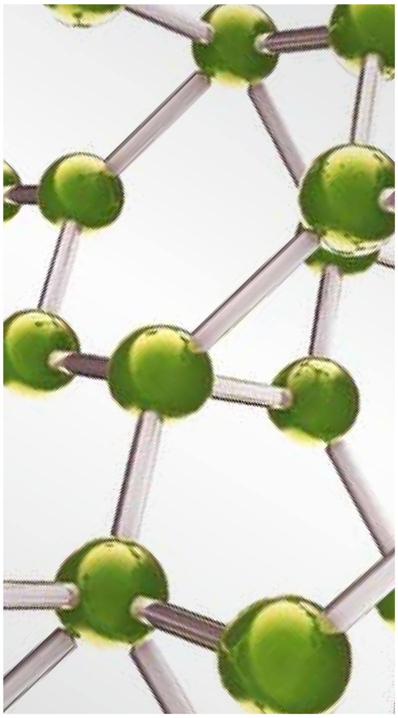
The European Heritage of Folk Medicines and Medicinal Foods: Its Contribution to the CAMs of Tomorrow

Guest Editors: Andrea Pieroni, Manuel Pardo-de-Santayana, Fabio Firenzuoli, and Cassandra L. Quave



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Editorial

The European Heritage of Folk Medicines and Medicinal Foods: Its Contribution to the CAMs of Tomorrow

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Europe has shared a vibrant history in the use of herbal medicines since ancient times. Still today, it serves as a crucial hotspot for the production and utilization of herbal remedies. Despite the popularity of homemade and commercial herbal products in Europe, a key disconnect still exists in the dialog between allopathic practitioners and patients that use CAM herbal products. There is a pressing need to connect the evidence-based use of medicinal plants and their derivatives to emerging strategies of medicine and conceptual models of healing, which aim to be culturally sensitive in nature and take into account the cultural and historical backgrounds of patients. A key turning point in this challenge has come from the interdisciplinary science of medical ethnobiology, which addresses traditional/folk uses of plants and other remedies, in both rural and urban environments. In this special issue of five papers, our aim was to showcase some of the challenges and advancements made in this field as illustrated through case studies of medico-ethnobotanical research and recent findings in the study of folk phytopharmaceuticals, while also addressing some of the most crucial bottlenecks limiting their transition into clinical practice.

The guiding paper of this special issue "*Medical ethnobotany in Europe: from field ethnography to a more culturally sensitive evidence-based CAM*?" provides a review of the medico-ethnobotanical field studies conducted in Europe over the past two decades, which have been focused primarily in the South and South-Eastern regions of rural Europe. This review demonstrates that such field studies represent an important foundation for understanding local small-scale uses of CAM natural products and allows for the assessment of how certain products could potentially be expanded into the global market. The article also delineates how field studies of this nature can provide useful information to the allopathic medical community as they seek to reconcile existing and emerging CAM therapies with conventional biomedicine. Some of the problems related to the status of traditional medical knowledge, which is at risk due to acculturation trends, are also addressed with the goal of fostering a sense of urgency to document and conserve knowledge concerning folk uses of medicinal plants.

In the second article "*Plant ethnoveterinary practices in two Pyrenean territories of Catalonia (Iberian Peninsula) and in two areas of the Balearic islands and comparison with ethnobotanical uses in human medicine*," the authors present the results of an ethnobotanical study focused on veterinary uses of plants in two Catalan Pyrenean and two Balearic regions, where approximately one hundred of plant taxa have been claimed to be useful for such purposes. A significant number of the plants discussed here have never been previously reported as medicinal. Moreover, the authors demonstrate how several ethnoveterinary applications coincide with those in human medicine, thus illustrating how a community's conceptual *herbal landscape* is the result of a complex ecological eco-evolution, where humans, animals, and plants are intricately linked.

Likewise, a similar topic is assessed in the third paper "*The relationship between plants used to sustain finches (Fringillidae) and uses for human medicine in Southeast Spain*," in which the authors describe their study of the complex interplay between local medicinal plants and plants traditionally used by wild bird hunters and breeders to capture and promote the captive breeding of songbirds in Southern Spain.

A fourth article "*Comparative medical ethnobotany of the senegalese community living in Turin (Northwestern Italy) and in Adeane (Southern Senegal)*" serves as an example of a case study on migrant health strategies in Europe. Here, the authors describe a medico-ethnobotanical survey conducted among both healers and laypeople living in one Senegalese migrant community of Northern Italy as it compares to the ethnomedical practices of their peers living in Adeane (Southern Senegal). This study reports that the large majority of the medicinal plants recorded among Senegalese migrants were also used in their country of origin, thus demonstrating the resilience of home remedies among migrants in Europe. Importantly, the authors also discuss the potential role that such data could have in shaping public health policies devoted to migrant groups in Western Countries, which seek to seriously take into account culturally sensitive approaches in the form of emic health-seeking strategies.

In the last article of the series "*Can estragole in fennel seed decoctions really be considered a danger for human health? a fennel safety update*," the authors discuss their investigation of the safety of one of the most widely used European medicinal plants and flavoring agents in food products: fennel. The safety of herbal products is a top concern for their transition into mainstream use. Recently, due to reports of estragole carcinogenicity, fennel has been alleged to be dangerous for humans—especially if used as decoction for babies. In this paper, the authors challenge these allegations, pointing out that estragole is inactivated by many substances contained in the decoction.

Acknowledgment

We dedicate this editorial to our coeditor, Professor Sulejman Redžić, University of Sarajevo, who passed away in January 2013. He is greatly admired for his lifelong dedication to the study of plant ecology, medicinal plants, and ethnobotany in the Balkans. He will be enormously missed.

Andrea Pieroni
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Review Article

Medical Ethnobotany in Europe: From Field Ethnography to a More Culturally Sensitive Evidence-Based CAM?

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European folk medicine has a long and vibrant history, enriched with the various documented uses of local and imported plants and plant products that are often unique to specific cultures or environments. In this paper, we consider the medicoethnobotanical field studies conducted in Europe over the past two decades. We contend that these studies represent an important foundation for understanding local small-scale uses of CAM natural products and allow us to assess the potential for expansion of these into the global market. Moreover, we discuss how field studies of this nature can provide useful information to the allopathic medical community as they seek to reconcile existing and emerging CAM therapies with conventional biomedicine. This is of great importance not only for phytopharmacovigilance and managing risk of herb-drug interactions in mainstream patients that use CAM, but also for educating the medical community about ethnomedical systems and practices so that they can better serve growing migrant populations. Across Europe, the general status of this traditional medical knowledge is at risk due to acculturation trends and the urgency to document and conserve this knowledge is evident in the majority of the studies reviewed.

1. Introduction

European folk medicine has held a special fascination for ethnographers, anthropologists and ethnobiologists alike. Rooted in a long history of tradition dating back to ancient Greek, Roman, and Arabic medical theories, this folk knowledge has been passed down via both written and oral pathways over the centuries. While some of these medical traditions have survived the passage of time relatively intact, many others have changed or disappeared, while "new" remedies and uses of plants have also emerged.

Today, European traditional medical knowledge is in a state of flux. In many cases, local traditional knowledge regarding the environment, wild food and medicine sources, and human health is in an alarming state of decline. This has prompted researchers to pursue field studies with the aim of documenting, preserving, and comparing data concerning these unique local ethnomedical practices. On the other hand, the mainstream popularization of certain complementary and alternative remedies for human health has promoted common knowledge of some heavily marketed species (many of which are nonnative to Europe). However, herb-drug interactions regarding these popular products are still poorly understood in most cases and present a dilemma for the European allopathic medical community (e.g., see [1] for a patient case study on self-medication with valerian and passionflower in addition to the prescribed anxiolytic drug, lorazepam). Furthermore, safety concerns resulting from decreased liver function and even hepatotoxicity in patients that self-medicate with herbs (sometimes due to use of the incorrect species) also merit the close attention of the medical community [2, 3].

Ethnobiological field studies in Europe can enhance our understanding not only of traditional healthcare practices, but also provide insight into human health and offer new solutions for food security. Specifically, ethnobiological data are useful to medical practitioners charged with the care of migrant and other populations that use CAM in that it can provide a basis for understanding folk medical beliefs about sickness, health, and therapies. Moreover, much research into the medicinal and nutritional value of plants that are presently underused in mainstream culture may actually lead to the development of the foods, pharmaceuticals, and CAMs of tomorrow.

1.1. A Brief History of Medicinal Plant Use in Europe. Europe represents a melting pot of culture and has a long history of transmission of knowledge of medical practices across geographic, cultural, and linguistic borders. Early *Materia Medica* and medical tomes by scholars like the Pedanius Dioscorides [4] and Avicenna (Ibn Sina) [5, 6] heavily influenced early medicine in Europe, resulting in the later production of numerous herbal texts, especially during the middle ages (A.D. 500–1400). Everyday medical needs were met in the household and more critical care was offered through religious outlets, such as monasteries, where herbal physic gardens were used to maintain important medicinal species [7]. The early pharmacopoeia of Europe was based in large part on products of botanical, animal, and mineral origin. Plant materials were collected or grown locally, and more exotic medicines, including spices like black pepper (*Piper nigrum* L., Piperaceae) and nutmeg (*Myristica fragrans* Houtt., Myristicaceae), became accessible through early land and, later, sea trade routes [8, 9]. Today, this tradition of incorporating exotics into the CAM pharmacopoeia continues throughout Europe, and examples of popular nonnative herbal CAM products include those containing arnica (*Arnica montana* L., Asteraceae) [10], cinnamon (*Cinnamomum* spp., Lauraceae) [11], ginseng (*Panax ginseng* C. A. Mey., Araliaceae) [12], and ginkgo (*Ginkgo biloba* L., Ginkgoaceae) [13], among others.

While many of the same plants popular today in European folk medicine have been in use for centuries, if not millennia—the ways in which they are used is often quite different from that documented in historical texts. Furthermore, there is extensive variation in the current day preparation and indication for use of medicinal plants across geographic and cultural planes, and this is clearly supported by the existing ethnobotanical literature concerning Europe.

2. Methodology

This review is based on an exhaustive survey of medicoethnobotanical field studies conducted in Europe over the last two decades (1992–2012) that have been indexed by Scopus [14–130]. Our aim was to analyze the relative influence of different European countries, ethnic groups, and biogeographical regions on the state of current European CAM. Given the importance of other less accessible studies to understanding the relevance of local traditional knowledge to CAM practices, a nonexhaustive list of local publications or PhD theses were also considered in the discussion of case studies of field ethnobotany in SW Europe—the Iberian Peninsula, in particular. These studies, however, were not included in our overall analysis of the data, which is based the Scopus search, reported in Figure 1.

For the purposes of this review, we have defined Europe to include the European continent plus Cyprus, Turkey, the Caucasus, and the Azores/Madeira/Canary Isles. We did not consider reviews or meta-analyses of preexisting data. Our criteria for the inclusion and exclusion of studies considered are detailed in Table 1. Figure 1 illustrates the data represented as they relate to the involved countries, ethnic groups, and biogeographical regions, respectively. Family assignments for all plants discussed in this review follow Angiosperm Phylogeny Group III guidelines [131, 132].

3. Medical Ethnobotany in Europe

Here, we have divided our discussion of medical ethnobotanical field studies in Europe into three general geographic regions: SW Europe, SE Europe, and the rest of Europe. We have placed the most emphasis in our discussion of the European literature on SW Europe in order to provide a detailed discussion with specific case studies and examples of the relevance of traditional knowledge recorded in field studies to future European CAM therapies.

3.1. Medical Ethnobotany in SW Europe. The Iberian Peninsula can be considered a small continent of around 600,000 km^2. It is separated from the rest of Europe by the Pyrenees, a mountainous barrier that has contributed to its relative isolation. It has a striking climatic, geological, geographical, biological, cultural, and linguistic diversity. Its vascular plants flora, with around 7,500 taxa, is one of the richest of Europe [133]. Lusitanians, Basques, Celts, Phoenicians, Greeks, Romans, Vandals, Arabs, and many other ethnicities and cultures have historically populated the region and the Iberian Peninsula is, therefore, considered a crossroad of civilizations. This continuum of migration and displacement since the earliest periods has contributed to a constant exchange of plants, ideas, customs, and knowledge. In this sense, the key role played by Portuguese and Spanish people in introducing American plants and their knowledge in Europe is especially relevant [134]. This rich biocultural diversity has become translated into a very deep ethnobiological knowledge that unfortunately has only partially reached us. Remnants of the wisdom and practices of these cultures can be traced in plant names, home remedies, or gastronomic recipes [135, 136].

Until the 1950s, Iberian society was mainly agrarian and rural. Most people were subsistence farmers and markets were weakly developed. There were exceptions such as some industrial regions in Catalonia or the Basque Country and big cities such as Madrid, Barcelona, Lisbon, or Porto. Many remote places remained isolated and only local markets, livestock fairs, the annual visit of transhumance herders, or an incipient tourism interrupted their isolation [137]. Professional medical care was not accessible for many rural people, since it was too expensive, and they could not afford it and, furthermore, many villages did not have doctors in the vicinity. Self-care prevailed, and most people relied in their

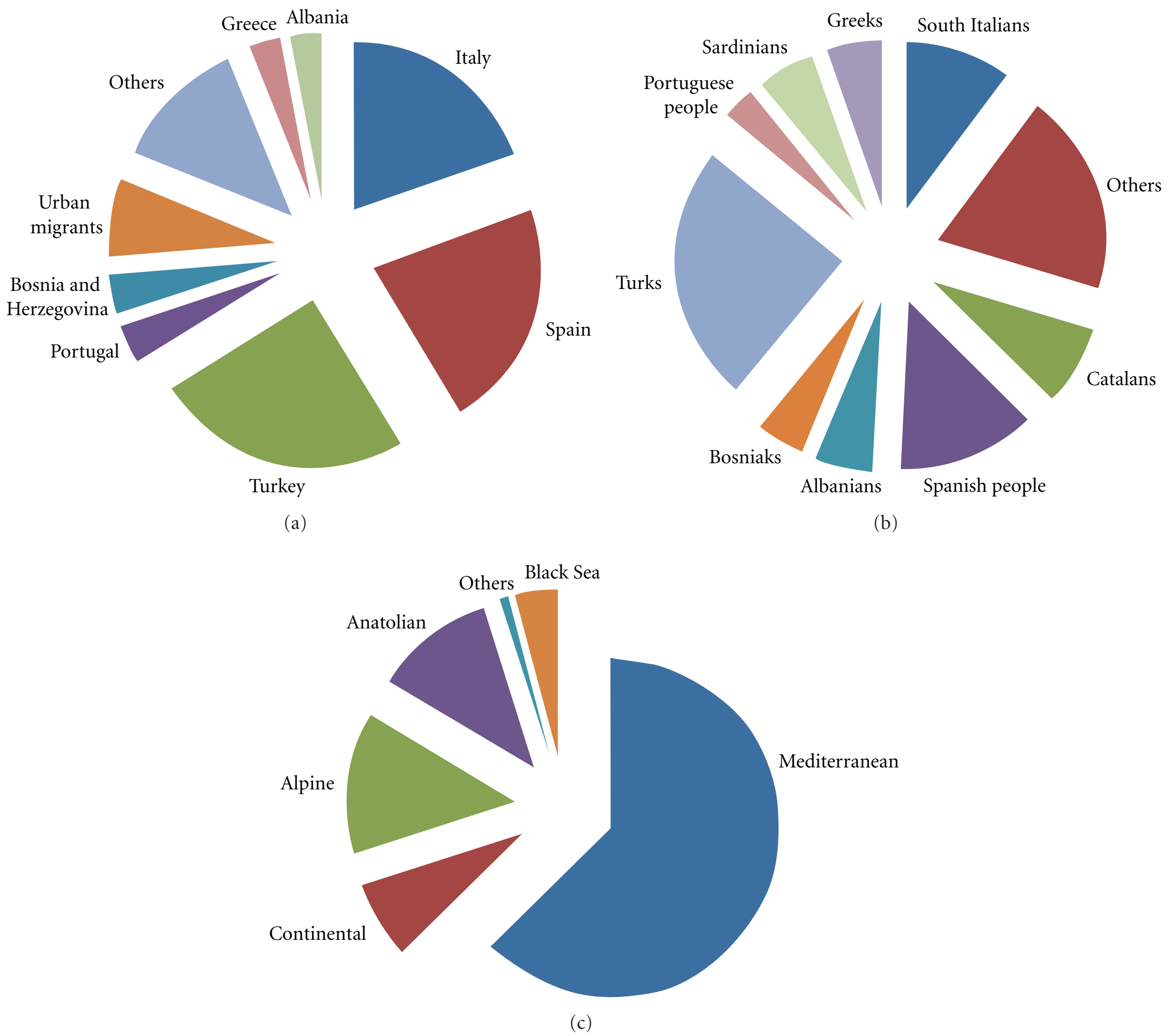

Figure 1: Representation of medicoethnobotanical studies included in our analysis as they relate to the (a) involved countries, (b) ethnic groups and, (c) biogeographical regions.

Table 1: Criteria considered for the inclusion or exclusion of studies in our analysis of medical field ethnobotany in Europe.

Inclusion criteria	Exclusion criteria
Medical ethnobotanical field studies	Meta-analyses were excluded if based on the data collected by others
Indexed in Scopus from 1992–2012	Works conducted on a single species or group of related species
Reports must provide precise details about the folk medicinal uses of plants	Field market surveys (unless the study involves folk-studies/TK of local or small-scale herb gathering and trade)
Works written in English (or have an English abstract)	Reports on large-scale trade of medicinal plants (i.e., commodities studies)

knowledge about home-remedies and the wisdom of other members of the community. Local healers, in particular, played a key role in both veterinary and human health care [138].

Deep transformations in the lifestyle of rural societies began in the 1960s with the process of industrialization and mechanization of the farms and the shift from a rural, agriculturally based, subsistence economy to a market oriented one [139]. This process has not been uniform throughout the region and there are some areas that completed the transition only within the past two decades. Millions of people migrated to other countries or to Iberian cities [137, 140]. Most young people preferred to adapt to the new ways of life, and they rejected the wisdom of their ancestors with the subsequent loss of an important part of the traditional ecological knowledge [141]. The National Health System spread until it provided universal coverage at the end of the 1970s in Portugal and the 1980s in Spain [142].

As domestic healthcare has been commonly considered by official medicine as an old practice that should be abolished, medicinal plant use came to be considered as a symbol of poverty or backwardness [138, 143].

Though not as common as in the past, there are still people who remember how life was when they mainly relied on the plants, animal, and materials found in their surroundings for food, medical, and other basic needs. However, the lack of direct contact with nature while tending animals, agricultural fields or home gardens has led to a strong erosion of this traditional ecological knowledge (TEK) and it is essential to record it before it is too late [138].

3.1.1. Research in Iberian Medical Ethnobotany. The rich traditional lore of the Iberian Peninsula has attracted many folklorists, ethnographers, and medical anthropologists and ethnobotanists since the end of the nineteenth century [144–148]. However, systematic ethnobotanical studies substantiated with reliable botanical identification, did not become the general standard until the 1980s [149]. Since then, Ethnobotany—especially Medical Ethnobotany—has grown rapidly in Spain and Portugal. This renewed interest has led to the creation of research groups in many universities and research centers (e.g., Instituto Politécnico de Bragança, Jardín Botánico de Castilla-La Mancha, Jardín Botánico de Córdoba, Museu Botânico de Beja, Universidad Autónoma de Madrid-IMIDRA-Real Jardín Botánico-CSIC, Universidad de Alicante, Universidad de Extremadura, Universidad de Granada, Universidad de Murcia, Universidade de Évora, Universitat de Barcelona).

More than 30 Ph.D. theses have been fully or partially devoted to the study of medical ethnobotany of Spanish and Portuguese territories (e.g., see [150–157]), and a high number of other surveys have been conducted in the last three decades (e.g., see references in Tables 1.1 and 1.2 in Carvalho 2005 [156], for Portugal and references in Appendix 1 in Morales et al. 2011 [133] for Spain and Table 2 in this paper). This has resulted in the Iberian Peninsula being one of the European regions with the largest number of ethnobotanical studies [141].

Many of these surveys have been published only locally (e.g., see [146, 147, 165, 166]) or are unpublished Ph.D., master, or graduate theses that are not accessible to an international audience (e.g., see [163, 167, 168]). Therefore, in order to facilitate its access, internet repositories have been created both in Portugal (http://www.etnobotanica.uevora.pt/) and Spain (http://bibdigital.rjb.csic.es/spa/index.php). Given the importance of benefit-sharing and returning and facilitating the conservation and dissemination of traditional knowledge to local stakeholders, many books have been written for a general public audience (e.g., see [169–171]). There are also a number of studies that have been published in national or international scientific journals, such as *Journal of Ethnopharmacology* [84, 105, 108], *Economic Botany* [111, 172, 173], *Journal of Ethnobiology and Ethnomedicine* [83, 128, 174], or *Revista de Estudios Extremeños* [175–177].

This rich level of production is reflective of the increasing social, political and scientific interest in traditional knowledge and specifically medical ethnobotany and the need to promote and conserve it. In fact, the Spanish legislation has assumed the principles of the Convention on Biological Diversity (CBD) in the law on Natural Heritage and Biodiversity [178] and in the Royal Decree that regulates the Spanish Inventory of Natural Heritage and Biodiversity [179].

3.1.2. Traditional Iberian Pharmacopoeia. According to a recent review of medicinal plants popularly used in Spain [180], the number of species employed is around 1,200, more than 15% of the Iberian flora. The figure of plants used in the Iberian Peninsula is surely remarkably higher, since the review does not include Portuguese or many Spanish studies. However, the richness of species is only a poor indicator of ethnomedical knowledge, since the number of remedies or medicinal plant uses is several times bigger. For instance, in Campoo, the 160 species used actually corresponds to 439 plant uses [160]. Likewise, in Montesinho, 169 medicinal species corresponded to 509 plant uses [159]. Moreover, in addition to the predominant role played by medicinal plants in local pharmacopoeias, it must be noted that many animal- and mineral-based remedies also serve a key role in folk-medical practices [105, 160, 177, 181–183].

In Iberia, more than 400 plants were used in the richest area, Pallars, a territory of the Catalan Pyrenees [61, 64]. These figures cannot be easily compared since there are significant differences in the study sites (area, population, richness of the flora) and in sample size (number of localities visited, and of informants interviewed). Medicinal plants were used for humans and animals, with the human pharmacopoeia usually being richer than the ethnoveterinary *materia medica*. For instance, 166 and 32 species were used in human and animal medicine in Montesinho, NE Portugal, 154 and 86 in Campoo, Cantabria [160], or 229 and 60 to the west of the Granada province respectively [81, 105].

Medicinal plants were mainly used for common disorders such as catarrh, pneumonia, fever, diarrhea, stomach and intestinal disorders, high blood pressure, wounds, bruises, or muscular pains. Many surveys concluded that digestive, respiratory, and skin disorders were among those most commonly treated with home remedies [159, 184].

Households commonly kept a few species for treating the most common disorders, serving as a sort of traditional First Aid Kit. Their contribution was essential to the families' well-being [138, 150]. This group of species is specific to each geographic area and included those species with the highest frequency of citation. This knowledge belonged to the collective memory of each area. For instance, in Gorbeialdea (Basque Country), this traditional medical repository contained *Urtica dioica* L. (Urticaceae) and *Verbena officinalis* L. (Verbenaceae) for respiratory disorders, *Chelidonium majus* L. (Papaveraceae) and *Allium cepa* L. (Amaryllidaceae) for skin conditions, *Plantago lanceolata* L. (Plantaginaceae) and other *Plantago species* for musculo-skeletal disorders, *Chamaemelum nobile* (L.) All. (Asteraceae) and *Helleborus viridis* L. (Ranunculaceae) for digestive diseases, and *Urtica dioica* for circulatory conditions [164].

Apart from those plants whose knowledge was shared by most people, there were also plants and remedies known only by specialists, such as healers or local experts with a

Table 2: Number and most important species (determined by highest consensus) in a selection of Iberian medical ethnobotany studies.

Study site	Number of medicinal plants	Reference	Most relevant species
Pallars (Catalonia, Spain)	437	[61, 64, 158]	*Thymus vulgaris* L. (Lamiaceae), *Sambucus nigra* L. (Adoxaceae), *Juglans regia* L. (Juglandaceae), *Olea europaea* L. (Oleaceae), *Vitis vinifera* L. (Vitaceae)
Montseny (Catalonia, Spain)	351	[63]	*Sambucus nigra* L. (Adoxaceae), *Thymus vulgaris* L. (Lamiaceae), *Olea europaea* L. (Oleaceae), *Tilia platyphyllos* Scop. (Malvaceae), *Abies alba* Mill. (Pinaceae)
Cabo de Gata (Andalusia, Spain)	253	[111]	*Sideritis* sp.pl. (Lamiaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Ballota hirsuta* Benth. (Lamiaceae), *Marrubium vulgare* L. (Lamiaceae), *Olea europaea* L. (Oleaceae)
W Granada province (Andalusia, Spain)	244	[81]	*Sideritis hirsuta* L. (Lamiaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Olea europaea* L. (Oleaceae), *Malva sylvestris* L. (Malvaceae), *Matricaria recutita* L. (Asteraceae)
Alta Vall del Ter (Catalonia, Spain)	220	[82]	*Arnica montana* L. (Asteraceae), *Hypericum perforatum* L. (Hypericaceae), *Thymus vulgaris* L. (Lamiaceae), *Sambucus nigra* L. (Adoxaceae), *Tilia platyphyllos* Scop. (Malvaceae)
Middle Navarra (Spain)	216	[79]	*Santolina chamaecyparissus* L. (Asteraceae), *Jasonia glutinosa* DC. (Asteraceae), *Thymus vulgaris* L. (Lamiaceae), *Urtica dioica* L. (Urticaceae), *Chamaemelum nobile* (L.) All. (Asteraceae)
Arrabida (Setúbal, Portugal)	176	[84]	*Geranium purpureum* Vill. (Geraniaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Olea europaea* L. (Oleaceae), *Phlomis purpurea* L. (Lamiaceae), *Mentha pulegium* L. (Lamiaceae)
Northern Navarra (Spain)	174	[79]	*Chamaemelum nobile* (L.) All. (Asteraceae), *Sambucus nigra* L. (Adoxaceae), *Verbena officinalis* L. (Verbenaceae), *Urtica dioica* L. (Urticaceae), *Allium cepa* L. (Amaryllidaceae)
Montesinho (Tras-os-Montes, Portugal)	169	[159]	*T uberaria lignosa* (Sweet) Samp. (Cistaceae), *Olea europaea* L. (Oleaceae), *Linum usitatissimum* L. (Linaceae), *Juglans regia* L. (Juglandaceae), *Pterospartum tridentatum* (L.) Willk. (Fabaceae)
Campoo (Cantabria, Spain)	160	[160]	*Sambucus nigra* L. (Adoxaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Urtica dioica* L. (Urticaceae), *Chamaemelum nobile* (L.) All. (Asteraceae), *Equisetum* sp. pl. (Equisetaceae)
Vall del Tenes (Catalonia, Spain)	153	[108]	*Malva sylvestris* L. (Malvaceae), *Matricaria recutita* L. (Asteraceae), *Tilia platyphyllos* Scop. (Malvaceae), *Sambucus nigra* L. (Adoxaceae), *Salvia lavandulifolia* Vahl (Lamiaceae)
São Mamede (Portalegre, Portugal)	150	[62]	*Centaurium erythraea* Rafn (Gentianaceae), *Malva sylvestris* L. (Malvaceae), *Olea europaea* L. (Oleaceae), *Pterospartum tridentatum* (L.) Willk. (Fabaceae), *Citrus sinensis* (L.) Osbeck (Rutaceae)
Serra da Açor (Central Portugal)	124	[161]	*Malva nicaeensis* All. (Malvaceae), *Sambucus nigra* L. (Adoxaceae), *Hypericum* sp. pl. (Hypericaceae), *Melissa officinalis* L. (Lamiaceae), *Sanguisorba verrucosa* (Link ex G. Don) Ces. (Rosaceae)
Piloña (Asturias, Spain)	107	[162]	*Chamaemelum nobile* (L.) All. (Asteraceae), *Ruta chalepensis* L. (Rutaceae), *Chelidonium majus* L. (Papaveraceae), *Origanum vulgare* L. (Lamiaceae), *Sideritis hyssopifolia* L. (Lamiaceae)
Sierra Mágina (Andalusia, Spain)	103	[163]	*Thymus zygis* L. (Lamiaceae), *Sideritis hirsuta* L. (Lamiaceae), *Ruta* sp. pl. (Rutaceae), *Olea europaea* L. (Oleaceae), *Eucalyptus camaldulensis* Dehnh. (Myrtaceae)
Riverside Navarra (Spain)	90	[80]	*Santolina chamaecyparissus* L. (Asteraceae), *Thymus vulgaris* L. (Lamiaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Urtica dioica* L. *(Urticaceae), Malva sylvestris* L. *(Malvaceae)*
Segarra (Catalonia, Spain)	92	[110]	*Thymus vulgaris* L. (Lamiaceae), *Malva sylvestris* L. (Malvaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Papaver rhoeas* L. (Papaveraceae), *Salvia lavandulifolia* Vahl (Lamiaceae)
Chaves, Montalegre (Tras-os-Montes, Portugal)	88	[34]	*Salvia officinalis* L. (Lamiaceae), *Plantago major* L. (Plantaginaceae), *Thymus pulegioides* L. (Lamiaceae), *Hypericum perforatum* L. (Hypericaceae)
Gorbeialdea (Basque Country, Spain)	82	[164]	*Urtica dioica* L. (Urticaceae), *Chamaemelum nobile* (L.) All. (Asteraceae), *Plantago* sp. pl. (Plantaginaceae), *Verbena officinalis* L. (Verbenaceae), *Chelidonium majus* L. (Papaveraceae)

wider extensive knowledge of herbs. Particular recipes made of plant mixtures, some herbal extracts, and special lotions and ointments were prepared by healers or wise women who provided them on request [138]. Other types of specialized medical therapies, such as the treatment of broken bones and many ethnoveterinary remedies were only applied by local healers [160, 185].

Some of these local experts were incredibly wise and had a precious store of extensive traditional knowledge. For instance, Palacín found in his ethnobotanical survey of Aragon, in which he interviewed more than 1,500 informants, that three women knew more than hundred medicinal plants [186]. One of them knew 230 medicinal plant species, 31 animals and 29 minerals with which she could prepare more than 1,450 remedies, a really extraordinary example of a traditional knowledge keeper. To record such an amount of knowledge was not easy, and Palacín had to interview her 69 times over a period of 6 years. Women have been recognized as having a deeper knowledge of traditional health strategies than men in many studies around the world [160, 177, 187].

Lamiaceae, Asteraceae, and Rosaceae are always among the most important families referred in these territories [35, 62, 81] as happens in many other ethnopharmacopoeias around the world [187–189]. A clear positive selection for the species of these families explains this preference. Here, we use a nonexhaustive list of species as examples to demonstrate a classification system, which is dependent on both the distribution of use and the origin of the plant species.

(1) *Common and abundant wild species with a wide distribution area*: this group includes examples such as *Chelidonium majus* L. (Papaveraceae), *Crataegus monogyna* Jacq. (Rosaceae), *Chamaemelum nobile* L. (All.) (Asteraceae), *Foeniculum vulgare* Mill. (Apiaceae), *Malva sylvestris* L. (Malvaceae), *Mentha pulegium* L. (Lamiaceae), *Paronychia argentea* Lam. (Caryophyllaceae), *Santolina chamaecyparissus* L. (Asteraceae), *Rosmarinus officinalis* L. (Lamiaceae), *Sambucus nigra* L. (Adoxaceae), and *Thymus vulgaris* L. (Lamiaceae) [180]. This group includes the most common species, widely used throughout the Peninsula. Most of them are also commonly used in other European countries, including Italy (e.g., see [47, 56, 68]), Greece [59, 67, 125], and Turkey [87, 88], among others.

(2) *Species with a broad range, but not abundant and highly appreciated*: this includes *Arnica montana* L. (Asteraceae), *Sideritis hyssopifolia* L. (Lamiaceae), *Gentiana lutea* L. (Gentianaceae)or *Osmunda regalis* L. (Osmundaceae), (e.g., [190, 191]).

(3) *West European or Iberian endemisms with a widespread use*: this group includes common, widely used, and highly valued species such as *Jasonia glutinosa* DC. (Asteraceae), *Centaurea ornata* Willd. (Asteraceae), *Thymus mastichina* L. (Lamiaceae) [192, 193],and other more restricted such as *Lilium pyrenaicum* Gouan (Liliaceae), *Lithodora fruticosa* (L.) Griseb. (Boraginaceae), and *Phlomis lychnitis* L. (Lamiaceae) [180, 190].

(4) *Restricted endemisms*: this includes *Artemisia granatensis* Boiss. (Asteraceae), *Erodium petraeum* Willd. (Geraniaceae), *Santolina oblongifolia* Boiss. (Asteraceae)and *Thymus moroderi* Pau ex Martinez (Lamiaceae) [149, 180].

(5) *Cultivated species whose use is very popular*: this group includes *Allium cepa* L., *A. sativum* L. (Amaryllidaceae), *Citrus limon* (L.) Osbeck (Rutaceae), *Chenopodium ambrosioides* L. (Amaranthaceae), *Bidens aurea* (Aiton) Sherff (Asteraceae), *Hylotelephium telephium* (L.) H. Ohba (Crassulaceae), *Juglans regia* L. (Juglandaceae), *Laurus nobilis* L. (Lauraceae), *Matricaria recutita* L. (Asteraceae), *Melissa officinalis* L. (Lamiaceae), *Olea europaea* L. (Oleaceae), *Ruta chalepensis* L. (Rutaceae), *Tilia platyphyllos* Scop. (Malvaceae), *Vitis vinifera* L. (Vitaceae), and *Zea mays* L. (Poaceae) [180].

Despite the fact that many of these plants have been widely used, they are abundant and have not suffered overexploitation. These species have the essential characteristics for being used in elementary healthcare: they are widespread, easily gathered, and have a vast array of medicinal properties and pharmacological effects [138].

On the other hand, there are also species that have suffered overexploitation. For example, in the case of *Artemisia granatensis* Boiss. (Asteraceae), an endangered species endemic to Sierra Nevada, its high demand eventually led to increased scarcity and the threat of extinction. Therefore, it was officially protected in 1982 [194]. This case, however, seems to be the exception more than the rule. For example, in other cases like that of *Osmunda regalis* L. (Osmundaceae), local management practices have helped to make its use sustainable. A study of traditional knowledge and management of this species in Cantabria found that some people were concerned about the rising demand from urban areas, since people from cities were unaware of the ecology of the fern. The scarcity of the fern has led rural residents to develop practices such as keeping its location secret, not harvesting the complete rhizome in order to avoid killing the plant and allowing its regeneration, and cultivating the species in home gardens [195]. The introduction and protection of wild medicinal species in home gardens has been also recorded in many other regions of Spain, Portugal and Austria [138, 192, 196].

3.1.3. Research in Italian Medical Ethnobotany. The Italian peninsula and islands (including Sardinia and Sicily) comprise a land mass of roughly 300,000 km^2. The vascular flora includes 6,711 species [197], which are distributed across geographic regions of mountains, hills, and plains [198]. Much like the Iberian peninsula, the rich lore and folk medical traditions of Italy attracted the attention of many scholars in the 19th to the first half of the 20th century (e.g., see the works of Giuseppe Ferraro [199, 200], Giovanni Pons, [201, 202], Giuseppe Pitrè [203], Oreste Mattirolo

[204], Ernesto de Martino [205], and Caterina Chiovenda-Bensi [206, 207]). However, it has only been in the past forty years or so that more systematic ethnobotanical surveys throughout Italy have emerged (see, e.g., [28, 31, 40, 41, 44–47, 53–56, 60, 65, 68, 98, 104, 126, 208–211]).

3.1.4. Traditional Italian Pharmacopoeia. Like the field studies conducted throughout the Iberian Peninsula, recent ethnobotanical studies undertaken over the past five years in Italy have also revealed a rich traditional pharmacopoeia that utilizes both local flora and fauna. Indeed, a multisite study of the zootherapeutic practices in select rural communities in several countries—including Italy (Basilicata), Spain, and Albania—revealed the use of 21, 11, and 34 animal species used in multiple ways as ingredients in the treatment of 50 (etic) categories of disease or illness [181]. Furthermore, there is also a strong documented tradition of use of plant remedies in the sites where these studies were performed. For example, in one study conducted in Basilicata, which focused only on the topical use of plants for the treatment of skin and soft tissue infection, 116 distinct remedies coming from 38 medicinal plant species were documented [41].

In other regions of Italy, traditional knowledge of medicinal plants is also still quite resilient. For example, in Campania, a study examining a broad range of medicinal applications of plants recorded traditional knowledge concerning 95 medicinal species, representing roughly 24% of the entire local flora [46]. In Liguria, a total of 367 distinct use reports concerning 82 medicinal species was recorded along with reports of high levels of dietary intake of wild species—likely serving as functional or medicinal foods [211]. In Molise [40] and Valvestino [31], the medicinal uses of 64 and 58 species were recorded, respectively. A 2011 study of the folk phytotherapy along the Amalfi coast revealed that 102 medicinal plants are used for medicinal purposes, with a total of 276 distinct uses [210]. One of the most interesting findings of this study was that 62% of the recorded uses were still in common practice, supporting the idea that though not necessarily reported to biomedical care providers, many Italians do commonly use CAM therapies as a key mode of therapy. Furthermore, this “hidden” practice of local CAM use is likely prevalent especially throughout southern Europe, where there is still a relative prevalence of traditional knowledge concerning folk therapies.

3.2. Medical Ethnobotany in SE Europe. Quite similarly to the examples presented of SW Europe, the SE regions have been subject to political and economic shifts that have heavily influenced local lifeways, economies, foodways, connectivity with nature, and as a consequence, transmission of traditional knowledge regarding health and local CAM practices. The rural regions of SE Europe represent some of the most vibrant scenarios for conducting medical ethnobotanical studies (see, e.g., field studies in Croatia [37, 112], Bosnia and Herzegovina [118], Albania [119, 212], Serbia [52, 213], Kosovo [214], Turkey [215], and Greece [59, 67, 125]). The reasons are numerous.

(1) This mountainous area is a hotspot for both biodiversity and cultural/ethnic diversities.

(2) The area has historically provided the botanical materials that are sold in the Western European herbal market (especially during the last few centuries).

(3) The majority of dried medicinal plants and an impressive number of locally gathered medicinal plants are still widely used in many households for local healthcare.

(4) Medicinal plants are central to many economic initiatives and programs devoted to rural development.

Moreover, medical ethnobotany studies in the Western Balkans (e.g., see [19, 26, 27, 59, 67, 112, 114, 118, 121, 216]) provide a unique arena for cross-cultural analysis of local uses of medicinal plants, which can contribute to the identification and development of a better understanding of factors that affect changes in plant uses and perceptions.

The ethnopharmacopeia of SE Europe shares some similarities with that of SW Europe, especially with regards to some of the most common medicinal species, including *Allium* spp. (Amaryllidaceae), *Hypericum* spp. (Hypericaceae), *Mentha* spp. (Lamiaceae), *Olea europea* L. (Oleaceae), and *Urtica dioica* L. (Urticaceae). Besides these few common species, however, there are many examples of medicinal plants being used in very distinct ways in different regions—even in areas sharing a similar flora, but a different cultural or linguistic heritage (Table 3). This point highlights the importance of documenting the TEK unique to diverse areas in Europe, as both unique preparations and medical applications of plants still commonly emerge.

3.3. Medical Ethnobotany in the Rest of Europe. In the other regions of Europe (i.e., in Central and Northern Europe), modern medical ethnobotanical studies are quite rare, due to the remarkable erosion of TK related to home-made plant-based remedies. In these countries, scholars have shifted their focus mainly to historical studies, using both scholarly and folkloric sources of information for their analyses (see, e.g., [217, 218]). Indeed, the majority of the ethnobotanical literature on Europe is focused on Mediterranean regions, with the greatest number of publications based on ethnobotanical field studies conducted in Spain, Italy, and Turkey (Figure 1).

On the other hand, CAM therapies of migrant communities in Northern Europe have presented an interesting topic of study, but most of these are dependent upon import of dried medicinal species from their cultural homeland (i.e., Africa, Asia, South America, Middle East, and etc.) and do not commonly incorporate the local flora [21, 41, 119, 120, 219–223]. The disappearance of autochthonous TK regarding CAM therapies in urban regions of northern Europe, where communities have less connectivity to the land and their natural resources, could be reflective of the future of southern Europe should the current trends in TK loss and erosion continue.

Table 3: Number and most important species (determined by high consensus) in a selection of south European medical ethnobotany studies.

Study site	Number of medicinal plants	Reference	Most relevant species
Inland Marches, Italy	70	[208]	*Allium cepa* L. (Amaryllidaceae), *Avena sativa* L. (Poaceae), *Balsamita major* (L.) Desf. (Asteraceae), *Calendula officinalis* L. (Asteraceae), *Castanea sativa* L. (Fagaceae), *Centaurea cyanus* L. (Asteraceae), *Daucus carota* L. (Apiaceae), *Hedera helix* L. (Araliaceae), *Hypericum perforatum* L. (Hypericaceae), *Juglans regia* L. (Juglandaceae), *Lavandula angustifolia* Mill. (Lamiaceae), *Malva sylvestris* L. (Malvaceae), *Matricaria recutita* L. (Asteraceae), *Ocimum basilicum* L. (Lamiaceae), *Papaver rhoeas* L. (Papaveraceae), *Prunus dulcis* (Mill.) D.A. Webb (Rosaceae), *Rosa canina* L. (Rosaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Rubus fruticosus* L. (Rosaceae), *Salvia officinalis* L. (Lamiaceae), *Sambucus nigra* L. (Adoxaceae), *Solanum tuberosum* L. (Solanaceae), *Spartium junceum* L. (Fabaceae), *Urtica dioica* L. (Urticaceae)
Dolomiti Lucane (Basilicata), Italy	103	[126]	*Allium cepa* L. (Amaryllidaceae), *Cynodon dactylon* (L.) Pers. (Poaceae), *Euphorbia cyparissias* L. (Euphorbiaceae), *Hordeum vulgare* L. (Poaceae), *Hypericum hircinum* L. (Hypericaceae), *Laurus nobilis* L. (Lauraceae), *Matricaria recutita* L. (Asteraceae), *Malva sylvestris* L. (Malvaceae), *Malus domestica* Borkh. (Rosaceae), *Vitis vinifera* L. (Vitaceae)
Arbëreshë (ethnic Albanians in N. Basilicata), Italy	120	[68, 209]	*Allium cepa* L. (Amaryllidaceae), *Allium sativum* L. (Amaryllidaceae), *Agropyron repens* L. (Poaceae), *Arundo donax* L. (Poaceae), *Borago officinalis* L. (Boraginaceae), *Cichorium intybus* L. (Asteraceae), *Ficus carica* L. (Moraceae), *Hordeum vulgare* L. (Poaceae), *Malus domestica* Borkh. (Rosaceae), *Malva sylvestris* L. (Malvaceae), *Marrubium vulgare* L. (Lamiaceae), *Matricaria recutita* L. (Asteraceae), *Olea europea* L. (Oleaceae), *Vitis vinifera* L. (Vitaceae)
Gollak region, Kosovo	92	[214]	*Allium cepa* L. (Amaryllidaceae), *Cornus mas* L. (Cornaceae), *Crataegus monogyna* Jacq. (Rosaceae), *Fragaria vesca* L. (Rosaceae), *Hypericum perforatum* L. (Hypericaceae), *Malus sylvestris* Mill. (Rosaceae), *Matricaria chamomilla* L. (Asteraceae), *Origanum vulgare* L. (Lamiaceae), *Plantago major* L. (Plantaginaceae), *Prunus cerasus* L. (Rosaceae), *Prunus persica* (L.) Batsch (Rosaceae), *Rubus idaeus* L. (Rosaceae), *Urtica dioica* L. (Urticaceae)
Prokletije Mountains (Montenegro)	94	[18]	*Achillea millefolium* L. (Asteraceae), *Hypericum perforatum* L. (Hypericaceae), *Rosa canina* L. (Rosaceae), *Sambucus nigra* L. (Adoxaceae), *Thymus serpyllum* L. (Lamiaceae), *Urtica dioica* L. (Urticaceae), *Vaccinium myrtillus* L. (Ericacaeae)
Pešter Plateau, Sandžak, SW Serbia	62	[213]	*Chenopodium bonus-henricus* L. (Amaranthaceae), *Gentiana lutea* L. (Gentianaceae), *Origanum vulgare* L. (Lamiaceae), *Hypericum* spp. (Hypericaceae), *Rosa canina* L. (Rosaceae), *Urtica dioica* L. (Urticaceae)
Sivrice (Elaziğ), Turkey	81	[23]	*Thymus haussknechtii* Velen, (Lamiaceae), *Mentha spicata* L. (Lamiaceae), *Malva neglecta* Wallr. (Lamiaceae), *Rosa canina* L. (Rosaceae), *Hypericum perforatum* L. (Hypericaceae), *Rheum ribes* L. (Polygonaceae), *Rubus discolor* Weihe & Nees (Rosaceae), *Portulaca oleracea* L. (Portulacaceae), *Urtica dioica* L. (Urticaceae)
Maden (Elaziğ), Turkey	88	[15]	*Mentha spicata* L. subsp. *spicata* (Lamiaceae), *Rosa canina* L. (Rosaceae), *Urtica dioica* L. (Urticaceae), *Anthemis wiedemanniana* Fisch. and C.A. Mey. (Asteraceae), *Bunium paucifolium* DC. var. *brevipes* (Freyn & Sint.) Hedge & Lam. (Apiaceae), *Tchihatchewia isatidea* Boiss. (Brassicaceae), *Thymus haussknechtii* Velen. (Lamiaceae)

4. The Adaptive Nature of Traditional Pharmacopoeias

Local knowledge is not static; rather it is highly adaptive. It is open to adopt new species and techniques and to reject others. Transhumant shepherds, schoolteachers, monks, nuns, or migrants who return to small communities after periods away all help to introduce new plants and therapies. Moreover, the tragic events of wars and forced migrations also lead to the movement of both plants and sets of traditional knowledge from one cultural terrain to another. For example, remnants of ancient Albanian medicinal plant uses and names can still be found today amongst the Arbëreshë diaspora in Italy, who are descendants of Albanians that fled to southern Italy following the Ottoman Turk invasion of their homeland about 500 years ago (e.g., see [68, 209]).

People are highly likely to experiment with "new" remedies that had been previously used and praised by friends or relatives [150]. An excellent example of this phenomenon of knowledge transfer is that of *Eucalyptus globulus* Labill. (Myrtaceae), which was introduced in Cantabria, Spain, at the end on the nineteenth century and became very popular in a few decades and is nowadays an essential element of Cantabrian pharmacopoeia [190].

Many researchers have described a deep erosion of traditional medical knowledge following the deep social and economic changes of the past few decades (e.g., [68, 141, 224]). In many instances, herbal remedies are no longer used due to replacement with pharmaceuticals. Species like *Ruta chalepensis* L. (Rutaceae), which was very popular 50 years ago, are not commonly used nowadays. This is in spite of their common presence in people's front yards; common knowledge of their original function has been lost. The same has happened with other species such as *Lilium candidum* L. (Liliaceae), *Syringa vulgaris* L. (Oleaceae),and *Iris germanica* L. (Iridaceae). In most cases, the memories of their medicinal applications have been lost and their roles have been restricted to environmental adornments [133].

Yet, on the other hand, researchers have observed an opposite trend with regards to a revitalization of traditional medical practices by youth and adult populations stemming from their concerns about the health risks of consuming industrial foods and pharmaceuticals [138]. In other words, an interest in pursuing a "natural" or healthier lifestyle as an alternative to the mainstream Western system has emerged and other alocthonous alternative herbs and medical systems such as acupuncture are being hybridized with local traditional health self-care practices and medicinal species. For example, commercial CAM products such as dietary supplements and nutraceuticals containing nonnative species like *Aloe vera* (L.) Burm. F (Xanthorrhoeaceae), *Echinacea* spp. (Asteraceae), and *Panax ginseng* C. A. Mey (Araliaceae) are all becoming very popular [108, 225]. The type of consumers who typically use these products as CAM therapies do not commonly gather them, since they often lack both the access to the plants and the deep knowledge necessary for their collection and preparation [138]. This lack of TK of the local medicinal flora also restricts their use of CAM therapies to those that they can access through commercial markets, which rarely includes local species.

Despite this general trend of abandonment of local medicinal species, especially in urban populations, recent medicoethnobotanical and epidemiological studies have shown that botanicals do still play a critical role in rural healthcare. In particular, composites like *Chamaemelum nobile* (L.) All., *Matricaria recutita* L. or *Santolina chamaecyparissus* L. are still widely used throughout Spain (Table 2). In southern Italy, wild plants like *Cichorium intybus* L. (Asteraceae), *Leopoldia comosa* (L.) Parl. (Asparagaceae), and *Scolymus hispanicus* L. (Asteraceae) [209, 226] continue to make up a key part of the diet as functional health foods, whereas other plants like *Malva sylvestris* L. (Malvaceae), *Matricaria recutita* L. (Asteraceae), and *Marrubium vulgare* L. (Lamiaceae) are among the most important wild medicinals regularly gathered and used in household medicine [54, 68, 126].

Although there is an overall trend of decline of local medicinal plant use in urban areas, there are still examples of these practices, especially in southern Europe. For example, in Spain, city dwellers use medicinal plants such as *Aloysia citrodora* Paláu (Verbenaceae), *Eucalyptus camaldulensis* Dehnh. (Myrtaceae), *Matricaria recutita* L. (Asteraceae), *Mentha x piperita* L. (Lamiaceae), *Santolina chamaecyparissus* L. (Asteraceae), *Tilia platyphyllos* Scop. (Malvaceae),and *Thymus vulgaris* L. (Lamiaceae) [177, 227, 228]. These species are either gathered from the wild or bought. According to a survey conducted in Gandía (Valencia, Spain), 14% of the interviewees gathered them, and 11% obtained them from relatives or friends that had collected them [227]. In cities such as Barcelona, herbs are mainly bought in herbal shops or supermarkets [228]. Most of the herbs have a long tradition of use in the areas, and 43% of the participants in Barcelona answered that family tradition was the main reason for using them [228].

Some of these practices are even becoming more popular. As a result of tourism market that demands local authenticity, there are herbal infusions, such as *Jasonia glutinosa* DC. (Asteraceae) or *Sideritis hyssopifolia* L. (Lamiaceae) that are highly appreciated and which are even becoming symbols of local identity. They are offered in bars and restaurants and *S. hyssopifolia* is even being marketed in touristic areas such as Picos de Europa National Park [192].

Despite the fact that many of these species are well known in the scientific phytotherapy literature, there are highly valued plants that do not appear in modern phytotherapy treatises. For example, this is the case for both *Osmunda regalis* L. (Osmundaceae) and *Atractylis gummifera* L. (Asteraceae) used in Cantabria and Extremadura, respectively [193, 195]. Most people hide their use of these species from their doctor in order to avoid reprimand, since many Spanish allopathic practitioners lack adequate training in CAM and phytotherapy and tend to exhibit a sense of disdain towards traditional medicine, which is commonly seen as irrelevant or even harmful [143].

However, health policies cannot ignore the risks of an unsafe use of herbs. For example, in the case of *A. gummifera*, two recent poisonings were detected, one of them fatal, likely due to an accidental substitution of *Centaurea ornata* Willd. (Asteraceae) for *A. gummifera*. Health risks are increased by trends for self-medication and the consumers' perception that traditional herbal remedies are always safe and free of side effects [193]. It is, therefore, essential that health professionals adopt a culturally sensitive attitude towards traditional medicine and ask about the consumption of these remedies while taking the patient's medical history.

5. Conclusions

Our review of the recent literature concerning medical ethnobotany in Europe highlights the dynamic nature of traditional knowledge concerning medicinal plants and traditional medical practices. While in some cases a resilience of local CAM practices has been observed, especially when ecotourism plays a role in creating a demand for authenticity of local products, this is not representative of most regions. In fact, alarmingly, many of the studies reviewed comment on the growing erosion of existing TK of folk medical practices that has accompanied acculturation processes and loss of linguistic diversity. In general, the younger generations are no longer able to identify the local flora that are useful as wild foods and medicines. In urban areas, those interested in continuing the incorporation of such products in their diet and lifestyle most often purchase them, or use other mainstream CAM products that are imported from other global sources. Likewise, migrant populations often import foreign medicinals to meet their health needs.

Pluralistic and culturally appropriate approaches, which include "emic" views of newcomers' health seeking strategies, are increasingly considered crucial in our public health policies. In fact, these are often considered the only approaches that can build a genuine understanding of the holistic essence of health as a composite of physical, psychological, and social aspects of well-being. Understanding migrants' medical ethnobotanies can, therefore, offer a unique arena for fostering this aim, and for implementing the safe use of CAMs within the multicultural framework of diversity in the new Europe.

Traditional knowledge of local health seeking strategies, including the use of local medicinal flora, can serve as a foundation for understanding small-scale uses of CAM natural products and allow us to assess the potential for the sustainable expansion of these practices into the larger European market as commercial CAMs. Medical ethnobotanical field studies can provide useful information to the allopathic medical community as they seek to reconcile existing and emerging CAM therapies with conventional biomedicine. This is of great importance not only for phytopharmacovigilance and managing risk of herb-drug interactions in mainstream patients that use CAM, but also for educating the medical community about ethnomedical systems and practices so that they can better serve growing migrant populations. Acculturation trends and economic shifts away from rural, agriculture-based local economies have contributed to a decline in knowledge of traditional health practices and TEK at large. All of these issues underline the critical importance of documenting the remaining traditional knowledge of local medicinal plants, especially in southern Europe, where it is still present and used in local health strategies.

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Review Article

Can Estragole in Fennel Seed Decoctions Really Be Considered a Danger for Human Health? A Fennel Safety Update

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Fennel (*Foeniculum vulgare* Mill.) mature fruit (commonly known as seeds) and essential oil of fennel are widely used as flavoring agents in food products such as liqueurs, bread, cheese, and an ingredient of cosmetics and pharmaceutical products. Moreover fennel infusions are the classical decoction for nursing babies to prevent flatulence and colic spasm. Traditionally in Europe and Mediterranean areas fennel is used as antispasmodic, diuretic, anti-inflammatory, analgesic, secretomotor, secretolytic, galactagogue, eye lotion, and antioxidant remedy and integrator. Topically, fennel powder is used as a poultice for snake bites. In Asian cultures fennel was ingested to speed the elimination of poisons. As one of the ancient Saxon people's nine sacred herbs, fennel was credited with the power to cure. Fennel was also valued as a magic herb: in the Middle Ages it was draped over doorways on Midsummer's Eve to protect the household from evil spirits. Recently because of estragole carcinogenicity, fennel has been charged to be dangerous for humans especially if used as decoction for babies. But this allegation do not consider the remedy is prepared as a matrix of substances, and recent researches confirm that pure estragole is inactivated by many substance contained in the decoction.

1. Introduction

Fennel (*Foeniculum vulgare* Mill.) belongs to the family of Apiaceae, and is an annual, biennial, or perennial herbaceous plant, depending on the variety, which grows in good soils from sunny mild climatic regions and is a well-known aromatic plant species. *Foeniculum vulgare* has two commercially important fennel types: bitter fennel, *Foeniculum vulgare* Mill. subsp. *vulgare* var. *vulgare*, and sweet fennel *Foeniculum vulgare* subsp. *vulgare* var. *dulce*. Several fennel parts are edible (bulbs, leaves, stalks, and fruits). Mature fruit (commonly known as seeds) and essential oil of fennel are used as flavoring agents in food products such as liqueurs, bread, cheese, and an ingredient of cosmetics and pharmaceutical products. Moreover fennel infusions are the classical decoction for nursing babies to prevent flatulence and colic spasms [1–4]. Traditionally in Europe and Mediterranean areas fennel is used as antispasmodic, diuretic, anti-inflammatory, analgesic, secretomotor, secretolytic, galactagogue, eye lotion, and antioxidant remedy and integrator.

It is thus of extreme importance the efficacy, quality, and most of all toxicology of fennel based remedies and preparations is assessed, namely, when estragole (Figure 1), one of its constituents, has been notoriously declared to be a carcinogen substance [5].

The European Food Safety Authority (EFSA) suggested the so-called Margin of Exposure (MOE) to be used to set priorities in risk management with respect to compounds that are both genotoxic and carcinogenic [6]. MOE is defined as the ratio between the lower confidence limit of the benchmark dose that gives 10% extra cancer incidence (BMDL10) and the estimated daily intake (EDI) for estragole is estimated from different food sources 0.07 mg/kg bw/day [7]. The MOE for pure estragole amounts to 129–471 and according to EFSA a MOE lower than 10.000 can be

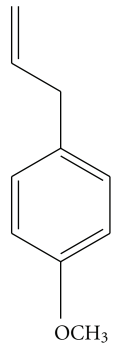

Figure 1: Estragole structure.

considered a priority for human risk [6, 8]. We contend that study of estragole as a single substance can be misleading and misrepresents the activity of this substance when present in the form of a complex herbal extract. This brings into question the validity of studies of pure compoudns that are taken outside of the context of the normal food matrix, which should serve as the benchmark for testing levels in human carcinogenicity studies.

2. Chemical Constituents of Fennel

According to the 2nd edition of the European Pharmacopoeia monograph, sweet fennel contains not less than 2.0% v/m of essential oil, calculated with reference to the anhydrous drug. The essential oil is constituted mainly by anethole (80%) (a substance with supposed anticancer properties), it contains not more than 10% estragole and not more than 7.5% fenchone [9]. Other minor constituents may be present including: R-pinene, limonene, β-pinene, β-myrcene, and p-cymene [9–11]. Furthermore, sweet fennel contains other nonvolatile constituents such as flavonoids and coumarins [12, 13], which have not received till now sufficient attention with regard to pharmacological properties [14].

In a paper the essential oil yield of bitter fennel fruits was 12.5 v/w, whereas 1.8 v/w volatile fraction (corresponding to plant material) was obtained by hydro-distillation of the plant infusion which is equivalent to 14.5% of the initial fennel essential oil. The main constituents of the volatile fraction of the fennel infusion were (hydro-distillation/SPE): trans-anethole (56.4%/58.4%), fenchone (36.2%/39.5%), and estragole (2.5%/2.2%); which were also the major compounds of the genuine bitter fennel essential oil. In infusions the proportion of ethers versus ketones was shifted significantly towards a higher of the latter, compared with the essential oil obtained from the fruits [15].

Generally prepackaged teabags marketed contain unbroken and/or crushed fruit or powdered drug. The use of unbroken fruit to prepare infusions is incorrect: because crushed or powered fruit gradually lose their essential oil content during aging [16], like many herbal remedies.

Many phytochemical researches have been conducted so far to investigate the chemical composition of fennel essential oil with different results: depending on the time of harvests, conservation, region, and area of cultivation. The major components of fennel are phenylpropanoid derivatives: *trans*-anethole and estragole (= methyl chavicol), and then alpha-phellandrene, limonene, fenchone, and alpha-pinene [17–20].

Essential oil composition depends upon internal and external factors affecting the plant such as genetic structures and ecological conditions; agricultural practices also have critical effects on yield and oil composition in the essential oil crops, although essential oil has some main components that can variate significantly according to the maturation period [21].

Piccaglia and Mariotti [19] indicated the presence of five different chemical groups in the essential oils isolated from fresh aerial parts of wild fennel collected in thirteen Italian areas: (1) trans-anethole, estragole, alpha-phellandrene; (2) *trans*-anethole, alpha-pinene, limonene; (3) estragole, alpha-phellandrene; (4) estragole, alpha-pinene; (5) alpha-phellandrene. About the chemical composition of fennel fruits (= seeds) the phenylpropanoid fraction (80–89%) and estragole (79–88%), dominated the fruit oil [18]. The relative amount of trans-anethole in these oils were much lower than those that characterize bitter fennel oils [22]. Some previous studies on fennel fruits essential oils have also mentioned estragole chemotypes in variable amounts (a variability in the variety), where estragole alone dominates the oil, or is present together with either trans-anethole or fenchone [18]. These results for the chemical composition of the essential oils of fennel aerial parts and fruits, support the view of Miraldi [7] that knowledge of fennel essential oils is still not enough to distinguish accurately all the existing varieties [18]. So it is very difficult to establish the effective amount of essential oil, estragole, and other substance in different industrial and homemade preparations. In a recent paper [23] was studied the chemical composition of 3 organically cultivated fennel cultivars: *Foeniculum vulgare* var. *azoricum*, var. *dulce* and var. *vulgare.* Gas chromatography/mass spectrometry analysis of the essential oils revealed the presence of 18 major monoterpenoids in all three cultivars but their percentage in each oil were greatly different [23]. The two *azoricum* and *dulce* cultivars are similar in their chemical composition but greatly different than the *vulgare* cultivar: *trans*-anethole accounted for 61% and 46% in the oil of *azoricum* and *dulce* cultivars, respectively, while it accounted for only 5% in the *vulgare* cultivar. Estragole was the major compound in the oil of the *vulgare* cultivar, with a concentration of 58% compared to 12% and 6% in the oils of *azoricum* and *dulce* cultivars, respectively [23]. The essential oils of two of the fennel cultivars, that is, *azoricum* and *dulce*, showed dramatically higher antioxidant activities than the essential oil of the *vulgare* cultivar [23]. The three oils contain similar concentrations of all other major compounds excluding trans-anethole and estragole suggesting that antioxidant activity is mostly related to the concentration of trans-anethole [23]. One of the major differences between the chemical structure of estragole and anethole is the double bond of the propenyl side chain: in anethole is conjugated with the aromatic ring while in estragole it is nonconjugated [23].

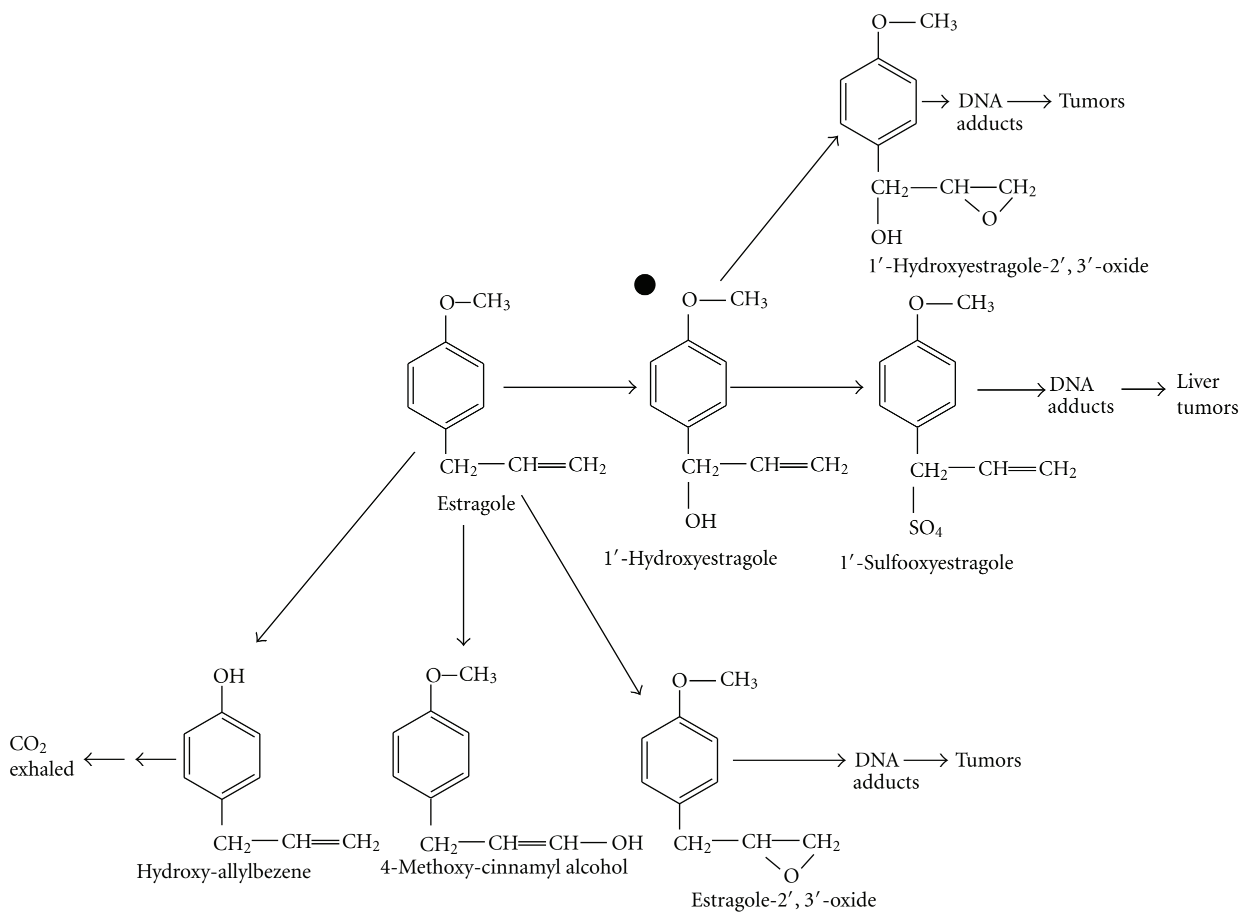

Figure 2: Bioactivation pathway of estragole.

3. Estragole Carcinogenicity *In Vitro* and Its Metabolic Pathways

For flavonoids formation of reactive intermediates proceeds by their enzymatic and/or chemical oxidation to quinone/quinone methide type metabolites [21], that are reactive alkylating intermediates. For alkenylbenzenes, including estragole, methyleugenol, elemicin, safrole, and myristicin the ultimate carcinogenic metabolites are their 1′-sulfooxy derivatives which degrade to alkylating carbocations that transformed in reactive substance, can give rise to DNA adducts.

Estragole is known to be metabolized along a number of pathways including O-demethylation (to give chavicol), epoxidation of the double bond, 1′-hydroxilation, and oxidative degradation of the side chain to carboxylic acids [24]. Zangouras et al. [24] indicate that at least two pathways, namely, O-demethylation and 1′-hydroxylation exhibit dose-dependency in both mouse and rat. Thus the proportion of the dose that undergoes O-demethylation declines in a dose-dependent fashion and is accompanied by an increase in the proportion of the dose that undergoes urinary elimination [24]. This change presumably arises from saturation of the enzyme systems responsible for O-dealkylation. The corollary of this is that at higher doses a relatively greater substrate level would be available for alternative metabolic reactions such as 1′-hydroxylation [24]. In the mouse the major route of estragole metabolism is via hydroxilation at the 1′ position [20, 25, 26]; producing derivatives with increased carcinogenic potential. Sulfuric acid esters of these compounds have been strongly implicated as the major ultimate electrophilic and carcinogenic metabolites *in vivo*. Thus mouse liver cytosols contain 3′-phosphoadenosine 5′-phosphosulfate-dependent sulfotransferase activity for 1′-hydroxysafrole and 1′-hydroxydehydroestragole [18, 19, 27].

The well-known bioactivation pathway of estragole proceeds by initial metabolic hydroxylation by cytochrome P450 enzymes, leading to the production of the proximate carcinogen 1′-hydroxyestragole, that by involvement of sulfotransferases is converted to the ultimate 1′-sulfooxyestragole; an instable substance that degrades to a reactive carbocation binding to different endogenous nucleophiles and inducing the production of DNA adducts [28], in particular hepatic macromolecular adducts [29]; and these as shown in rodents when given as a pure compound and at high dose-levels-induced hepatomas [30] (Figure 2).

To study bioactivation and detoxification of suspect toxic substance derived from estragole the PBK (Physiologically based kinetic) model was extended to a physiologically based dynamic (PBD) model, by which predict the formation of

DNA adducts in the liver of male rats [31]. A PBD model was developed by extending the PBK model through linking the area under the curve for 1′-hydroxyestragole formation predicted by the PBK model to the area under the curve for 1′-hydroxyestragole in *in vitro* incubations with rat hepatocytes exposed to 1′-hydroxyestragole [26]. The PBD model thus obtained, was validated by *in vivo* experimental data on DNA adducts formation in the liver of mice exposed to estragole, since data from rat were not available [26]. Literature reports the formation of 1 adduct in 10.000–15.000 DNA nucleotides after a single i.p. injection of about 400 mg estragole/kg bw/day to female CD-1 mice [32]. At this dose the PBD model predicts the formation of E-3′-N^2-dGuo, the major estragole DNA adduct formed [33] in the liver of rat at a level amounting to 4 adducts in 10.000 nucleotides. Thus, levels of DNA adducts formation in the two studies are within the same order of magnitude [26]. The slight difference can be explained by the difference in the experimental design of the two studies. At dose levels that match the available estimates for the daily intake of estragole, amounting to 0.01 mg/kg bw [34] and 0.07 mg/kg bw estragole [35], the PBD model predicted amounts of E-3′-N^2-dGuo DNA adduct formed of, respectively, 2 and 12.8 in 10^8 nucleotides.

Estragole, like other allylbenzene analogs in the liver, is subject to biotransformation which can generate reactive electrophilic intermediates; the allylic epoxides form readily *in vitro*, but can be rapidly further metabolized to less toxic dihydrol or glutathione conjugates [36]. Epoxide metabolites of allylbenzene are highly reactive and the metabolic pathway initiated by epoxidation has an equivalent potential for biochemical damage to that posed by the 1-hydroxylation pathway [36].

Using levels of epoxides 100-fold the maximal exposure to estragole in human diet in cells of different species, human liver cells had by far the highest allylic epoxide hydrolase activity, seven to 10 times higher than that seen in rat liver; probably the level of physiological protection against these reactants in humans, is higher than in other animal species [36]. Dihydrodiol derivatives were recovered at significant levels in urine of animals fed estragole, so dihydrodiol metabolites presumably represent end products of the epoxidation pathway, and carried out in a test accounted for up to 30% of the total metabolic clearance of estragole [37, 38]; an important outcome because it is approximately the same contribution to the overall metabolic clearance provided by the most studied 1′-hydroxylation pathway.

Recent studies have shown that 1′-hydroxyestragole glucuronide generation is a major pathway of estragole metabolism in rats and mice, which is dose-dependent and accounts for as much as 24% and 33% of the estragole urinary metabolites in rats and mice, respectively [39].

1′-hydroxyestragole and derivated glucuronides are major metabolites formed by human hepatocytes *in vitro*. By 24 h, about 12.5% of estragole is converted to 1′-hydroxyestragole glucuronide by human liver cells [39]. Hence, glucuronidation represents another significant route of detoxification of estragole in all species studied and humans too, that can be activated, although in a different way, by many different flavonoids that are part of the fennel matrix decoction. As shown in the paper of Iyer [39] 1′-hydroxyestragole glucuronidation in 27 individual human liver samples significantly ($P < 0.05$) correlated with the glucuronidation of other UGT2B7 substrates (morphine and ibuprofen). Iyer et al. [39] have determined that 1′-hydroxyestragole, which is the precursor to 1′-sulfooxyestragole, the active metabolite of estragole believed to be carcinogenic, is conjugated mainly by UGT2B7 using cDNA expressed UGT isoforms and correlation studies with other UGT2B7 substrates. UGT1A9 and UGT2B15 were also found to conjugate 1′-hydroxyestragole; this implies that concomitant chronic intake of therapeutic drugs and dietary components that are UGT2B7 and/or UGT1A9 substrates (which are both expressed in the gastrointestinal and liver tissues) may interfere with estragole metabolism [40, 41]. Because the carcinogenicity of 1′-hydroxyestragole is clearly dependent on the balance between formation of the active metabolites, (1′-sulfooxyestragole) and epoxides, and detoxification by glucuronidation; marked interindividual differences in the rate of 1′-hydroxyestragole glucuronidation, may have important toxicogenetic implications. The screen of 1′-hydroxyestragole glucuronidation in liver samples from 27 individuals indicated a significant intersubject variability, with a coefficient of variation of 42% [39].

4. The Issue of Estragole Carcinogenicity

Interest in the safety of estragole as a food flavoring stems from observations on the closely related compound safrole, which is both hepatotoxic and hepatocarcinogenic in rodents. Estragole has been shown to be an hepatocarcinogen in preweanling CD-1 mice and preweanling B6C3F1 mice [30, 42]. Administration of 0.23 or 0.46 (w/w) estragole in the diet of CD-1 mice for 12 months resulted in hepatomas in 56 and 71% of the mice [30]. About these results it is probably important to underline that in the first paper [42] the incidence of hepatomas in CD-1 mice (*verum* group), receiving only the vehicle (trioctanoin), was 12%; in a second group [42], 24% of males and 2% of female of CD-1 mice that received trioctanoin were bearing an hepatoma; in another experiment 26% of males that received only trioctanoin by i.p. injection after 12 months had hepatomas, and even 12% of not injected male B6C3F mice developed a hepatoma [30]. We think these data should stimulate reflection about real worth of these experiments in the evaluation of estragole and its derivatives, that probably has been overestimated.

Anthony et al. [27] in his paper reports the metabolism of [^{14}C] estragole in rats (by oral intubation) and mice (by i.p. injection) studying the variation of metabolism with dose over the range 50 g to 1000 mg/kg in both species. In mice elimination was essentially complete within 24 hr, and in rats receiving a high dose (500–1000 mg/kg), there was significant excretion on day 2. In both species the main route of elimination of very low doses was exhalation of $^{14}CO_2$

and urine was a minor route [27]. In these experiments as the dose level increased, the exhalation of $^{14}CO_2$, expressed as a percentage of the dose fell, while excretion in the urine rose. In rats and mice the proportion of urinary ^{14}C present as 1′-hydroxyestragole and 4-methoxy-cinnamyl alcohol rose significantly with dose. The excretion of acidic metabolites, indicated by the percentage of urinary ^{14}C extracted into ether at pH 1.0 was unaffected by dose size in the mouse and fell in the rat. The elimination of polar unextractable metabolites fell significantly with increasing dose in both species [27]. It is of paramount importance to consider the implications of these results in respect to the papers of Miller and Drinkwater [30, 42], because the dose they administered to animals must be contrasted to the estimated human daily intake of only 70 μg (approximately 1 μg/kg). (Flavor and Extract Manufacturer's Association, 1978).

In fact the hepatocarcinogenicity of estragole in mice has been clearly related to its conversion to 1′-hydroxyestragole, but factors influencing its formation may also cause a related variation in the incidence of tumors and in this context the nonlinear relationship between dose, animal species, and elimination of the 1′-hydroxy metabolite is important [33], particularly in connection with human metabolism. Sangster [25] showed in 2 healthy individuals, administered 1 mg/day of estragole, the excretion of 1′-hydroxyestragole glucuronide in human urine amounts to only 0.3% of the administered dose (0.02 nmol/kg 24 hr), a value far lower than that obtained in rodents even at the lowest doses (0.05 mg/kg body weight; 1′-hydroxyestragole excretion in 24 h in rat 4.5 nmol/kg; in mice 4.5 nmol/kg) [27]. Probably rodent carcinogenicity tests overestimate the risk of estragole carcinogenicity.

Another important difference in estragole metabolism between mice and humans is highlighted by an examination of dose dependency. In this case, the genotoxic metabolite found in urine, 1′-hydroxyestragole, can be used as a indicator of interspecies differences. In mice increasing doses of estragole leads to increasing levels of the metabolite in urine: low doses (0.05–50 mg/kg body weight) led to 1.3–5.4% 1′-hydroxyestragole; high doses (500–1,000 mg/kg body weigh), led to 11.4–13.7% 1′-hydroxyestragole. In humans, the amount of 1′-hydroxyestragole in the urine remained constant at 0.2–0.4% throughout a wide dosage range (1–250 mg estragole or 0.01–5 mg/kg body weight) [25]. A subsequent study on the metabolism of trans-anethole found that it was eliminated by humans 6 to 9 times quicker than by mice [43].

Consideration of these issues (dose, administration form, and differences in metabolism between species) raises doubts about the conclusion that fennel seed can be "reasonably anticipated to be a human carcinogen" [44], It is clear that human and animal metabolism cannot be directly compared but we think data should deserve attention.

In an experiment with male Sprague-Dawley rats (180–200 g) using a CCl_4 model, using pure fennel essential oil extract was demonstrated a protective effect against the toxicity induced by CCl_4 in rats. Which constituent(s) of the extract is responsible for this effect was not fully investigated [45]. The anticarcinogenic activity of fennel essential oil considered as a matrix of substance is confirmed by another recent paper using a methanolic fennel extract, that showed a mean ± standard deviation 50% inhibitory concentrations were 50 ± 0.03 μg/mL for the MCF7 breast cancer cell line and 48 ± 022 μg/mL for the Hepg-2 liver cancer cell line. The significant increase in malondialdehyde levels and the significant decrease in catalase activity and glutathione content in liver and tumor tissue in mice bearing Ehrlich ascites carcinoma improved after administration of the extract. *In vitro* pretreatments with fennel essential oil significantly inhibited the frequencies of aberrant metaphases, chromosomal aberrations, micronuclei formation, and cytotoxicity in mouse bone marrow cells induced by cyclophosphamide and also produced a significant reduction of abnormal sperm and antagonized the reduction of cyclophosphamide-induced superoxide dismutase, glutathione, catalase and inhibited increased malondialdehyde activities content in the liver [46]. In a study evaluating the efficacy of a fennel seed methanolic extract for its antioxidant, cytotoxic, and antitumor activities and for its capacity to serve as a nontoxic radioprotector in Swiss albino mice, and on different types of human cell lines *in vitro*, was also assessed the natural antioxidant compounds of the extract for use in industrial application [47]. The extract showed remarkable anticancer potential against a breast cancer cell line (MCF7) and liver cancer cell line (Hepg-2). It also showed strong free radical-scavenging activity (100%). In the conclusions the authors stated that could be used as a safe, effective, and easily accessible source of natural antioxidants to improve the oxidative stability of fatty foods during storage [47].

Nevertheless, has been recently demonstrated a direct carcinogenicity of estragole and found *in vitro* low levels of DNA adducts, with a significant dose response up to 1000 mM, suggesting the possibility of a direct-acting mechanism of adduction [48]. Experiments were also conducted to evaluate the persistence of DNA adducts produced by estragole in V79 cells, after a 25-hour recovery period. The results indicated that adducts are still present after this recovery period, suggesting that at these levels (1000 mM) repair is not efficient. And was shown that estragole did not induce apoptosis in all the assays performed for all concentrations tested, except at the highest concentration of 2000 mM [48]. For this dose and a 24-hour period estragole induced apoptosis to a limited extent, compared with the positive control. The MTT assays also show no significant cytotoxicity (above 50% cellular viability) and the authors concluded that estragole does not induce apoptosis at physiologically relevant doses.

In summary, according to the results obtained, it seems that the genotoxicity of estragole *in vitro* at high doses may ensue in part from direct adduction of DNA which can lead to alkali-labile sites in DNA, resulting in tails in the comet assay, and SCE, due to DNA strand-breaks. Nevertheless, the authors state that doses necessary to induce a genotoxic response are far from physiologically relevant human doses, and therefore the relevance of these adducts for tumor induction in humans *in vivo* needs to be further clarified [48].

5. Inhibition of DNA Adduct Formation Inhibition of Carcinogenesis

Recently has been demonstrated that formation of DNA adducts by 1′-hydroxyestragole and cofactor for SULT-mediated conversion could be inhibited by basil extract, the same result was then confirmed in intact human hepatoma cells [49]. This result suggests the likelihood that bioactivation and carcinogenicity may be much lower when estragole is administered at low dose and in a natural matrix.

In experiments using basil derivatives the flavonoid nevadensin, it was able to efficiently inhibit the sulfotransferasemediated conversion of 1′hydroxy alkenylbenzenes to the corresponding 1′-sulfooxy metabolites responsible for the DNA adduct formation [28]. Further experiments also indicated that nevadensin-mediated inhibition of the formation of the ultimate carcinogenic metabolite of estragole, occurs without reducing the capacity to detoxify 1′-hydroxyestragole via glucuronidation or oxidation [28]. This indicates a potential shift in the phase II metabolism of alkenylbenzenes upon coexposure with nevadensin and/or other flavonoids capable of sulfotransferase inhibition [26]. Assuming a 1% instead of a 100% uptake of nevadensin (similar to a nevadensin: estragole molar ratio of 0.01), the model still predicts about 17% and 43% inhibition of 1′-sulfooxyestragole formation as compared to control in rat and human, respectively [28], so it appears much more active in humans. In the paper of Alhusainy et al. [28] has been shown that at a molar ratio of nevadensin to estragole of 0.06, at which the two compounds are expected to be present in basil, the model predicts an almost complete inhibition of 1′-sulfooxyestragole formation in the liver of male rat and human when assuming 100% uptake of nevadensin.

In the paper of Rietjens [26] even a 1% nevadensin bioavailability at a dose of 50 mg/kg bw of estragole, a dose level in the range of the BMDL10 for tumor formation, dosing of an equimolar quantity of nevadensin, is predicted to result in only 2.4% 1′-sulfooxyestragole formation compared to the amount formed in the uninhibited situation. Our group has isolated and identified nevadensin also in different fennel extracts, so we think nevadensin probably has the same protective effect in fennel extracts too [50].

Moreover using 60 different basil fractions, besides the one identified as nevadensin, about half were able to inhibit SULT activity with different potency [29], and so it can be extrapolated that all together can completely stop SULT activity.

A significant difficulty in evaluating the metabolic, biochemical, and toxicological data for estragole as well as other alkenylbenzenes is that human exposure to these substances results from exposure to a complex mixture of food, spice, and spice oil constituents which may significantly impact the biochemical fate and toxicological risk of the alkenylbenzenes [51].

Recently Alhusainy et al. [51] have shown that given a normal diet may contain a variety of SULT inhibitors, experiments were performed to assess the effect of combined flavonoid exposure on SULT activity as well as on oxidation of 1′-hydroxyestragole to 1′-oxoestragole. To this end a test mixture was defined that mimics a realistic dietary flavonoid mixture and included four flavonoids that were found to be abundant in alkenylbenzene-containing herbs and spices and able to inhibit SULT activity, namely: quercetin, kaempferol, apigenin, and nevadensin, the latter being previously identified as a potent SULT inhibitor present in basil [29]. The compounds were not cytotoxic to HepG2 cells under the conditions used in these experiments and revealed that a significant reduction in the formation of E-3′-N2-dGuo compared to control (no flavonoid(s)) is observed in the human HepG2 cells following coadministration of 50 M of the substrate 1′-hydroxyestragole and 23 M of a flavonoid mixture containing quercetin, kaempferol, myricetin, apigenin, and luteolin (each at a concentration corresponding to its relative contribution in the diet). Altogether, the data indicates a shift metabolism from sulfonation and oxidation to glucuronidation which is a detoxification pathway for 1′-hydroxyestragole [51]. Finally, it is worth noting that even when the concentration of estragole was increased 1000 fold keeping the concentrations of the SULT inhibiting flavonoids at the values defined in the paper, the percentage inhibition of 1′-sulfooxyestragole formation remains the same as obtained at the 1000-fold lower dose of estragole. This is a characteristic of noncompetitive inhibition, where the level of inhibition depends only on the dose of the inhibitors [52].

In our opinion the same effect can be deduced for fennel decoction too, because flavonoids (nevadensin) are a very common substance in plants and can be easily extracted by herb decoction. In fact flavonoids induce detoxifying enzymes such as NAD(P)H: quinone oxidoreductase 1 and glutathione S-transferase which represent important defense mechanism against electrophilic toxicants and oxidative stress [49, 53]. Their prooxidant activity can result in the formation of highly reactive quinone/quinone methide metabolites which fulfill the requirements for electrophilic responsive elements-mediated induction of detoxifying enzymes [26]. It has been demonstrated that the electrophilic responsive elements-mediated response to flavonoids is increased in cells with reduced cellular GSH levels and decreased in cells with increased levels of GSH, supporting a role for the flavonoid quinone/quinone methides in electrophilic responsive elements activation [49, 53]. In infant fennel decoction formulas, the content of estragole was found to range from 241 to 2058 mg L^{-1} in infusions obtained following the same preparation mode (in 100 mL of boiling water) [54]. Authors analyzing these data and taking into account estragole concentration data and applying an approach similar to that used by the ESCO Working Group by a lower estimate of exposure showed the daily consumption of three cups (100 mL) of the tea (2.25 g of comminuted seeds) had the highest estragole level (2058 $\mu g\,L^{-1}$, teabag product no. 7; amount of estragole in a tea portion 206 μg) gave place to an exposure of 10 μg/kg bw/day; from this exposure level, they calculated MOE values ranging from 870 to 3210, [54] still a concerning number especially if considered that the decoctions are used for treatment of infant colics. Nevertheless in our opinion because fennel seeds decoctions are a very common remedy used by Italian mothers and if we accept the fact that is an effective hepatocarcinogenic substance, liver pediatric cancer incidence should rise, while in Italy (and in all over the world too) hepatic tumors are extremely rare in children. The Italian official AIRTUM [55] database included only 20 new cases of hepatomas in 1998–2002 in children (age 0–14), corresponding to 1% of incident pediatric neoplasms and incidence trends in 1988–2002 in Italy is −4% [55]. We think these data can confirm that fennel decoction use in infants do not rise significantly the risk of primary liver cancer.

6. The Concept of Carcinogenicity

Although international variations in diet and cancer indicate that diet is an important risk factor for many cancers, it has been difficult to ascribe a clear role in cancer causation to exposure to specific individual chemicals or mixture of chemicals [56]. So far, only alcohol intake (cancer of the oral cavity, pharynx, esophagus, and breast) and food contaminated with aflatoxins have clearly been documented as risk factors in humans [57]. Since evidence of carcinogenicity in laboratory animals is generally taken as an indication of potential human carcinogenic hazard, much emphasis is given to the interpretation of findings of animal carcinogenicity and the extrapolation of such findings to humans [56]. The first step in the carcinogenicity hazard identification is to establish whether or not the fennel decoctions are carcinogenic, so we have to establish if we are speaking of pure estragole or a decoction containing estragole and other substances (flavonoids).

Decision about carcinogenicity is generally based on a standard two-year carcinogenicity bioassay in rodents but we think that important evidence should be based on epidemiological data that probably give the definitive answer to the problem. In a recent paper [58] that should be considered a preferred approach to establish carcinogenicity of food basing on data available from animal dose-response analyses and human exposure, has been established by important international bodies (WHO, EFSA, ILSI Europe) a consensus about MOE (margin of exposure) but in the same paper it has been stated that MOE can be used only for prioritisation of risk management actions although the conference stated the difficulty to interpret it in term of real health risk for humans.

There are a number of issues that are central in this step [56]. First, it is important to decide whether the observed tumors in animal experiments are biologically relevant for humans based on the mode of action. So it is fundamental to understand how the toxic substance work, and establish if it is genotoxic or a carcinogen nongenotoxic, the so-called: MOA (mode of action), and site or sites of tumor formation. Second, it must be ascertained whether the existing toxicokinetic and toxicodynamic data are sufficient to reach a definitive conclusion about the likely shape of the dose-response curve for the carcinogenic effect. Especially for food and herbal derivatives it may be particularly difficult. Thirdly, data should be sought, in addition to those from traditional genotoxicity studies, that contribute to an understanding of the mode/mechanism of action. Then any possible influence of nongenotoxic processes, for example, hyperplasia, on the dose-response relationship should be addressed [56]. Finally, it is important to identify data which suggest whether or not there may be one or more subpopulations with special sensitivity/susceptibility to the carcinogenic effect (e.g., dependent on life-stage, gender, and genetic polymorphisms) [56].

Since such judgments in practice almost always rely on animal data, potency estimates are calculated from dose-response information seen in animal experiments, these being surrogates for the human situation [56]. Experimental studies have revealed large variations, of up to 10^8–10^9, in the doses of various carcinogenic substances needed to induce tumors in animal experiments [59].

Although hazard identification is a crucial step in the risk characterization process, it is important to recognize that it would be inappropriate to evaluate the toxicity of chemicals solely on the results of hazard identification, based merely on the intrinsic toxicity of the molecule [60]. It happens that data obtained in animals experiments carried out reaching MTD (maximum tolerated dose) may have little biological meaning since they may induce pathophysiological responses that are of little relevance for those that may be the result of much lower doses [60]. A more qualified choice of the dose range in animal studies would lead to a better and meaningful extrapolation process from animals to humans. The key for a correct extrapolation of animal data to humans is the understanding of the mode of action of chemicals. Unfortunately, this is not always the case, like is the case of d-limonene and formaldehyde. D-Limonene is recognized as an experimental carcinogen because causes nephropathy and kidney tumors in male rats, through binding to α_{2u}-globulin in the kidney; but it is a globulin male rat specific and do not represent any risk for human health [60, 61]. Formaldheyde has been classified as a known human carcinogen, causing several cancer, and particularly nasopharyngeal cancer and leukemia, but innocuous if added to milk as a bacteriostatic, because is rapidly transformed in spinacine, an innocuous substance [62].

Traditionally, an uncertainly factor of 100 is used, based on a 10-fold factor to allow for differences between average humans and a 10-fold factor to allow for differences between average humans and sensitive individuals [60]. A "false negative" decision about the carcinogenicity of a substance occurs when the bioassay fails to produce a statistically significant increased tumor incidence when in fact the chemical truly causes an increase in the tumor incidence at the dose tested. This is a statistical limitation resulting from the number of animals (generally 50) used per species-sex-dose group. Using the estimate of the dose-response trend obtained from other studies for each specified tumor type/tissue site in animals and the standard error of the trend, it is possible to estimate the approximate probability (power) of detecting a statistically significant trend only as a function of the sample size [63]. But if much more animals are used per dose group the statistical analysis could change the results and a substance can be categorized as carcinogenic, only because the sample size is changed [63].

7. Conclusion

In all of the animal studies reviewed, isolated, purified estragole was used. Thus the findings give a toxicological profile of this only molecule and not the profile risk of the entire decoction. In humans estragole usually enters the body as a component of fennel tea, or as a food that has been seasoned with herb that contains many other substance like nevadensin, epigallocatechine, other flavonoids, and anethole, that have a protective role and so counterbalance to the possible effect of pure estragole. In this context estragole occurs in the form of an extremely complex phytochemical mixture. If data about single constituent *in vivo* can be used as basis for statements about a herb, then data about other constituents should also be fully considered, because we think it is the only way to establish definitively if a substance is dangerous or not; and if it is a substance used from many years and in particular subsets of consumers or patients epidemiological data, when available, can help in establishing, together with the real mode of use, the effective risk for consumers.

Conflict of Interests

The authors declare that they have no conflict of interests.

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Research Article

Plant Ethnoveterinary Practices in Two Pyrenean Territories of Catalonia (Iberian Peninsula) and in Two Areas of the Balearic Islands and Comparison with Ethnobotanical Uses in Human Medicine

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This paper presents the results of an ethnobotanical study centred in veterinarian uses in two Catalan Pyrenean regions (Alt Empordà -AE- and High River Ter Valley -AT-, Iberian peninsula) and two Balearic Islands areas (Formentera -FO- and northeastern Mallorca -MA-). In the areas studied, 97 plant species have been claimed to be useful for veterinary purposes. A total of 306 veterinary use reports have been gathered and analysed. The ten most reported plants are *Tanacetum parthenium* (24 use reports), *Parietaria officinalis* (15), *Ranunculus parnassifolius* (14), *Meum athamanticum* (13), *Olea europaea* (13), *Quercus ilex* (12), *Ruta chalepensis* (12), *Sambucus nigra* (10) and *Thymus vulgaris* (10). According to comprehensive reviews, a high number of novelties for plant ethnoveterinary are contributed: 34 species and one subspecies, 11 genera, and three families have not been reported in previous works in this field, and 21 species had only been mentioned once. Several ethnoveterinary uses are coincidental with those in human medicine. Although ethnoveterinary practices are less relevant than in the past in the territories considered, as in all industrialised countries, the knowledge on plant properties and applications is still rich and constitutes a large pool of evidence for phytotherapy, both in domestic animals and humans.

1. Introduction

Community animals have always been and continue to be intimately linked to human societies' life. Domesticated (livestock, horses, poultry, other cage food animals such as rabbits, and most pets) and wild animal species (some occasionally captured pets, e.g., certain cage birds) live together with people, who obtain benefits and, at the same time, take care of them. Traditional veterinary practices are documented from as long as 14,000 years ago [1], being at least as ancient as animal domestication [2]. Given the kind of animals dealt with, the rural environment is where such practices (often including healing) are most extended, but pets and other small domestic animals are also quite present in urban areas. This is why ethnoveterinary knowledge is currently in use not only in developing countries, where often no other resources are available, but in developed ones as well, where it constitutes a very valuable complement and/or alternative to the so-called Western veterinary medicine [3].

Ethnoveterinary knowledge constitutes a relevant part of ethnobiological knowledge [1]. Data on veterinary plant uses are universally and significantly present in every general ethnobotanical prospection, and even more in those, very frequently, biased to ethnopharmacological aspects. This can be illustrated with a few -out of the very abundant-case examples of monographic ethnobotanical studies in different continents including diverse geographical or thematic approaches and different kinds of societies as regards industrialization level [4–9].

Apart from ethnoveterinary data appearing in general ethnobiological works, a considerable effort has been made to address this subject specifically. All angles of animal health care have been studied, among which those with an ethnographic focus are very relevant. A recent bibliographic compilation [3] provides data from 118 countries all over the world regarding 200 health troubles in 25 livestock species. A great number of papers on ethnoveterinary appear both in ethnobiological and veterinary journals, indicating contemporary interest of the subject in distinct fields. This means that the folk knowledge on animal health problems and the most frequent plant-derived remedies used to treat them are not merely an affair of past times but continue to play an important role in alternative or complementary medicine. To exemplify this we will quote again only an extremely reduced part of the very numerous sources specifically devoted to ethnoveterinary uses and practices, also covering different parts of the world, some of them very general and others focused on a single animal [10–26]. Strictly medical veterinary uses are often complemented with animal feed. In fact, a relatively new return to natural detected in the field of ethnoveterinary (not only referring to traditional ancestral plant use but also to modern uninformed access to plant products as well) has made the border between feed and medicine rather diffuse when addressing health care in animals [15]. In any case, the advanced state of art of ethnoveterinary has already made possible a synthetic work aiming to constitute a worldwide inventory of botanicals for animal health including 451 plant species [27]. All the above-cited general works [4–9] contain, in addition to veterinary ones, data on human medicinal uses, and some of the ethnoveterinary-centred ones also establish the comparison between medicinal uses addressed to humans and animals in the same sociogeographical group [23].

Ethnobotanical studies in Europe -most of them, as already stated, containing ethnoveterinary data- have been and still are abundant ([28] and references therein). Among these, in southern Europe, and in particular in Iberian territories, dealt with in the present paper, specific ethnoveterinary work is not at all scarce, especially in recent times [16, 29–35]. Nevertheless, in Catalonia only two works particularly deal with ethnoveterinary [31, 36], whereas no studies on this subject have been published to date concerning the Balearic Islands.

The efforts made over the last years to inventory the ethnoveterinarian heritage respond to the fact that industrialisation and rural depopulation have diminished the dependence of people on animals and caused a decrease in traditional animal healing [1] and that the ethnoveterinary knowledge is weak, since it depends exclusively on oral transmission [19]. This weakness is particularly worrying in developed countries, where much more industrial medicine is available and easy to use. Ethnobotanical studies focused on medicinal and on food plants have been previously published from the two Catalan regions considered ([37–39] and references therein), but only very scarce ethnobotanical information is available from the islands of Mallorca and Formentera ([40, 41] and references therein), and ethnoveterinary medicine has not been addressed at all, to date, in any of those territories. Consequent with this situation, the aims of the present work are (1) to inventory plant ethnoveterinary resources in several Catalan and Balearic regions in order to compare the data obtained in insular and continental territories; (2) to evaluate the degree of coincidence of veterinary and human medicinal plant uses in the zones considered; (3) to assess consensus and reliability of these uses and so the vitality of complementary and alternative medicinal practices and their real incidence in the healthcare system.

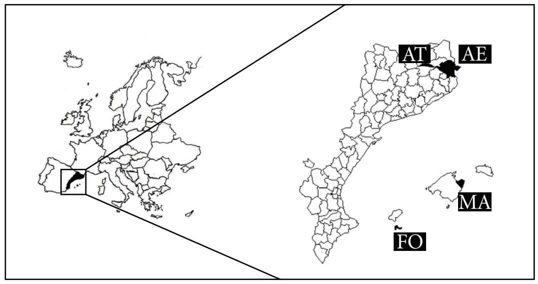

Figure 1: Location of the studied areas in Europe and in the Catalan linguistic area. AE: Alt Empordà; AT: High River Ter Valley; MA: northeastern Mallorca; FO: Formentera.

2. Methods

2.1. Study Areas. The territories studied are located in southwestern Europe (Figure 1) and grouped in two close but distinct geographical areas as follows. On the one hand, two regions in the eastern Pyrenees (Catalonia, Iberian peninsula): the district (in Catalan "comarca") of Alt Empordà (AE), in the foothills of the Pyrenees, and the high mountain area of the High River Ter Valley (AT). On the other hand, two regions in the Balearic Islands: the Artà peninsula area (northeastern) in Mallorca (MA) and Formentera (FO). All these territories share political administration (Spanish) and language (Catalan) and have a common ethnographic and cultural background, with the logical regional nuances.

The Alt Empordà territory comprises 1,358 km^2 and has around 138,000 inhabitants living in 68 municipalities. The climate is mainly coastal Mediterranean, with a global mean rainfall of 550–750 mm per year and an annual mean temperature of 15.2°C (data from the Catalan Meteorological Service [42]). The most well-known and deep-rooted meteorological phenomenon is a northwesterly wind called the *tramuntana*, responsible for some natural effects, such as some wind-adapted vegetation forms and the desiccation of crops. The district contains an uneven distribution of distinct biogeographical regions—two predominantly Mediterranean ones and also the Eurosiberian in certain mountainous areas [43]. Economically, this area has evolved from an initial agriculture and livestock raising and subsequent industrial forestry exploitation (especially cork) to the more recent tourism and real-estate boom, stronger on the seaside Costa Brava. The High River Ter Valley occupies 294 km^2 within the Ripollès district. To the North, the valley is limited by peaks that reach almost 2,900 m. The weather is typical of high mountain areas, with cold winters (mean temperature around 3°C) and a mean annual precipitation of 1,284 mm (data corresponding to 2003, Birba, pers. comm.), although the proximity of the Mediterranean Sea softens the climatic conditions. The predominant vegetation belts are the alpine and subalpine [43, 44]. This valley is inhabited by 4,526 people (municipal census, 2004), distributed in 18 population centres belonging to six municipalities. Some of them have suffered an important population decrease, although in recent years houses have been gradually reoccupied as second residences. Agriculture is not very relevant, given its climatic conditions and uneven territory, but many farms and houses within the villages have their own homegardens for private consumption.

Formentera is the smallest of the four inhabited Balearic Islands. It occupies 82 km^2 and has 9,147 inhabitants (data from 2008) [45] living in nine population centres belonging to one municipality. Its maximum altitude is 195 m, and the climate is Mediterranean with an arid tendency, with an annual mean temperature of 18.6°C and an annual mean rainfall of 370 mm [46]. The main vegetation landscape on this island is the coastal Mediterranean one [43]. Agriculture, timber exploitation, fishing, and salt production have been relevant activities on the island, but nowadays tourism is the most important economic activity. The prospected area in Mallorca is the Artà peninsula, covering the highest part of the Eastern Mountains, in the northeastern corner of the island. It comprises three municipalities: Artà (7,549 inhabitants), Capdepera (11,929), and Son Servera (12,286). One municipality (Artà) belongs to the North district and two municipalities to the Eastern (Capdepera and Son Servera) [45]. The climate in the area is typically Mediterranean (from the coast to the highest peaks, approximately 600 m) with an annual mean temperature of 16.5°C, a mean rainfall of 805.9 mm, and 70% of mean relative humidity [46]. Plant landscapes are basically limited to those of the Mediterranean biogeographic region with a particular relevance of coastal communities [47]. The three municipalities currently share their main reliance on tourism, having left aside the primary sector of agriculture and livestock, which used to be the main activities throughout their history. Currently the percentage of active people engaged in this economic sector (data from 2010) [45, 48] is only 1.24 for the whole island, and a relevant part of peasants are retired people who continue to cultivate some extension of land not far from the place where they live.

2.2. Informants and Periods of Field Work. The information was obtained from people either born and (almost) permanently located in each concerned territory or having lived there most of their life. The informants' selection has been basically done on a snowball basis, mostly starting with people known by the authors or by some authors' friends or relatives. All the authors of the present paper have been born in and live in or have links and frequent contacts with one of the studied territories, which facilitated the approach to the informants. A special emphasis has been made in contacting older people, since we supposed them to possess a higher amount of traditional knowledge due to the years of experience and the possibility of remembering pretouristic times, although young people have also been taken into account. In AE 101 interviews with a total of 179 informants (71% women, 29% men, maximum, minimum, and mean ages 95, 23, and 71 years, resp.) were carried out from 1995 to 2008. In AT 42 interviews concerning 60 informants (63% women, 37% men, maximum, minimum, and mean ages 87, 45, and 71 years, resp.) were performed in 2004 and 2005. In FO, 12 interviews were performed with 14 informants (78.6% women, 21.4% men, maximum, minimum, and mean ages 90, 68, and 80 years, resp.) in 2010 and 2011. In MA 42 informants (40% women, 60% men, maximum, minimum, and mean ages 99, 28, and 77 years, resp.) were interviewed between 2005 and 2011.

2.3. Ethnobotanical Interviews. The conversations were recorded, and pictures were taken during their development, all this with the permission of the informants. We did not use a closed questionnaire and avoided as much as possible asking direct questions, so as not to coerce the interviewees and so diminish their spontaneity. We used a combination of what the ethnographers call nonstructured or nondirected interview and the model termed as structured, direct, or focused interview [49], the latter called semistructured in most ethnobiological literature [50]. In some cases we also practised what the above-cited authors termed group interview, but those with only one informant constituted the majority. Since, as already stated, the authors live in or go frequently to the study areas, participant observation [50, 51] has also been conducted in a large number of cases. Most times more than one conversation with an informant was performed. During the interviews we asked the informants, in addition to their providing data on plant knowledge, to tell us how, when, and where they collected the plants, how they kept them, and how they prepared them for use. One of the principal points in our interviews being medicinal plants, an effort has been made to steer the conversation not only towards comments relevant to human medicine but also touching the health and treatment of domestic animals. So, we asked the informants about plants traditionally used in the area for treating animal illnesses.

2.4. Plant Collection and Identification. Plant materials of all taxa mentioned were collected according to the advice and recommendations of the informants and, whenever possible, together with them. They were identified using the *Flora dels Països Catalans* [52], the *Flora Manual dels Països Catalans* [53], and counting, in some cases, on the help of specialists in floristic and systematic botany. For foreign or cultivated species determination we followed [54, 55]. Vouchers are deposited in the herbarium BCN (*Centre de Documentació de Biodiversitat Vegetal, Universitat de Barcelona*).

2.5. Data Analysis. Data collected were introduced and analysed using a database we had designed [56] to ensure an organized pool of the gathered information from interviews. This permitted the standardisation of data entry and further analysis. This database has been designed as an open source interface, a constantly growing platform for ethnobotanical data collected within Catalan-speaking territories. Technical characteristics of the database are a MySQL server, read on php format and data exported as csv. With comparison intentions, we made an analysis of the coincidences and the degree of novelty between our own data and data from bibliography on ethnoveterinary plant uses in different areas (see the literature quoted in the introduction, especially [27], which constitutes a checklist of world ethnoveterinary plants).

Several quantitative ethnobotany indices accounting for the relevance and/or reliability of folk plant knowledge have been calculated for the ethnoveterinary plant uses in the territories studied: ethnoveterinaricity index (EvI), an adaptation of Portère's ethnobotanicity index (EI, [57]) to veterinary plant uses; informant consensus factor (F_{IC}, [58]); cultural importance index for each species and for all the territories (CI, [59]), on the basis of all informants, having or not provided veterinarian information. Also, the Jaccard's similarity index [60] has been calculated from the matrix of all use reports (for the four areas) using R software [61], and its visualisation has been designed as a PCA (principal component analysis) plot. This plot is complementary to a 4-term Venn diagram [62] that compares the number of plant species shared (one-to-one and by groups) among studied territories. Statistical analyses were carried out using XLSTAT 2009 v.3.02 (Addinsoft Corporation) available for Microsoft Excel 2003. Descriptive statistics (including rank, mean, and standard deviation, among other parameters) have been calculated for all the studied variables. One-way ANOVA has been conducted in order to test the differences, if any, in the CI among three studied areas (MA and FO are grouped to avoid a sampling bias). Least significant difference (LSD) test was carried out after ANOVA analysis to identify which pairs are significantly different. Chi-square (χ^2) tests are used to compare the parameters (part of plant, pharmaceutical form, etc.) among studied areas.

3. Results and Discussion

In the Catalan and Balearic areas studied, 97 plant species (101 taxa to the levels of subspecies and variety; 49 in AE, 49 in AT, 11 in FO, 17 in MA) have been claimed to be useful for veterinary purposes. Table 1 presents the plants recorded, grouped in alphabetical order of genera, with indication of scientific and local Catalan names, herbarium voucher number, botanical family, part used, pharmaceutical form, administration way, and veterinary and human uses. Table 2 summarizes numerical information on the informants and the territories studied, the plants used, reports, local names, families and related data, and some quantitative ethnobotany indexes calculated for these plant uses in the areas prospected.

Apart from the plants used against animal diseases, a considerable percentage of plant species are employed in the different areas as fodder: 21% (AT), 73% (AE), 16% (MA), and 14% (FO). This paper being specifically devoted to medicinal uses, we did not consider all feed plants as having an ethnoveterinary application. Anyway they, too, contribute to animal health, and in many cases the informants attribute them with medicinal properties complementary to the nutritional effect. These plants fit within the category of folk functional foods, proposed by Rigat et al. [37] to include plants traditionally used as nutraceuticals or food medicines, terms usually applied in human medicine, but perfectly transposable to veterinary medicine. As Pearson [15] remarked, there is a frequent possible confusion between feed and drug in ethnoveterinary.

The number of veterinary plant taxa (101) is intermediate between those recorded in the two precedent investigations on this subject in the Catalan cultural area (89 in Montseny [31], 195 in Pallars, Pyrenees [36]). It also occupies a medium position in a ranking going from 36 to 280 taxa used for animal health care in European, African, Asian, and American territories [12, 18, 19, 22, 23, 33–35]. In fact, it is not far from the average of the data contained in the 10 studies reported in the preceding lines (121.3 average taxa for the 11 studies), representing a large geographical range and up to a third of the 451 taxa collected in a world checklist of veterinary botanicals [27]. The big differences among plant number in these areas may be attributed, apart from geographical and possible cultural facts, to the different extension of the territories prospected (from small communities to entire countries). In any case, we can consider the number of plant taxa reported in the present study as rather high, taking into account the decrease in folk animal health practices experienced in industrialised areas [1].

The ten most reported plants were *Tanacetum parthenium* (24 use reports), *Parietaria officinalis* (15), *Ranunculus parnassifolius* (14), *Meum athamanticum* (13), *Olea europaea* (13), *Quercus ilex* (12), *Ruta chalepensis* (12), *Sambucus nigra* (10), *Thymus vulgaris* (10), and *Malva sylvestris* (9). Among these plants, there are some of the most reported also in other Mediterranean territories, especially *Malva sylvestris*, *Parietaria officinalis*, *Ruta chalepensis*, *Sambucus nigra*, and *Thymus vulgaris* [18, 30, 31, 33, 35, 36]. An originality of this study is the report in top position in the ranking of *Meum athamanticum* and *Ranunculus parnassifolius*. These two central European high mountain plants [53], reported, respectively, for the second and first time in veterinary (see Section 3.2 and Table 1), are much appreciated in one of the regions studied (AT), the first one as postlabour coadjuvant and the second one for different kinds of uses, antineoplastic included. Another high mountain *Ranunculus* species (*R. aconitifolius*) has been recorded from Occitan shepherds of a French Central Massif region with a use (resolutive) coincidental with one of those of *R. parnassifolius* in the studied area [26]. It is worth mentioning also the plant occupying the 11th position in our list as per number of reports, *Eryngium campestre*. This plant, only reported in veterinary to date with the same use in another Catalan region [31], and with different uses in Andalusia [34] and Aragon [63], is widely employed in two of the areas prospected (AE, AT) as an

Table 1: Plants with veterinary medicinal uses claimed in the areas studied. VR: veterinary reports; HR: human medicine reports (only those coincidental with veterinary ones); CI, CIg: cultural importance index [54] for each area and in all the territories studied (global); AE: Alt Empordà; AT: High River Ter Valley; MA: northeastern Mallorca (Mallorca); FO: Formentera. Asterisks (*) indicate the subspecies, species, genera, and families not reported as useful in veterinary in [27, 30], and crosses (+) indicate the subspecies, species, genera, and families reported only once as useful in veterinary in these quoted works (both signs are placed after the name of the category concerned).

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Achillea ptarmica L* subsp. *pyrenaica* (Sibth. ex Godr. in Gren. et Godr.) Heimerl (Asteraceae, BCN 24701)	camamilla, camamilla de muntanya, camamilla de Rojà	Inflorescence	Tisane (with *Sambucus nigra*)	Internal	Antidiarrhoeal	1	0	AT (0.05, 0.01)
			Tisane (with sodium bicarbonate and olive oil)	Internal	Laxative	1	0	AT
			Tisane (with *Thymus vulgaris* and *Tilia platyphyllos*)	Internal	Salutiferous	1	1	AT
*Aeonium** *arboreum* (L.) Webb and Berthel. (Crassulaceae, BCN 81566)	consolva	Stem	Direct ingestion	Internal	Egg calcifier	3	0	FO (0.21, 0.01)
Agave americana L. (Agavaceae+, BCN 46860)	figuerassa grossa, figuerassa de marge	Leaf	Direct application	External	Vulnerary	1	0	AE (0.006, 0.003)
Agrimonia eupatoria L.+ (Rosaceae, BCN 29619)	gremònica, tapaculs	Leaf	Tisane	Internal	Antidiarrhoeal	1	1	AE (0.006, 0.003)
Allium cepa L. (Liliaceae, BCN 28655)	ceba	Bulb	Tisane	Internal	Laxative	1	2	AE (0.006, 0.003)
			Direct ingestion	Internal	Anticatarrhal (fowl pip)	1	2	MA (0.024, 0.007)
Allium sativum L. (Liliaceae, BCN 24708)	all	Bulb	Direct application	External	For stings	2	2	MA (0.071, 0.02)
			Direct ingestion	Internal	Salutiferous	1	1	MA
			Liniment (with *Senecio vulgaris*)	External	Anti-inflammatory (antigotose)	1	1	AT (0.017, 0.02)
			Liniment (with *Bryonia cretica* or *Umbilicus rupestris*)	External	To heal wounds	2	2	AT
Aloe vera (L.) Burm.f.* (Liliaceae, BCN 27242)	aloe vera	Leaf	Direct application	External	Bone reinforcer	1	0	MA (0.024, 0.003)
Althaea officinalis L. (Malvaceae, BCN 24709)	malví	Root	Liniment (with *Bryonia cretica* or *Umbilicus rupestris*)	External	To heal wounds	1	1	AT (0.017, 0.003)

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Alyssum maritimum (L.) Lam.* (Brassicaceae, BCN 29622)	herba fetgera	Flowered aerial part	Direct ingestion	Internal	Antiicteric	1	0	AE (0.006, 0.003)
Arum italicum Mill.+ (Araceae, BCN 32358)	xèrria	Fruit	Ointment	External	Anti-inflammatory	1	1	AE (0.006, 0.003)
Arundo donax L.+ (Poaceae, BCN 24720)	canya	Root	Tisane	Internal	Unknown	1	0	AT (0.017, 0.003)
Avena sativa L. (Poaceae, BCN 29839)	civada	Aerial part	Direct ingestion	Internal	Blood pressure regulator	1	0	AE (0.006, 0.003)
Beta vulgaris L.+ subsp. *vulgaris* (Chenopodiaceae, BCN 24724)	bleda	Leaf	Medicinal broth	Internal	Postpartum coadjuvant (emollient)	2	0	AT (0.033, 0.007)
Brassica oleracea L.+ subsp. *oleracea* (Brassicaceae, BCN 32181)	bròquil	Flowered aerial part	Tisane	Internal	Antidiarrhoeal	1	0	AE (0.006, 0.003)
Bryonia cretica L.+ subsp. *dioica* (Jacq.) Tutin (Cucurbitaceae, BCN 24730)	carbassí, carbassina	Root	Bath	External	Antiparasitic	1	0	AT (0.07, 0.01)
			Liniment (with *Umbilicus rupestris*)	External	To heal wounds	2	1	AT
			Poultice	External	Antidermatose	1	0	AT
Calendula officinalis L. (Asteraceae, BCN 24732)	calèndula	Flower head	Essence	External	Antitoxic	1	1	AT (0.017, 0.003)
Capsella + *bursa-pastoris* (L.) Medic. (Brassicaceae, BCN 24736)	bossa de pastor, caps blancs	Flowered aerial part	Tisane	Internal	Postpartum coadjuvant (anti-hemorrhagic and antihypertensive)	1	1	AT (0.017, 0.003)
Capsicum annuum L. (Solanaceae, BCN 24737)	pebre coent	Fruit	Maceration in oil	External	Insect repellent	2	0	MA (0.05, 0.007)
Centaurium * *erythraea* Rafn subsp. *erythraea* (Gentianaceae+, BCN 29849)	herba de santa Aura	Flowered aerial part	Tisane	Internal	Hypertensive	1	0	AE (0.006, 0.003)
Ceratonia siliqua L.+ (Fabaceae, BCN 32177)	garrofa (fruit)	Grain	Direct ingestion	Internal	Antidiarrhoeal	1	0	AE (0.006, 0.003)
Citrus limon (L.) Burm. f.+ (Rutaceae, BCN 46853)	llimoner, llimonera, llimona (fruit)	Fruit juice	Direct application	External	Ocular antiseptic	1	0	AE (0.006, 0.01)
			Direct ingestion	Internal	Internal antiseptic	1	1	MA (0.024, 0.01)
		Fruit (epicarp)	Medicinal soup (boiled rice with lemon peel)	Internal	Antidiarrhoeal	1	0	AT (0.017, 0.01)
Clematis flammula L.* (Ranunculaceae, BCN 29856)	santjoanet, vidauba	No data	Poultice	External	For swine erysipelas	1	0	MA (0.024, 0.003)
Cucurbita maxima Duch. in Lam. (Cucurbitaceae, BCN-S 1499)	rabequet (fruit)	Fruit	Ointment	External	Anti-inflammatory	1	1	AE (0.006, 0.003)
Cucurbita pepo L.+ (Cucurbitaceae, BCN 24757)	carbassa	Fruit	Ointment	External	Antiseptic	1	1	AT (0.017, 0.003)

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Daphne gnidium L. (Thymelaeaceae+, BCN 29687)	tintorell, matapoll	Stem	Direct application	External	Vulnerary	1	0	AE (0.01, 0.01)
					Antidiarrhoeal	1	0	AE, FO (0.07, 0.01)
Diplotaxis erucoides* (L.) DC. (Brassicaceae, BCN 29861)	cap blanc	Flowered aerial part	Direct ingestion	Internal	Galactofugue	1	0	AE (0.006, 0.003)
Dracunculus vulgaris* Schott. (Araceae, BCN 24765)	herba escurçonera	Bulb	Embrocation	External	Antitoxic	2	2	AT (0.05, 0.01)
		Flower	Direct application	External	Antitoxic	1	1	AT
Eriobotrya japonica* (Thunb.) Lindl. (Rosaceae, BCN 66823)	nisprero, nispro (fruit)	Leaf	Decoction	Internal	Antidiarrhoeal	2	4	MA (0.05, 0.007)
Eryngium campestre L. (Apiaceae, BCN 31274)	espinacal	Flowered aerial part	Ointment	External	Antiophidian	1	0	AE (0.006, 0.03)
		Root	Liniment	External	Antiophidian	2	2	AT (0.12, 0.03)
		Aerial part	Direct application	External	Antiophidian	4	4	AT
					Antialgic	1	0	AT
Eryngium bourgatii L.* (Apiaceae, BCN 24881)	espinacal	Root	Liniment	External	Antiophidian	1	1	AT (0.08, 0.02)
		Aerial part	Direct application	External	Antiophidian	4	4	AT
Eucalyptus globulus Labill.+ (Myrtaceae, BCN 29696)	eucalipto, calipto	Leaf	Vapour	Internal	Anticatarrhal	2	47	AE (0.006, 0.007), FO (0.07, 0.007)
Foeniculum vulgare Mill. (Apiaceae, BCN 24888)	fonoll	Aerial part	Direct ingestion	Internal	Antidiarrhoeal	1	0	MA (0.02, 0.003)
Fraxinus excelsior L. (Oleaceae, BCN 24890)	freixe	Cortical parenchyma	Liniment (decoction with *Bryonia cretica*)	External	To heal wounds	1	1	AT (0.03, 0.007)
			Bath (decoction with *Quercus pubescens*)	External	To heal wounds	1	1	AT
Gentiana acaulis L.+ (Gentianaceae+, BCN 24892)	genciana	No data	No data	External	Antidermatose	1	0	AT (0.02, 0.003)
Gentiana lutea L.* (Gentianaceae+, BCN 24893)	genciana	Root	Bath	External	Vulnerary	1	0	AT (0.02, 0.003)
Geranium rotundifolium L. (Geraniaceae, BCN 29701)	cicuta	Aerial part	Ointment	External	Vulnerary	1	1	AE (0.006, 0.003)
Globularia alypum L. (Globulariaceae*, BCN 53082)	cossiada	Tender aerial part	Direct ingestion	Internal	Anorexigen	1	0	MA (0.02, 0.003)

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Herniaria hirsuta L.* subsp. *cinerea* (DC.) Arcang. (Caryophyllaceae, BCN 23330)	trencapedra	Aerial part	Tisane	Internal	Diuretic	2	5	MA (0.05, 0.003)
Herniaria glabra L.+ (Caryophyllaceae, BCN 24901)	herba de mil granes, herba de les mil granes	Aerial part	Tisane	Internal	Antiicteric	1	0	AT (0.02, 0.003)
Hypericum perforatum L. (Clusiaceae, BCN 29874)	herba de Sant Joan	Flowered aerial part	Ointment	External	For mastitis	1	0	AE (0.006, 0.003)
Juniperus communis L. subsp. *alpina* (Suter) Čelak* (Cupressaceae, BCN 24910)	ginebre, ginebró, oli de ginebre	Fruit	Ointment	External	Antidermatose	3	2	AT (0.05, 0.01)
Juniperus communis L. subsp. *communis* (Cupressaceae, BCN 29878)	ginebre	Fruit	Ointment	External	Anti-inflammatory/ Antialgic/ Antiecchymotic	1	0	AE (0.01, 0.007)
					Vulnerary	1	0	AE
Juniperus oxycedrus L.+ (Cupressaceae, BCN 29879)	càdec, ginebró	Fruit	Ointment	External	Vulnerary	1	0	AE (0.03, 0.02)
					Demulcent	1	0	AE
					Antifungal	1	0	AE
					Internal antiseptic	1	0	AE
					For a sprained leg	1	0	AE
Lavandula latifolia Medic.+ (Lamiaceae, BCN 29882)	espígol	Flowered stem	Direct application	External	Antiophidian	1	0	AE (0.006, 0.003)
Lilium * *pyrenaicum* Gouan (Liliaceae, BCN 24918)	consolta, consolta groga	Bulb	Liniment	External	To heal wounds	1	1	AT (0.03, 0.007)
			Poultice	External	To heal wounds	1	1	AT
Linum usitatissimum L. (Linaceae, BCN 47281)	lli, llinet, oli de llinosa (product)	Grain	Ointment	External	Vulnerary	1	0	AE (0.01, 0.007)
			Enema	Internal	Laxative	1	6	AE
Lithospermum * *officinale* L. (Boraginaceae, BCN 24922)	herba pedrera, mill del sol, tabac	Aerial part with fruits	Tisane	Internal	Postpartum coadjuvant	1	0	AT (0.006, 0.003)
Lythrum salicaria L.+ (Lythraceae, BCN 29724)	tapaculs	Flowered aerial part	Tisane	Internal	Antidiarrhoeal	3	3	AE (0.02, 0.01)

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Malva sylvestris L. (Malvaceae, BCN 24924)	malva	No data	Tisane	Internal	Anti-inflammatory	1	4	FO (0.07, 0.003)
		Flower	Decoction	Internal	Antiseptic	2	1	AT (0.13, 0.03)
		Flowered aerial part	Tisane (with *Parietaria officinalis*)	Internal	Postpartum coadjuvant	2	1	AT
			Tisane (with *Parietaria officinalis*, *Plantago lanceolata*, and *Plantago major*)	Internal	Postpartum coadjuvant	1	0	AT
					Diuretic	1	0	AT
			Tisane (with *Umbilicus rupestris*)	Internal	Purgative	1	0	AT
			Enema (with *Parietaria officinalis*)	Internal	Purgative	1	0	AT
Marrubium vulgare L. (Lamiaceae, BCN 29726)	herba del mal roig	Aerial part	Tisane	Internal	For swine erysipelas	1	0	AE (0.006, 0.003)
Matricaria recutita L.[+] (Asteraceae, BCN 29890)	camamilla	Inflorescence	Direct ingestion	Internal	Digestive	1	28	AE (0.01, 0.007)
					Gastric and intestinal anti-inflammatory	1	13	AE
Mentha spicata L.[*] (Lamiaceae, BCN 29995)	menta del consol	Tender aerial part	Tisane	Internal	Postpartum coadjuvant	1	0	AE (0.006, 0.003)
Mentha suaveolens Ehrh.[+] (Lamiaceae, BCN 29994)	herbasana	Aerial part	Tisane	Internal	Antihelminthic	1	1	MA (0.02, 0.003)
Mercurialis annua L. (Euphorbiaceae, BCN 29896)	murcarol	Aerial part	Tisane	Internal	Laxative	2	2	AE (0.02, 0.01)
			Direct ingestion	Internal	Laxative	1	0	AE
Meum[+] *athamanticum* Jacq. subsp. *athamanticum* (Apiaceae, BCN 24933)	herba del meu, meu	Root	Tisane (decoction with *Senecio leucophyllus*)	Internal	Postpartum coadjuvant (antiseptic)	13	1	AT (0.23, 0.05)
		Whole plant	Tisane (decoction with *Saxifraga longifolia*)	Internal	Postpartum coadjuvant	1	0	AT
Nicotiana rustica L.[+] (Solanaceae, BCN 46839)	tabac pota	Leaf	Direct ingestion	Internal	Emetic	1	1	FO (0.14, 0.007)
Ocimum basilicum L.[+] (Lamiaceae, BCN 29897)	fàbrega	Aerial part	Tisane (bath)	External	Puerperal antiseptic	1	0	AE (0.01, 0.007)
					External antiseptic	1	0	AE

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Olea europaea L. var. *europaea* (Oleaceae, BCN 29898)	olivera, oli d'oliva (product)	Fruit	Ointment	External	For mastitis	1	0	AE (0.06, 0.04)
					Antiscabby	1	0	AE
					Vulnerary	1	0	AE
					Cicatrizing	4	0	AE, FO (0.07, 0.04)
					Antiseptic	1	0	AE
			Direct application	External	Haemostatic	1	0	AT (0.03, 0.04)
			Tablets	Internal	Salutiferous	1	1	AE
			Poultice	External	Insect repellent	3	0	AT, MA (0.05, 0.04)
Origanum ⁺ *vulgare** L. (Lamiaceae, BCN 29742)	orenga	Flowered stem	Direct ingestion	Internal	Postpartum coadjuvant	1	0	AE (0.006, 0.007)
		Aerial part	Tisane	Internal	Internal antiseptic	1	2	FO (0.071, 0.007)
Oryza sativa L. (Poaceae, BCN 39208)	arròs	Grain	Tisane (boiled rice with lemon peel)	Internal	Antidiarrhoeal	1	2	AT (0.02, 0.003)
Parietaria officinalis L. subsp. *judaica* (L.) Béguinot (Urticaceae, BCN 29745)	blet de paret, cama-roja	Aerial part	Boiled plant and its decoction	Internal	Laxative	1	1	AE (0.006, 0.003)
Parietaria officinalis L. (Urticaceae, BCN 24942)	blet, blet de paret	Aerial part	Decoction (with *Malva sylvestris*)	Internal	Antiseptic	2	2	AT (0.3, 0.05)
			Medicinal broth (with *Beta vulgaris*, bread and olive oil)	Internal	Postpartum coadjuvant (emollient)	9	1	AT
			Tisane (decoction with *Malva sylvestris*)	Internal	Postpartum coadjuvant	1	0	AT
					Diuretic	1	0	AT
					Purgative	1	1	AT
			Enema	Internal	Purgative	1	1	AT
Petroselinum crispum (Mill.) Hill⁺ (Apiaceae, BCN 29905)	julivert	Leaf	Direct ingestion	Internal	Aphrodisiac	1	0	AE (0.01, 0.01)
		Whole plant	Direct application	Internal	Aphrodisiac	1	0	AT (0.02, 0.01)
		Root	Poultice	External	Antiparotid (for mumps)	1	0	AE
Pimpinella anisum L. (Apiaceae, BCN 47278)	anís (fruit)	Fruit	Elixir	Internal	Ruminant antistatic	1	0	AE (0.006, 0.003)
Pinus halepensis Mill.⁺ (Pinaceae, BCN 29826)	pi, pi bord	Bark	Direct application	External	Epithesis	1	0	AE (0.006, 0.007)
		Resin	Ointment	External	External antiseptic	1	3	MA (0.02, 0.007)

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Pinus sp. (Pinaceae)	pega negra (product)	Resin	Ointment	External	Puerperal antiseptic	1	0	AE (0.01, 0.007)
			Patch	External	For a sprained leg	1	0	AE
Pinus sylvestris L.+ (Pinaceae, BCN 27259)	pi, pi roig, pega negra (product)	Resin	Poultice	External	Epithesis	1	0	AT (0.02, 0.003)
Plantago lanceolata L. (Plantaginaceae, BCN 24949)	plantatge, plantatge estret, plantatge llarg	Leaf	Tisane (with *Parietaria officinalis*)	Internal	Postpartum coadjuvant (diuretic)	1	0	AT (0.02, 0.003)
Plantago major L. (Plantaginaceae, BCN 24950)	plantatge, plantatge ample, plantatge rodó	Leaf	Tisane (with *Parietaria officinalis*)	Internal	Postpartum coadjuvant (diuretic)	1	0	AT (0.02, 0.003)
Pteridium aquilinum (L.) Kuhn (Polypodiaceae, BCN 46068)	falguera	Frond	Direct application	External	For flea infestation	1	1	AE (0.006, 0.003)
Quercus ilex L. subsp. *ilex* + (Fagaceae, BCN 29932)	alzina, aulina	Bark	Tisane (bath)	External	Vulnerary	6	2	AE (0.05, 0.04)
			Tisane	Internal	Antidiarrhoeal	3	0	AE
			Bath	External	Antiseptic	3	1	AT (0.05, 0.04)
Quercus petraea (Matt.) Liebl.* (Fagaceae, BCN 24964)	roure	Internal bark	Bath (with *Fraxinus excelsior*)	External	Antiseptic	3	0	AT (0.07, 0.01)
			Bath	External	Cicatrizing	1	1	AT
*Ramonda** *myconi* (L.) Reichenb. (Gesneriaceae, BCN 24965)	orella d'ós	Aerial part	Tisane	Internal	Postpartum coadjuvant (antiseptic)	1	0	AT (0.02, 0.003)
Ranunculus parnassifolius L.* (Ranunculaceae, BCN 24967)	herba del mal gra	Whole plant	Liniment	External	Antigangrenous	1	1	AT (0.2, 0.05)
			Liniment, bath	External	Antiseptic	4	5	AT
			Liniment, bath	External	Resolutive	4	5	AT
			Liniment, poultice	External	Antineoplastic	5	6	AT
Rosmarinus officinalis L. (Lamiaceae, BCN 29937)	romaní	Flowered stem	Tisane	Internal	Postpartum coadjuvant	1	0	AE (0.006, 0.007)
		Aerial part	Direct ingestion	Internal	Antidiarrhoeal	1	0	FO (0.07, 0.007)

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Ruta chalepensis L. (Rutaceae, BCN 29940)	ruda	Aerial part	Direct ingestion	Internal	Carminative	1	0	AE (0.006, 0.04)
					Ruminant antistatic	2	0	MA (0.07, 0.04)
			Direct application	External	Postpartum coadjuvant (antiseptic)	3	0	AT (0.10, 0.04)
					Tranquilizer	1	0	FO (0.14, 0.04)
					Flea repellent	1	0	FO
			Embrocation (with *Bryonia cretica* or *Umbilicus rupestris*)	External	To heal wounds	1	2	AT
			Liniment	External	To heal wounds	1	2	AT
					Anti-inflammatory	1	0	AT
			No data	Internal	Antihelminthic	1	10	MA
Sambucus nigra L. (Caprifoliaceae, BCN 29943)	sabuquer, sabuc, flor de sabuc	Inflorescence	Fumigation	External	For mastitis	1	0	AE (0.006, 0.03)
		Flower	Tisane (with *Achillea ptarmica*)	Internal	Antidiarrhoeal	2	1	AT (0.15, 0.03)
			Tisane	Internal	Intestinal antiseptic	2	14	AT
			Essence (with *Achillea ptarmica*)	Internal	Antidiarrhoeal	2	1	AT
			Essence	Internal	Intestinal antiseptic	2	14	AT
		Fruit	Syrup	Internal	Intestinal antiseptic	1	9	AT
Santolina chamaecyparissus L.* (Asteraceae, BCN 29944)	camamilla	Flower head	Tisane	Internal	Internal antiseptic	1	5	FO (0.07, 0.01)
			Bath	External	Ocular antiseptic	2	8	MA (0.07, 0.01)
			Enema	Internal	Puerperal antiseptic	1	0	MA
Saxifraga longifolia Lap.* (Saxifragaceae)	corona de rei	Aerial part	Tisane (with *Ramonda myconi* or *Meum athamanticum*)	Internal	Postpartum coadjuvant (antiseptic)	1	0	AT (0.02, 0.003)
Saxifraga paniculata Mill.+ (Saxifragaceae, BCN 24992)	corona de rei	Aerial part	Tisane	Internal	Intestinal anti-inflammatory	1	1	AT (0.03, 0.007)
					Postpartum coadjuvant	1	0	AT

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
Scabiosa columbaria L.* (Dipsacaceae, BCN 24993)	escabiosa, escapiosa, herba d'escapiosa	Aerial part	Tisane	Internal	Antiparasitic	1	0	AT (0.02, 0.003)
Sedum + *sediforme* (Jacq.) Pau* (Crassulaceae, BCN 29792)	mort-i-viu, herba de Sant Pere	Leaf	Poultice	External	Anti-inflammatory/ Antialgic/ Antiecchymotic	1	0	AE (0.01, 0.007)
					Antiseptic	1	0	AE
Sedum + *telephium* L.* (Crassulaceae, BCN 24995)	arròs de paret, bàlsam, herba grassa, matafocs	Leaf	Ointment	External	Antidermatose	2	2	AT (0.03, 0.007)
Sempervivum montanum L.* (Crassulaceae, BCN 24996)	matafoc de muntanya	Aerial part	Liniment	External	Antidermatose	1	0	AT (0.02, 0.003)
Senecio leucophyllus L.* (Asteraceae, BCN 24998)	herba blanca	Aerial part	Tisane (decoction with *Meum athamanticum*)	Internal	Postpartum coadjuvant	1	0	AT (0.02, 0.003)
Solidago virgaurea L.* (Asteraceae, BCN 25007)	vara d'or	Flowered aerial part	Tisane	Internal	Antitoxic	1	0	AT (0.02, 0.003)
Sonchus oleraceus L. (Asteraceae, BCN 29953)	llipsó, lletissó	Aerial part	Direct ingestion	Internal	Galactogenous	1	0	AE (0.006, 0.01)
			Liniment (with *Senecio vulgaris*)	External	Anti-inflammatory	1	1	AT (0.05, 0.01)
					Antigotose	1	1	AT
			Liniment	External	Vulnerary	1	1	AT
Sorbus aucuparia L.* (Rosaceae, BCN 25009)	moixera de guilla	Aerial part	Direct application	External	Antiviral	1	0	AT (0.02, 0.003)
Tanacetum parthenium (L.) Schultz Bip.+ (Asteraceae, BCN 29960)	tanarida, herba del remuc, camamilla, camamilla amargant, camamilla borda, camamilla de parets, danarida, herba danarida	Flowered aerial part	Tisane	Internal	Ruminant antistatic	3	0	AE (0.08, 0.08)
			Direct ingestion	Internal	Ruminant antistatic	7	0	AE
			Tisane	Internal	Antiicteric	1	0	AE
				Internal	Antidiarrhoeal	2	0	AT (0.15, 0.08)
				Internal	Digestive	2	3	AT
				Internal	Antinausea	1	1	AT
				Internal	Unknown	5	0	AT
			Tablets	Internal	Ruminant antistatic	2	0	AE
				Internal	Antiicteric	1	0	AE

Table 1: Continued.

Scientific names (family, voucher specimen)	Catalan names	Part used	Pharmaceutical form	Administration way	Veterinary use	VR	HR	Area (CI, CIg)
*Taraxacum** *officinale* Weber in Wiggers (Asteraceae, BCN 25948)	dent de lleó	Leaf	Direct ingestion	Internal	Bone reinforcer	1	1	AE (0.006, 0.003)
Thymus vulgaris L. (Lamiaceae, BCN 29961)	farigola, frígula, frigola	Flowered stem	Tisane (bath)	External	Antiseptic	5	40	AE (0.06, 0.03)
					Ocular antiseptic	2	10	AE
					Vulnerary	1	8	AE
			Direct ingestion	Internal	Carminative	1	1	AE
		Tender aerial part	Tisane	Internal	Postpartum coadjuvant	1	0	AE
Thymus serpyllum L. subsp. *chamaedrys* (Fries) Čelak+ (Lamiaceae, BCN 25019)	farigoleta, farigoleta de muntanya, serpó	Flowered aerial part	Tisane	Internal	Antidiarrhoeal	1	1	AT (0.02, 0.003)
Thymus serpyllum L. subsp. *nervosus* (Gay ex Willk.) Nyman* (Lamiaceae, BCN 25020)	farigoleta, farigola de muntanya, farigola de pastor, farigolet, xerpoll	Flowered aerial part	Tisane	Internal	Antidiarrhoeal	3	1	AT (0.05, 0.01)
Triticum aestivum L. (Poaceae, BCN 29963)	blat	Bran	Poultice	External	Diuretic	1	0	AE (0.006, 0.003)
Umbilicus rupestris (Salisb.) Dandy+ (Crassulaceae, BCN 25029)	barret de paret	Aerial part	Liniment (boiled with olive oil and *Allium sativum*, *Althaea officinalis*, *Bryonia cretica*, *Lilium pyrenaicum*, *Ruta chalepensis*, *Petroselinum crispum*, *Sedum* sp.)	External	To heal wounds	1	1	AT (0.05, 0.01)
			Direct application	External	To heal wounds	1	1	AT
			Tisane	Internal	Purgative	1	0	AT
Urginea maritima (L.) Baker (Liliaceae, BCN 58049)	ceba marina	Bulb	Maceration in oil	External	Insect repellent	2	0	MA (0.05, 0.007)
Urtica dioica L. (Urticaceae, BCN 29814)	ortigues	Aerial part	Direct application	External	Aphrodisiac	1	0	AE (0.006, 0.003)
Veratrum album L. (Liliaceae, BCN 25034)	veladre	Aerial part	Tisane	External	Antiparasitic (for mange in sheep)	1	0	AT (0.05, 0.01)
Verbascum sinuatum L. (Scrophulariaceae, BCN 29967)	trepó	Flower	Tisane	Internal	Antidiarrhoeal	1	1	AE (0.006, 0.003)
Vicia faba L. (Fabaceae, BCN 46826)	favera	Grain	Direct ingestion	Internal	For studs' fertility enhancement	1	0	AE (0.006, 0.003)
Vitis vinifera L. (Vitaceae, BCN 29972)	vinya, vi (product), vinagre (product)	Fruit juice	Vinegar	External	Anticatarrhal	1	1	AE (0.02, 0.02)
					Diuretic	1	0	AE
					Antiseptic	1	1	AE
					Tranquilizer	1	0	FO (0.14, 0.02)
			Medicinal wine	Internal	Restorative	1	0	MA (0.02, 0.02)
					Blue comb	1	0	FO

Table 2: General data on the territories studied, data concerning ethnoveterinary and related aspects, and ethnobotanical indexes.

	AE	AT	FO	MA	Total
General Data					
Extension (km^2)	1358	294	81.2	238	1971.2
Population	118718	4526	9147	31764	164155
Number of total informants	179	60	14	42	295
Number of informants with veterinary reports	46	41	4	13	104
Number of taxa in the flora of the territory	1650(1)	1600(2)	574(3)	780(4)	—
Total of livestock (includes cattle, sheep, goats, pigs, horses, and poultry)	2345153(5)	28088(6)	3229911(7)		5525414
Ethnoveterinary and other ethnobotanical data					
Number of taxa with veterinary uses	49	49	11	17	100
Number of species with veterinary uses	48	47	11	17	96
Number of veterinary use reports	106	146	16	28	306
Number of coincidental human and animal medicine use reports	33	104	4	16	157
Number of local Catalan names of plants with veterinary uses	55	70	11	18	154
Number of botanical families containing plants with veterinary uses	31	27	10	13	41
Number of veterinary reports/number of informants with veterinary reports	2.30	3.56	4.00	2.15	2.94
Number of animal feed taxa	73	21	14	16	—
Number of human medicinal taxa	334	220	92	117	—
Percentage of veterinary uses coincidental with human medicinal ones	30.1	52.2	38.5	50	42.9
Ethnobotanical indexes					
Ethnoveterinaricity index (EvI)	0.03	0.03	0.02	0.02	—
Informant consensus factor (F_{IC})	0.54	0.68	0.33	0.40	0.67
Average index of cultural importance (CI) calculated per area	0.01	0.05	0.10	0.04	0.04
Average index of cultural importance (CI) calculated for all studied areas	0.01	0.01	0.02	0.01	0.01

(1) [77]; (2) J. Vigo (pers. comm.); (3) [79]; (4) [80]; (5) [81]; (6) [81]; (7) Data for the whole Balearic archipelago [73].

antiophidian. In addition, another species of the same genus (*E. bourgatii*, not reported to date in veterinary) occupies the 13th position in the list also with the same use. These two taxa were not recorded (as another congeneric one, *E. foetidum*, was) in a comprehensive checklist of plants used against snake bite, containing 773 taxa [64], and only one reference to an undetermined *Eryngium* sp. is provided in a work on Turkish ethnoveterinary [65].

The families containing more taxa with claimed veterinary uses are Lamiaceae (10 taxa), Asteraceae (9), Apiaceae (6), Liliaceae (6), Pinaceae (6), and Crassulaceae (5). Some of them (Apiaceae, Asteraceae, Lamiaceae, Liliaceae) are at the same time large families and typically abundant in Mediterranean areas, and they are among the more represented families in most ethnobotanical works in this biogeographical region ([66] and references therein). Another one, Pinaceae, not so big in terms of number of taxa, is landscape dominating in significant parts of the studied areas. All these families but one (Crassulaceae) are among the top ten in the recent world inventory of veterinary ethnobotany [27]. Most of these families are coincidental with the main ones appearing in other studies in the Catalan linguistic area [31, 36], as well as in other Iberian [33–35] and other Mediterranean [18, 30] territories. In an area within Argentina, a great distance from those here studied, the cosmopolitan families Asteraceae and Lamiaceae are coincidental as some of the most reported ones, but others, such as Verbenaceae and Zygophyllaceae, make a difference [23]. Similarly, in a South African region Asteraceae also occupy a preeminent place, but not Lamiaceae, whereas Capparaceae and Euphorbiaceae are particularly relevant [19], contrarily to the currently considered area. More differential families may be recognized in a study performed in an Indian territory, where even the Asteraceae do not appear and the Lamiaceae are only represented by one report among results given for 17 families [17]. This predominance as more reported families of those large and with many representatives in the flora of the area considered agrees with the statement of Johns et al. [67] that the closer to the user a plant grows, the more it is employed. We could also verify this point in many works on folk plant uses in human medicine ([68] and references therein). Of course, the presence of well-known medicinal plants in all these particularly relevant families goes in the same sense. The Crassulaceae, located in position 23 in this catalogue and with only 39 taxa present in Catalan language territories (an area much larger than the one we cover) [54], constitute a particularity of the studied zone. One cultivated/subspontaneous and four wild taxa of four genera belonging to this family are profusely used (11 reports), mostly externally, for wounds and dermatologic affections, although the internal use of *Aeonium arboreum* on the island of Formentera (three reports) as a hens' egg calcifier (i.e., to add calcium and so to reinforce the eggshell) should be highlighted.

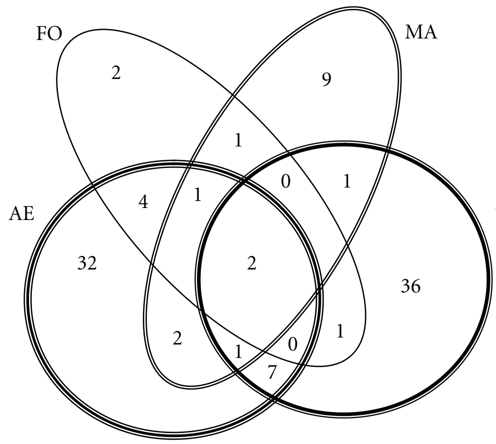

Figure 2: Venn's diagram showing the coincidences in plant species used in the four territories studied. See Figure 1 caption for abbreviations.

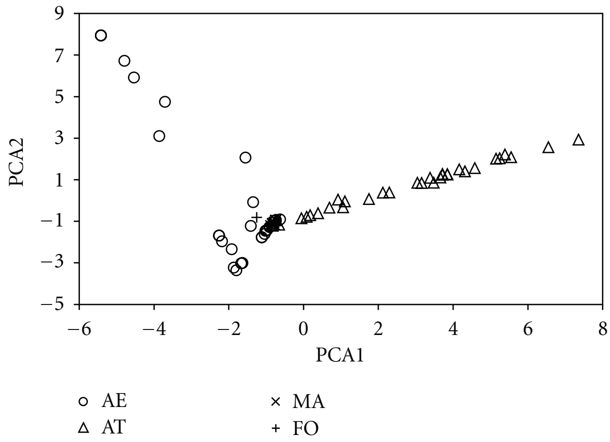

Figure 3: Principal component plot showing the similarities between use reports in the four studied territories. See Figure 1 caption for abbreviations.

3.1. Comparison among the Studied Territories. In this section, graphical information and descriptive statistics are presented in order to give a detailed interpretation of the comparison among prospected territories. On the one hand, and according to the 4-area Venn diagram of Figure 2, only two species (in the very centre of the graph) have been cited in all the territories; these are *Olea europaea* var. *europaea* and *Ruta chalepensis*. If we look, on the one hand, at the Venn diagram, we notice that the information from Alt Empordà and High River Ter Valley is nearly independent in itself, but Formentera shares almost all the uses and plant species reported (9 shared versus its total of 11). Meanwhile, Mallorca appears in the crossroad in between the three other areas, and nearly half of all the species cited by Mallorcans (9) are different from the species of the other places studied. Notwithstanding, there are 8 plant species cited in Mallorca uniformly distributed among the rest of the areas. No plant species coincidences were found among the groups AE-AT-FO and AT-MA-FO, probably because of the lesser data from Formentera included in the analysis.

On the other hand, if we look at the PCA plot (referring similarities between use reports (Figure 3)), we also find a convergence zone where several use reports from the four areas coincide. The condensation of Mallorcan data at this point could be explained due to the eight largely distributed species above mentioned, as well as the data from Formentera, which appear close to this area for sharing many of its taxa with the other regions. Moreover, the AE data spread distribution of the PCA plot, as opposed to AT, may be explained because many use reports are cited by a unique informant, so that the similarity line is upward deflected. In short, PCA plot reveals that, considering not only plant species but UR, islands have ethnobotanical similarities and there are shared UR citations with the four regions considered in the study.

One-way ANOVA and LSD test show statistically significant differences in the CI among four studied areas ($P < 0.05$) excepting for AT versus MA ($P > 0.05$). When MA and FO are grouped, no significant differences between these two Balearic Islands and AT were found ($P > 0.05$). Chi-square tests also show differences between observed and expected frequencies in all studied areas for the three variables included: part used ($\chi^2 = 199.34$ df $= 44$ $P < 0.0001$), pharmaceutical form ($\chi^2 = 211.96$ df $= 48$ $P < 0.0001$), and veterinary uses ($\chi^2 = 338.77$ df $= 118$ $P < 0.0001$).

The comparison of ethnoveterinary data from the four areas leads us to consider that the common heritage of plant uses (and specifically for veterinary treatments in the present work) throughout the Catalan-speaking territories is nuanced by local features. It has to be emphasized that this is the first cross-regional ethnobotanical comparison made up with Catalan data. Similarly to other comparative studies using coordinated methodology and dealing with ethnobotanical data [18, 68, 69], it is very difficult to assure that there is a standard traditional veterinary knowledge among the four areas without contemplating floristic, bioclimatic and sociohistorical aspects.

3.2. Comparison with Previous Reports and Novelty in Uses in the Regions Studied. A certain number of plant species and plant uses are new or very scarcely previously reported in ethnoveterinary. We have first compared our results with a recent world catalogue of plants used in this field [27], built with information from 222 publications and including data on 451 taxa at specific or subspecific levels, 308 genera and 116 families. From this comparison, we found that 42 species and one subspecies, 17 genera and five families do not appear in this inventory and must thus be considered new or very scarcely reported as useful in veterinary. In addition, 27 taxa are also not very commonly used in veterinary, since they were reported only once in the world inventory, 17 of them with data coming from a previous work of our team in Montseny [31], an area belonging to the same cultural community of the currently considered zones. These new or rarely recorded taxa have been crossed with a review of plants used in ethnoveterinary in Italy ([30], not quoted in

[27]), containing information on 280 species or infraspecific taxa belonging to 71 families. In this review, eight species, six genera, and two families not listed in [27] appeared, as well as six of the species cited only once. Thus, the novelties contributed in the present paper are 34 species and one subspecies, 11 genera, and three families, plus 21 species only mentioned once. Irrespective of the wide reach of the two reviews considered, it is sure that the amount of new taxa could be reduced with a still more comprehensive literature cross (e.g., four plants reported in this study and only previously cited once in veterinary according to the above-mentioned sources have been very recently mentioned in Andalusia [34], and one, *Meum athamanticum*, not appearing in any of the checklists mentioned was already reported by Font Quer in 1961 [70]). Nonetheless, we believe that in any case the number of taxa of different taxonomic level not, or very rarely, previously reported as used in veterinary is significant. The comparatively small amount of work on ethnoveterinary in Europe could contribute to explain this high level of new information.

3.3. Parts of Plant Used, Preparation and Administration Forms, and Plant Use Categories. A summary of the top ten used plant parts, preparation and administration forms, is graphically represented in Figure 4. This figure also includes the ten most cited veterinary use categories, which are compared to human medical indications in Section 3.5. The plant parts most commonly used for veterinary remedies preparation, concerning the general overview of the four areas, are aerial parts (leaves and stems; 71 reports), flowered aerial parts (44 reports), fruits (26 reports), roots (25 reports), and leaves (19 reports). However, it is outstanding that only aerial parts and leaves are represented in the four areas, meaning that leaves (alone, or together with the stems in which they are inserted) are the most popular organ in terms of geographical extension. These numbers do not differ much from other ethnoveterinary studies [31, 33–35] neither do they from human ethnopharmacological works for the same areas [66, 71, 72], where aerial parts and leaves are at the top of list of plant part analysis. The percentage of internal administration form (54.03%) is not much higher than the external (45.97%), but still tisanes are the preferred preparation method (with 86 reports) for animal traditional therapies. Tisanes are not difficult to prepare but, after tisane, we count the direct ingestion (34 reports) and direct application (31 reports), which are even easier ways to treat animals (most of them are grass-eating domestic animals). With particular regard to excipients—apart from water—olive oil has to be counted as the most important in the four areas. The use of olive oil ointments for external administration appears in a fourth place in the preparation classification, and it is especially formulated as vulnerary, cicatrizing, and against dermatologic ailments.

The most cited veterinary use category as an absolute value for all the territories altogether is the postpartum coadjuvant. However, this is not a significant set since there are 42 reports out of 46 that have been collected for the AT area. For the whole area prospection, the most representative veterinary indication is the antidiarrhoeal. Indeed, plants aimed to treat gastrointestinal disorders are frequently on the top of the latest ethnoveterinary usage lists [23, 34, 35]. Top veterinary uses concerning every study territory separately are diverse enough: vulnerary for AE, postpartum coadjuvant for AT, egg calcifier for FO, and insect repellent for MA. The reason of these differences may lie on the type of livestock treated; for example, results from Mallorca have a socioeconomic bias on sheep treatment since these animals have historically been the first islander meat resource, well ahead of the pig [73]. The treatment of sheep against fly larvae explains that many plant citations have been made for insect repellent.

3.4. Quantitative Ethnobotany: Indices Assessing the Importance, Persistence, and Reliability of Veterinary Plant Uses in the Regions Studied. The ethnoveterinaricity index (EvI), which we have defined here adapting the classical ethnobotanicity index to include only use reports of plants concerning animal health, is low in all the studied areas. It oscillates between 0.02 and 0.03, this meaning that only around 2-3% of plants present in these territories are claimed to be useful in veterinary. General ethnobotanicity indices or indices referring to all medicinal plant uses in Mediterranean territories oscillate between 0.05 and 0.51, the average value for 21 territories being 0.22 [66]. The percentage of plants used in veterinary is, logically and in all cases, lower than general ethnobotanicity indices. In the present case, it is also lower than in the two previous reports on Catalan ethnoveterinary (0.06 in Montseny [31] and 0.13 in Pallars [36]), but similar to that recorded in another Iberian area (0.02 in Navarra [33]).

The mean informant consensus factor (F_{IC}) considering the four areas studied is 0.67, and it ranges from 0.33 to 0.68, being bigger in the two Catalonian areas (AE 0.54, AT 0.68) than in the Balearic ones (FO 0.33, MA 0.40). This index, with the maximum value of 1, shows the consistency of uses among the informants of a given territory, and thus it is one of the indicators of reliability for such uses. The values of the Catalonian areas are close to that from Montseny, 0.66 [31]. In general, F_{IC} values for ethnoveterinary are clearly lower than those of works on human medicinal uses in the same territories (AE 0.91, AT 0.87, MA 0.71, FO 0.73) ([66, 71, 74], Mayans, Carrió, and Vallès, unpubl. res.). This suggests a preeminence of human medicine over veterinary, at least in current times, in the society prospected: veterinary uses are less homogeneous and consistent that human medical ones, since they are in fact perceived nowadays as less relevant, less necessary. In any case, it is interesting to remark that the ethnoveterinary F_{IC}s are proportional to the general (for all medicinal plant uses) ones in each territory, confirming the above-described fact. Most works on ethnobotany of veterinarian plants do not mention F_{IC} values. The ones reported for eight zones of Navarra (Western Pyrenees, Spain) range from 0 (in the main cities areas) to 0.63, the mean being of 0.37 [33]. These values are slightly lower, but similar to those recorded in the present paper; in Navarra, the F_{IC} for general medical ethnobotany is also higher than

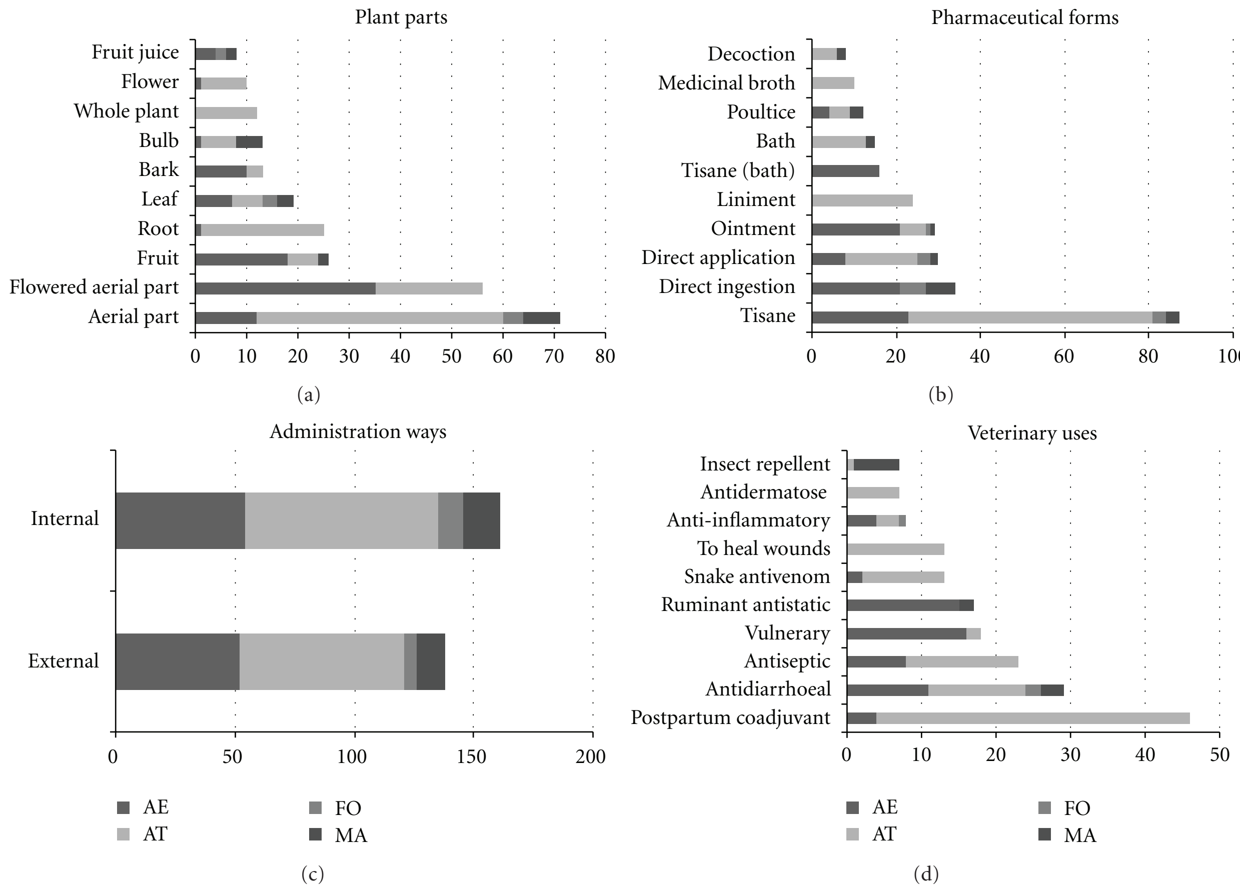

Figure 4: Summary of the top ten used plant parts, preparation and administration forms, and of the top ten veterinary uses in the four territories studied. See Figure 1 caption for abbreviations. The figures in the graphics mean number of use reports.

the veterinary one (0.65 [75]). Finally, it is worth mentioning that F_{IC} of the whole territory studied (0.67) are lower but not very far from those for human medicinal uses in some Mexican and Indian regions (0.75, 0.79 [76–78]). The latter were recorded in countries where folk medicinal plant knowledge is considered relevant and currently in use. To summarize, there is not a very pronounced agreement in ethnoveterinary plant uses, but neither it is extremely low, when taking into account the indicative figures from other territories and the current relevance of domestic animals along with the modern way to address their health troubles.

Another way to assess the relevance of folk plant uses is the recently described cultural importance index (CI, [59]). The global values of this index are low in the areas prospected (Table 1), ranging from 0.01 to 0.02. This is not surprising taking into account that in each territory, and in all of them together, the number of plants claimed as useful is high, and for many of them a scarce number of reports has been collected. In addition, even the interviewees who did not report any veterinary use are counted. The CI ranges per area, also calculated on the basis of all informants, not only those having provided veterinarian information, are slightly or clearly—depending on the cases—higher: 0.06–0.08 (AE), 0.02–0.27 (AT), 0.07–0.21 (FO), and 0.02–0.07 (MA). Just to give an example of the different CI values in a veterinary and in a human medicinal ethnobotanical survey, *Santolina chamaecyparissus* in MA has 0.07 for ethnoveterinary and 0.81 for human pharmaceutical ethnobotany [74], this indicating the much higher number of informants that report medical uses as opposed to those claiming veterinary ones. This index was rather designed to highlight the most relevant plants used for a specific purpose in a particular cultural area; this is why the most reported plants bear the larger indices. This index assesses the relevance of a plant in a culture. Here culture can be understood either in its broad sense (in our case, the Catalan one, common to all studied areas) or in its restricted sense, distinguishing in the present case high mountain (AT), medium mountain and plain (AE) and insular (FO, MA) cultures. All these cultures in a more restricted sense are shaped on the one hand by belonging to a linguistic community and on the other hand by geographical and socioeconomic conditions: as stated above (Section 3.1); the common base is modelled by and diversified with local specificities. The top ten plants regarding report number, quoted in the first paragraphs Section 3, have, logically, the highest CIs in the whole area studied, but some plants not present in this list bear the highest CIs in particular territories, such as *Aeonium arboreum* (FO), *Allium sativum*, and *Santolina chamaecyparissus* (MA). The description of this index is recent, and so very few papers include it in their analyses. Nevertheless, an ethnoveterinary study of an Iberian area, Arribes del Duero (Salamanca, Western Spain), also shows a high number of low CIs (with a minimum value of 0.04), but at the same time some very high, four of them higher than 1.

3.5. Comparison between Veterinarian and Human Medicinal Plant Uses. Table 1 shows the agreements between veterinary and human medicinal plant uses in the areas studied, meaning the strict coincidence not only of the plant employed but of its claimed properties as well. The number of total human and veterinary medicine uses is presented in Table 2. There are of course many more human medicinal uses different from those addressed to animal health ([66, 71, 74], Mayans, Carrió, and Vallès, unpubl. res.), but we have highlighted here only the uses that are common to both people and animals.

Table 2 shows that the number of plants reported to be useful in veterinary medicine is dramatically low as compared with that of those indicated to be used in human medicine in the same territories (15.3% in AE, 21.8% in AT, 12% in FO, 14.5% in MA). Yet the proportion of informants who reported veterinary uses is low, also in every area prospected (absolute figures in Table 2; 25.7% in AE, 68.3% in AT, 28.6% in FO, 31% in MA). Facing this situation, the question arises as to whether it could be the consequence of a bias in data recording. It is true that when talking about medicinal plants (one of the main focuses in our ethnobotanical interviews), it is implicitly clear for both interviewers and interviewees that human medicinal uses have to be addressed, whereas the reference to veterinary uses is not so evident. So, we must admit a slight weight of this factor in this difference between human and animal medicinal plant use reports. Nevertheless, in many cases in which the point of ethnoveterinary uses is explicitly present in the conversations, this does not significantly increase the information on animal health care. In addition, the number of veterinary plants recorded in the areas prospected is not lower than those published for other studies in the same biogeographical region [18, 31, 33–36]. Moreover, 68.3% of AT informants provided ethnoveterinary data as compared with 25.7% in AE, but the increase of information only represented 6.5%. We believe that the decline in human dependence on domestic animals in so-called western societies explains basically the unbalance between both kinds of medicinal plant uses. In this sense, it is interesting to remark that AT (the territory studied with a larger proportion of informants supplying ethnoveterinary information and of veterinary uses recorded) is a high mountain area in which domestic animals still play a significant role, at least more than in the other places.

In any case, the 306 veterinary use reports of 101 taxa in the four areas considered constitute a large therapeutic corpus, with a not insignificant part in agreement with human medicinal uses also claimed by the informants. The proportion of coincidental human and animal plant-use categories in all the studied areas is 42.9%, ranging from 30.1% to 52.2% in the different territories (Table 2). In terms of number of reports of the same use of a plant in human and animal health, the figures are also high (Table 2), representing a 52.7% of agreement when all areas are considered together, and being of 31.1% in AE, 69.8% in AT, 25% in FO, and 59.3% in MA. Again, AT is the territory with the highest coincidence in use categories and reports, this indicating a still important degree of validity of veterinary practices in this area since the more animal health care uses persist, the more they may coincide with those for human health troubles, in general more operative and easily recalled.

In most cases, the plants for which human medicine reports are coincidental with veterinary ones are among the most commonly used to address people's ailments. As an example, in MA, four of the plants so considered (*Allium sativum*, *Citrus limon*, *Herniaria hirsuta*, and *Santolina chamaecyparissus*) appear in the list of the top five medicinal species in the area. In these cases plant preparations for animals are often similar to those for humans [74], showing on the one hand how important animals were in times gone by and on the other hand the proximity of veterinary and human medicine and so the relevance of ethnoveterinary data as evidences for phytotherapy in general. In AE the panorama is similar (present data and [66]) to one of the top species (*Allium sativum*) coincidental with MA.

Two use categories in which there is a convergence of veterinary and human medical uses are gastrointestinal and skin troubles. On the one hand, digestive, antidiarrhoeal, gastrointestinal antialgic and anti-inflammatory are uses corresponding to usually nonsevere chronic illnesses very often treated with folk phytotherapeutic remedies ([34, 66] and references therein). On the other hand, skin affections may also be nonsevere troubles (such as warts) and have a particular incidence in rural societies, in people dealing with agricultural and livestock-raising activities (wounds and some kinds of skin infections), this kind of affection being almost as common in humans as in the animals they take care of. Conversely, a use category that was once shared by people and domestic animals, labour and postlabour coadjuvant, is now almost exclusively restricted to animals, basically cows. The explanation is evident: the medical assistance in labour has increased dramatically more in human beings than in livestock, apart from the fact that many labour coadjuvants may have abortive effects if used in a nonadequate manner or period of time, and there is a higher vigilance of this aspect in people than in domestic animals.

3.6. Concluding Remarks. Our research in four European areas has verified that, as Mathias et al. [3] wrote, ethnoveterinary practices constitute viable alternatives or complements to conventional, Western-style veterinary medicine. The collection of information on ethnobotanical uses of plants in veterinary medicine, as done in the present work, is the first step of the process that can permit the passage from folk, often small-scale, uses to industrial or at least medium-scale applications. It is undoubtedly one of the beneficial and appropriate ethnoveterinary interventions that, in words of Wanzala et al. [1], represent a major challenge in the development of this discipline in the 21st century. Muhammad et al. [16] stated that these data provide a basis for further validation of practices and plant uses in the context of a professional approach to ethnoveterinary medicine. Additionally, we stress that recording these data is already in itself a part of this validation, since it provides scientific evidence of plant uses, after which, chemical, pharmacological, and other issues should be addressed. Some examples of legislation and herbal products development in western Europe [82] make us believe that further ethnobotanical studies in the field of veterinary are needed, followed by a coordination with different stakeholders (livestock raisers, veterinary surgeons, chemists, health policy managers and deciders, pharmaceutical firms, among others) in order to integrate ethnoveterinary knowledge—as we have seen, closely related to human ethnomedicinal one—in health policies.

As for all domains of ethnobiology, the inventory of ethnoveterinary practices is urgent, mostly in industrialised countries. Concerning specifically animal health care, in relatively few years we have passed, at least in southwestern Europe, from a lifestyle in which, according to a popular saying, the illness of the mule was considered worse for a rural family than a trouble in a member of the family to a situation of almost no dependence on domestic animals and from the practical absence of veterinary doctors and industrial medicines to the inverse situation even in the smaller population nuclei. The popular saying regarding the mule, obviously an exaggeration, can still be heard amongst elderly people in the regions prospected, but today the situation is different. Thus, a certain amount of ethnoveterinary knowledge in the areas described is no longer in practice and must be collected—not only as a cultural and biological heritage, but also as possible sources for new drugs for animals and humans—before it is too late.

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Research Article

Comparative Medical Ethnobotany of the Senegalese Community Living in Turin (Northwestern Italy) and in Adeane (Southern Senegal)

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A medico-ethnobotanical survey was conducted among the Senegalese migrant communities of Turin (Piedmont, NW Italy) and their peers living in Adeane (Casamance, Southern Senegal), both among healers and laypeople. Through 27 in-depth interviews, 71 medicinal plant taxa were recorded and identified in Adeane and 41 in Turin, for a total of 315 different folk remedies recorded in Senegal and 62 in Turin. The large majority of the medicinal plants recorded among Senegalese migrants in Turin were also used in their country of origin. These findings demonstrate the resilience of home remedies among migrants and consequently the role they should have in shaping public health policies devoted to migrant groups in Western Countries, which seek to seriously take into account culturally sensitive approaches, that is, emic health-seeking strategies.

1. Introduction

In the last decade, the ethnobotany of migrant populations, especially in Western countries, has become the focus of a number of studies, which have investigated the trajectories of change of Traditional Medicines (TMs) and especially Traditional Knowledge (TK) concerning medicinal plants. Moreover, such studies have made progress in gaining a better understanding of newcomers' health-seeking strategies. These data are crucial in the implementation of culturally sensitive approaches in public health and nutritional policies in the host countries and/or to improve phytopharmacovigilance [1–5].

In particular, in Europe, the ethnobotanical knowledge of various migrant groups has been studied in different (mainly urban) contexts: Turkish and Russian migrants in Germany [6, 7]; Thai women in Sweden [8]; Surinamese migrants in The Netherlands [9, 10]; South-Asians [11–14] and Andeans in England [15–17]. From these previous studies, three key findings have emerged so far.

(i) Newcomers' TK and related domestic practices may show various degrees of resilience (i.e., the attitude to recover from the changes, which originate from the displacement).

(ii) The resilience is highly dependent on practical circumstances (distance between the home and the host countries, corresponding to possibilities of frequent travel), but also on complex cultural exchanges ongoing between the diasporas and the autochthonous and/or other migrant populations. For example, factors such as (1) the occurrence of relevant transnational social and trade networks between the migrants and their home country, (2) the availability of traditional practitioners and/or herbs and food plant items in food shops in the host country, (3) identity-bound perceptions in relation to specific botanicals (which may be considered culturally important), (4) laws in place in the host countries allowing or tolerating the occurrence of non-autochthonous food/medicinal plants, and (5) multicultural approaches in the institutionalised public health frameworks of the host country, all play crucial roles in determining the resilience and sustainability of these TM practices in the migrants' host country.

(iii) The aforementioned cultural negotiations that impact TK resilience are rapidly changing on both temporal and spatial scales, and even the "representation" of plants and remedies related to "traditions" is in a state of flux among generations over time.

In Italy, no ethnobotanical study has addressed these specific issues thus far, despite the fact that the country has faced tremendous changes in its social structure over the last two decades. In fact, these changes are due in large part to the arrival of a significant number of young and middle-aged migrants from Africa and especially Eastern Europe (most notably, Romanians and Albanians). Nowadays, it is estimated that five million migrants live in Italy, with an increase of three million in the last ten years [18]. The large majority of migrants live in the Central-Northern regions of the country; one-fifth of which are Romanians, followed by Albanians and Moroccans. The Senegalese are quantitatively the 17th largest migrant community in Italy, but they represent the biggest "black" African community in the country, encompassing approximately 73,000 members. Moreover, this community is also historically one of the most important migrant groups in Italy, as it formed a significant presence already in the 1980's [18].

Recent sociological studies have pointed out the existence of a Senegalese transmigrant movement made of people who are regular "comers and goers" between Africa and Europe and that their perception of a successful return is still associated—in contrast with other African communities—with permanent return to their homeland. This final aim is, however, generally compromised with aspirations of economic advancement and family obligations [19, 20]. Most of the earnings of Senegalese migrants are used for investment in housing in their home country, significantly altering the landscape of local cities [21].

Despite the fact that a study has well demonstrated the link between depression and rapid changes in the social organisation among Senegalese migrants [22], a fair public debate on culturally sensitive approaches in transcultural health policies is still lacking in Italy. This could be due to the state of political discourse in Italy, which has been highly influenced over the last years by instances of xenophobia, and which has subsequently affected several political actors and policy makers [23–27].

The aims of this study were to record uses of natural remedies (including food preparations perceived as "healthy") among the Senegalese community of Turin (Northern Italy) and in their country of origin, to compare these two ethnobotanies and to consequently formulate considerations on how TK changed or is changing following displacement of Senegalese citizens.

2. Material and Methods

2.1. The Study Area and Fieldwork

2.1.1. Turin, Italy. Turin (approx. 900,000 inhabitants, Piedmont, NW Italy, Figure 1) hosts an important Senegalese migrant community counting approx. 1,200 members (2004) [28]. The most significant influx of Senegalese in Turin only began at the end of 1980s. At that time, young males migrated to Italy from various areas of the Senegalese countryside and especially from those areas which were badly affected by the great drought of the 1970s. Traditionally, families gave their fourth or fifth child away to the Islamic brotherhood of believers for instruction in the faith and to work for the order, mainly engaging in agricultural activities. With the advance of desertification, however, the practice of agriculture was increasingly difficult and, as a consequence, the order allowed young people to move abroad to work in industry and services [28].

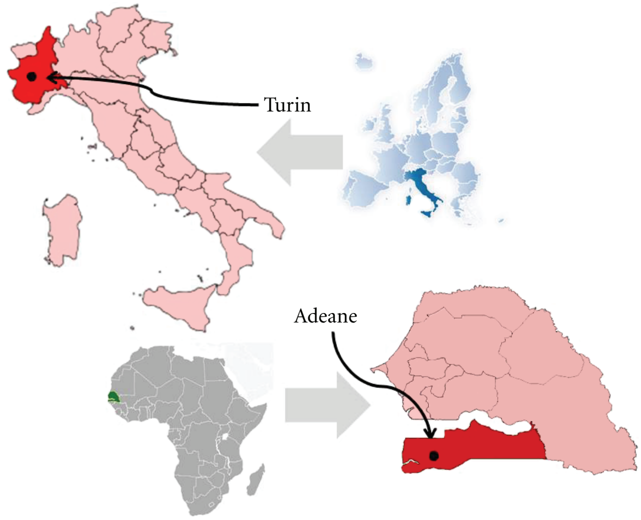

Figure 1: Location of the study sites.

It was therefore a progressive flow, and not a mass migration, that characterized the Senegalese emigration to Italy. As often happens, the journey for many has been fragmented at various stages due to issues such as the search of a visa or other means of entry into the country. However, in Turin, the first arrivals had no intention of staying, since their aim was to work hard for a few years and return the home country. With time, however, things have changed, resulting in more stable settlements in the Italian landscape [28].

2.1.2. Adeane, Senegal. Adeane is a town of 9,000 inhabitants, located an hour's drive from Ziguinchor, the largest urban centre in the region of Casamance, Southern Senegal (Figure 1). The climate in Casamance is the most humid of the country and subtropical forests prevail in the landscape. The abundance of rain in the Casamance permits the cultivation of a wide variety of crops.

The Casamance is inhabited mainly by the Jola ethnic group (Diola, in the French transliteration), which constitute approximately 60% of the population. Those of the Wolof ethnic group, which represent the ethnic majority in Senegal, constitute only 5% in the Casamance region. The largest portion of the Casamance inhabitants identifies their religious beliefs with Islam, while 17% are Catholics. This isolation has determined a strong regional identity and thus the culture of its people as well as its environmental heritage has been well preserved for a long time. The regional economy is based in part on tourism, especially along the coast and on the sale of crops like rice, peanuts, and millet.

2.1.3. The Fieldwork. Fieldwork was conducted over a period of one month (November 2010) in Turin and over a period of a second month (December 2010) in Adeane (Casamance, Southern Senegal). Turin was selected as a field site because it is the home of a vibrant Senegalese community, while the area of Casamance in Senegal was chosen because it is considered the most biological and cultural diverse region of the country, as well as the most conservative in terms of folk practices.

Participants in Turin were selected using snowball techniques among the first generation of Senegalese migrants ($n = 8$, all males), while in Casamance the same technique was used to select "laypeople" ($n = 15, 7$ females and 8 males). Additionally, in Adeane 4 healers (3 males and 1 female) were also interviewed. Prior Informed Consent (PIC) was obtained verbally before commencing each interview. Ethical guidelines followed the International Society of Ethnobiology Code of Ethics [29].

Questions concerning the use of medicinal and/or food plants were asked via a previous free listing of pathologies and related use of "home remedies." For each named item, the field researcher (RE) asked for exact details of how the home medicine/food was prepared and its folk medical/food use. Interviews were conducted in Italian in Turin and in French in Casamance.

In Casamance, the named plant items were collected, when available, photographed, dried, identified by a local plant taxonomist (Professor Amadou Tidiane, Department of Agricultural Studies, University of Ziguinchor, Senegal) and via the West African plants photo database [30], and deposited at the Herbarium of the University of Gastronomic Sciences, Pollenzo, Italy. The nomenclature follows IPNI [31], with family assignments following the current Angiosperm Phylogeny Group III recommendations [32, 33].

2.2. Data Analysis. The ethnobotanical data collected from Turin and Adeane were compared with each other. Moreover, the ethnobotanical data were compared with the preexisting literature on Senegalese TM and the traditional pharmacopoeia of Senegal [34–36].

3. Results and Discussion

3.1. The Medical Ethnobotany of the Senegalese Migrants in Turin. Table 1 reports all medicinal plants quoted by the Senegalese migrants in Turin. In total, 47 folk taxa were recorded as medicinally used in Turin; 41 of these have been botanically identified. Of these remedies, only a few (eight) could be considered food medicines, thus contradicting what previous studies among migrants medical ethnobotanies have found [6, 13, 17]. This may be due to the fact that regular provision of African vegetables and other fresh food ingredients is scarce in Turin, where generally only dried spices and medicinal plants are imported. Another explanation may be that the Senegalese migrant community in Turin is mainly represented by males, who—in contrast to women—are not holders of culinary knowledge and therefore they do not generally have experience in managing healthcare via the diet within the domestic domain.

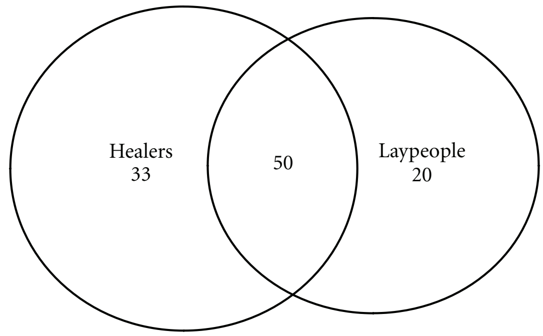

Figure 2: Overlap between the folk medicinal taxa quoted by healers and laypeople in Adeane.

All remedies quoted in Turin are generally bought in small ethnic food shops and mini-supermarkets located in city centre and managed by African and/or Chinese migrant entrepreneurs. A few of the most quoted taxa (*Acacia, Adansonia, Guiera, Hibiscus*) are well-known African medicinal plants, which are however lacking in the Western TM pharmacopoeia.

3.2. The Medical Ethnobotany of Adeane in Senegal. Table 2 reports all medicinal plants quoted in Adeane. In total, 71 species, representing 31 botanical families, were recorded as components to TMs in Adeane. However, although the large majority of recorded medicinal taxa were found in the reviews of the Senegalese TM [34–36], only a minority (<40%) of the actual medicinal plant uses are reported in the considered literature. This confirms the highly dynamic character of the home medicines in rural Africa and highlights the urgent need for inventorying folk plant uses beyond those that are cited in the "standardized" TM reviews.

Documentation and evaluation of these home remedies are very important, since they represent a means of primary healthcare for most. Figure 2 illustrates the overlaps between the plants quoted in Casamance by healers and laypeople. Laypeople's knowledge of medical plants is quite remarkable and confirms that the actual practice of household phytotherapy in Africa is much broader of what we sometimes label as "Traditional Medicine," which is generally restricted to the knowledge, practices, and beliefs of healers. Moreover, despite living in the same village, while healers and laypeople use in large part the same medicinal plants (Figure 2), the actual plant reports (plant-based preparations used for a given health problem) are highly divergent (Figure 3). These findings confirm a remarkable "internal" variability of the African medical ethnobotanies, as a recent study in rural Mozambique also pointed out [37].

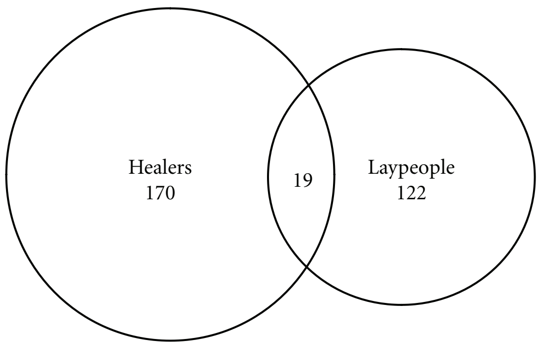

Figure 3: Overlap between the medicinal plant reports quoted by healers and laypeople in Adeane (a single medicinal plant report is defined as "*a given taxon x, prepared as y, used for z*").

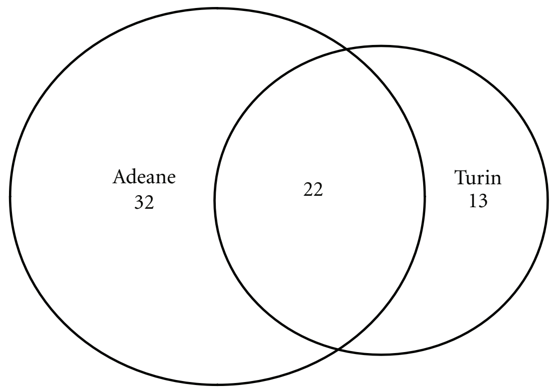

Figure 4: Overlap between the botanical genera quoted as medicinally used in Turin and Adeane (by laypeople).

3.3. Comparison between the Senegalese Medical Ethnobotanies of Turin and Adeane. A comparison between the laypeople's medical ethnobotany in Turin and Adeane demonstrates that Senegalese in Senegal use more plants than Senegalese in Turin (Figure 4). This may be due to an objective difficulty to acquire all African plants used in country of origin in the new cultural environment in Italy and also to an adaptation process. Migrants moved in fact from their original rural areas in Senegal (where the use of herbal TMs is widespread) to urban environments in Europe, where practices of use of medicinal plants are only available within the context of Western modern herbalism and phytotherapy: Senegalese TM practitioners seem in fact not to be present in Turin. Moreover, migrants from Senegal in Turin also generally rely on Western pharmaceuticals.

However, the large majority of the medicinal botanical genera recorded in Turin are also used in the country of origin, thus confirming some resilience of original practices following displacement into another landscape. The fact that a few other genera (twelve) have been quoted instead by migrants in Turin, but not in Adeane, could possibly be explained in two ways.

(i) Senegalese migrants living in Turin did not all come from the southern part of Senegal. For instance, a few of them may have brought plant uses to Turin that are unknown in the folk medicine of Southern Senegal.

(ii) A few genera recorded quoted in Turin (i.e., *Hibiscus*, *Zingiber*) may represent the result of cross-cultural exchanges of TMs with other migrant populations in Turin, especially with the North African migrants, who also share the same religion, and with members of the Chinese migrant community who own ethnic food markets in Turin.

Out of this comparative study, a few plant families have emerged as being integral to the TM practices of the Senegalese study participants both in Turin and Adeane. In particular, a great variety of Fabaceae species were quoted as having medicinal applications in Turin (7 species) and Adeane (15 species). The second and third most represented botanical families amongst the Turin participants were Combretaceae and Malvaceae, with 5 and 3 species quoted, respectfully. In Adeane, however, Malvaceae was the second most quoted family (5 species), followed by Apocynaceae and Solanaceae (4 species each), and then Combretaceae, Myrtaceae, Euphorbiaceae, and Meliaceae, represented by 3 species each.

Interestingly, despite the presence of a thriving Senegalese community in the north Italian landscape for more than 30 years, relatively few Italian medicinal plants appear to have been incorporated into the TM practices of this group. Take, for example, the notable lack of incorporation of several European mints (Lamiaceae) in the TM practices of the Senegalese in Turin. Various Lamiaceae species, such as mint, basil, peppermint, rosemary, thyme, horehound, and oregano, grow in the wild and/or are cultivated in the Italian countryside and the use of such species for medicinal purposes dates back to more than 2,000 years ago in this region, as evidenced by their presence in the ancient textbooks of the Mediterranean *Materia Medica* [38]. Moreover, the important use of Lamiaceae species as medicinal plants is crucial also in the medico-ethnobotanical literature of Piedmont ([39] and references therein). The conspicuous absence of Lamiaceae uses in the Senegalese migrant community is maybe reflective of their isolation from the Italian environmental and medical landscape, which may have been further enhanced by the characteristic male composition of the Senegalese community in Italy.

4. Conclusion

Our study illustrates that the herbal medicines used by the Senegalese in Turin are very different from those of the Italian herbal landscape and that the migrant population in Turin is instead reliant on the undependable trade and movement of plant materials from their homeland to ethnic markets in the city. This shows maybe a scarce integration of this African community into the host society.

Moreover, the access and availability of important original medicines, especially medicinal foods, are greatly diminished in Turin, creating a significant disruption in their TM system. This may also have been influenced by the general lack of female Senegalese migrants, who would typically be

Table 1: Medicinal plant remedies used by Senegalese migrants in Turin.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Qs
Adansonia digitata L. (Bombacaceae)	Baobob	Seed	Eaten	Diarrhoea	+
Acacia nilotica (L.) Willd. ex Delile (Fabaceae) UNISGSEN15	Mbano (m) Nep nep (w)	Seed	Grind the seeds and put the powder on the lips	Burning lips	+++
			Grind the seeds and put the powder on the painful tooth	Toothache	
		Root	Make a decoction and drink just a little bit	Indigestion	
			Externally applied	Wounds	
		Bark	Drink the beverage together with *Tamarindus indica* fruit pulp and *Hibiscus sabdariffa* flowers	Fatigue	
Acacia tortilis (Forssk.) Hayne (Fabaceae) UNISGSEN05	Senjen (w)	Root	Grind it, add salt, and put it on the haematoma	Haematoma	+++
			Drink the decoction	Eye inflammations Bellyache	
			Drink the decoction while eating some sugar, repeating the procedure three times a day	Worms	
			Macerated in water for two days; the macerate drunk	Sexual impotence Stomachache Kidney troubles	
Adansonia digitata L. (Malvaceae) UNISGSEN20	Buy (w) Baobab (f)	Fruit	Drink the beverage made using the pulp around the seeds	Diarrhoea	+++
			Same as above, adding *Hibiscus sabdariffa* flower	Diarrhoea	
Allium cepa L. (Amaryllidaceae)	Cibolle	Bulb	Eaten	Sexual impotence Cold	+
Allium sativum L. (Amaryllidaceae)	Ail (f) Ladji (w)	Bulb	Put a piece of garlic on the right wrist if the sore tooth is in the upper jaw and vice versa for the lower jaw (chanting Koran's verses helps the pain to disappear)	Toothache Sexual impotence	+++
			Eaten	Intestinal worms Lowering the blood pressure Cold and cold prevention	

Table 1: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Qs
Anacardium occidentale L. (Anacardiaceae)	Anacardo	Seed	Drunk	Antibiotic	+
Annona senegalensis Pers. (Annonaceae)	Suncun	Leaf	Put (powdered) on the fire	Magic remedy (supposed to counteract bad spirits)	+
Arachis hypogaea L. (Fabaceae) UNISGSEN16	Arachide (f) Gerte (w)	Seed	Eat the seeds	Stomachache	+
Balanites aegyptiaca (L.) Delile (Zygophyllaceae)	Dattier du désert (f) Soumpu Gurp Petit cola	Leaf	Grind the leaves and drink the infusion prepared with the powdered leaves	Sore throat	+++
		Fruit	Chew the fruit without ingesting it	Stomachache Digestive Fatigue Nausea	
Calotropis procera (Aiton) W.T. Aiton (Apocynaceae) UNISGSEN55	Kipampaan (p) Poftan (m) Pomme de Sodome (f)	Root	Cut the roots into small pieces, put it into a cotton handkerchief, squeeze, it and inhale the aroma	Sinusitis	+
		Stems juice	Externally applied	Wounds	
Cassia italica (Mill) Sprengel (Fabaceae)	Layduur (w)	Leaf	Drink the infusion prepared with ground leaves	Constipation	+++
			Drink the infusion prepared with ground leaves	Intoxication	
		Root	Leave the root soaking all night and drink the water in the morning, before breakfast	Intestinal worms	
Cassia occidentalis L. (Fabaceae) UNISGSEN11	Adiana (w) Bantaare (p) Bentamarè (s) Kassala (m) Mbanta xobi (w)	Leaf	Put leaves around the head	Headache	+
			Baths	Fatigue	
Cassia tora L. (Fabaceae) UNISGSEN76	Cassepuante (f) Ndur (w)	Leaf	Use it as a mouthwash	Mouth infections	+
Ceratotheca sesamoides Endl. (Pedaliaceae)	Jorokh lane (w)	Leaf	Put the leaf into water at room temperature and after it releases oil, apply the oil to the body	High fever	+
			Dried leaf is soaked in water; the water is drunk	Bellyache	
Citrus limon (L.) Osbeck. (Rutaceae)	Citron (f) Limon (w)	Fruit	Drink the juice	To lose weight Digestive Strengthening Malaria (drunk in the coffee)	++

Table 1: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/ to regulate)	Qs
Combretum aculeatum Vent. (Combretaceae)	Sawat (w)	Leaf	Put ground leaves and sugar into water and instil the solution in the eyes	White spot in the eye on the pupil	+
Combretum glutinosum Perr. ex DC. (Combretaceae)	Chigommier (f) Rat (w)	Leaf	Drink the decoction	Bronchitis/cough Sexual impotence	+
Combretum micranthum G. Don (Combretaceae) UNISGSEN10	Quinkeliba (f) Sekhaw (w)	Leaf	Drink the decoction (sometimes adding cloves)	Cold Flue Lung infections Sore throat Antihypertensive	+++
		Flower	Drink the decoction with milk every morning	Enhancing the "well-being"	
			Make a decoction with *Xylopia aethiopica* seeds and cloves (*Eugenia caryophillata* flower buds)	Vision problems	
Dioscorea spp. (Dioscoreaceae) UNISGSEN83	Igname (f) Yam (w)	Root	Eat the root	To gain weight	+
Elaeis guineensis Jacq. (Arecaceae)	Palmier à huile (f) Tiir (w)	Fruit → Oil	Add oil and coffee to *Vitellaria paradoxa* butter and dab on the body Dab on the body	To get rid of the "dead" blood when feeling weak Boils	+
Eucalyptus globulus Labill. (Myrtaceae) UNISGSEN88	Eucaliptus (f) Khotta bu tel (w)	Leaf	Put it around the head while listening to the reading of the Koran	Headache	+
Eugenia caryophyllata Thunb (Myrtaceae) UNISGSEN38	Girofle (f) Xorompole (w)	Flower bud	Use the infusion prepared with *Xylopia aethiopica* seeds and *Combretum micranthum* flower	Vision problems	+
Euphorbia balsamifera Ait. (Euphorbiaceae)	Salan Salan mbechi	Branch	Cut the branch and put the latex on the wound	Wounds	++
Ficus iteophylla Miq. (Moraceae)	Xassum loro (w)	Root	Drink the decoction	Bellyache	+++
		Leaf	Drink the decoction	Digestive asthma	
		Leaf	Dab on the affected part	Backache skin allergies	
Grewia bicolor Juss. (Malvaceae)	Kel (w)	Leaf	Drink the decoction	Fatigue Bronchitis/cough Digestive	++
Guiera senegalensis J.F. Gmel. (Combretaceae) UNISGSEN18	Ngueer (w) Mamakumkoyo (m) Mamankuiò (s)	Root	Drink the decoction	Cold	+++
		Leaf	Drink the decoction	Bronchitis/cough kidney troubles Fatigue stomachache	

Table 1: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Qs
Hibiscus sabdariffa L. (Malvaceae) UNISGSEN12	Bissap (w) Karkadè (f)	Flower (red)	Put the infusion into the eyes	Itchy eyes	+++
			Drink the decoction	Bellyaches Menstrual pains Preventing ageing Fatigue Fever Improving the blood circulation	
			Put the infusion into the eyes	Eye problems	
			Drink the beverage together with *Tamarindus indica* fruit pulp and *Acacia nilotica* bark	Fatigue	
		Flower (white)	As a food medicine—as a main ingredient of a dish prepared with boiled meat of fish, cooked with tamarind and chilies (*lakk bissap*)	Fatigue	
Maerua crassifolia Forssk (Capparaceae)	Sothiou (w) Sothiou suukar	Branch	Chew the branch	Halitosis	+
Mangifera indica L. (Anacardiaceae) UNISGSEN37	Manguier (f) Màngo joolaa (w)	Leaf	Drink the decoction	Tetanus	++
Manihot esculenta Crantz (Euphorbiaceae) UNISGSEN07	Gnambi (w) Manioc (f) Mañok (m)	Root	Eat the root	To gain weight	+
Moringa oleifera Lam. (Moringaceae)	Nebedai	Leaf	Eaten in sauces, generally accompanied with meat and couscous	Diabetes	+
Musa paradisiaca L. (Musaceae)	Bananier (f)	Leaf	Topical application of the leaf infusion	Burns	+
Panicum miliaceum L. (Poaceae)	Mil (f)	Fruit	Eat millet (couscous)	To gain weight Fatigue	+
Parinari macrophylla Sabine (Chrysobalanaceae)	New (w) Tamba	Leaf	Drink the infusion made from 7 leaves	High blood pressure	+
		Leaf	Drink the infusion	Stomachache	
Piper nigrum L. (Piperaceae)	Mex pobare (w) Poivre noir (f)	Fruit	Eat the dried berry	Runny nose	+
Tamarindus indica L. (Fabaceae)	Tamarin (f) Daqaar (w)	Fruit pulp	Eaten, or drunk, in a beverage made adding the bark of *Acacia nilotica* and the flower of *Hibiscus sabdariffa*	Fatigue	+
Terminalia catappa L. (Combretaceae)	Badamier (f) Toubab (w) Xopp kerte	Not specified	Not specified	Antibiotic, antifungal	+
Piper nigrum L. (Piperaceae)	Mex pobare (w) Poivre noir (f)	Fruit	Eat the dried berry	Runny nose	+
Tamarindus indica L. (Fabaceae)	Tamarin (f) Daqaar (w)	Fruit pulp	Eaten, or drunk, in a beverage made adding the bark of *Acacia nilotica* and the flower of *Hibiscus sabdariffa*	Fatigue	+

Table 1: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Qs
Terminalia catappa L. (Combretaceae)	Badamier (f) Toubab (w) Xopp kerte	Not specified	Not specified	Antibiotic, antifungal	+
Vitellaria paradoxa C.F. Gaertn. (Sapotaceae)	Karitè (f)	Seed → butter	Add salt to the butter and dab on the back	Backache	+++
			Add coffee, *Elaeis guineensis*' oil and dab on the body	To get rid of the "dead" blood when feeling weak	
			Dab the butter on the body	Massage on the child's body, to make the child stronger. Bone strengthening	
			Dab the butter on hair	Hair loss	
Xylopia aethiopica A. Rich. (Annonaceae) UNISGSEN70	Diar (w) Jar	Seed	Drink the decoction, also a spice in the coffee	Sexual impotence	++
			Instill the infusion of seeds into the eyes	Eye problems, conjunctivitis	
			Instill the infusion of seeds into the ear	Otitis	
			Pour the infusion made from the seeds, *Eugenia caryophyllata* flower buds and *Combretum micranthum* flower	Vision problems	
Zingiber officinale Roscoe (Zingiberaceae) UNISGSEN09	Djindjer (w) Djinjeroo (m) Gingembre (f)	Fresh rhizome	Eaten, or juice drunk, or decoction	Sexual impotence Blood circulation	+++
Not identified	Berbef (w)	Leaf	Drink the decoction Use the rough leaf like a sponge under the shower	Worms Pruritus	+
		Fruit	Make a pasta and dab on the skin	Itchiness	
Not identified	Bonye			Antibiotic	+
Not identified	Khambata (w)	Leaf	Drink the infusion	Headache	+
Not identified	Ndiadame	Fruit	Cook it slowly and eat it; it is really bitter	Intestinal worms	+
Not identified	Sangol (w)	Root	Put it in water for up to two minutes and drink it (very bitter)	Intestinal worms	+
		Leaf	Soak in water and externally apply on the skin	Itchiness	
Not identified	Watenobout (w)	Branch	Put the latex that comes out of the broken branch on the wound	Wounds	+

(f): French; (m): Mandingo; (p): Pulaar; (w): Wolof; Qs: quotations: + quoted by 1 or 2 informants only; ++ quoted by 3, 4, or 5 informants; +++ quoted by 5 informants or more.

Table 2: Plants used as medicines in Adeane, Casamance, Southern Senegal.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Acacia albida Delile (Fabaceae) UNISGSEN019	Kade (f) Kadd (w) Baransango	Root Bark	Instill the infusion in the eye	Vision problems	+		3
Acacia nilotica (L.) Willd. ex Delile (Fabaceae) UNISGSEN15	Acacia mlotique (f) Nep nep (w) Mbano (m)	Root	Apply the infusion externally	Herpes		+	2
				Toothache		+	
Acacia seyal Delile (Fabaceae)	Suuro	Leaf	Topical application of liquid resulting from pressed leaves	Toothache	+		1
Acacia tortilis (Forssk.) Hayne (Fabaceae) UNISGSEN05	Senjen (w)	Root	Soak in water for some time and drink	Tapeworm	+		11
				Stomachache	+		
				Bellyache (abdominal pains)	+	+	
			Drink the cold infusion	Rheumatism	+		
			Apply the infusion on hair	Strengthening the hair	+		
			Boiled in water and the vapour is inhaled	Cold		+	
			Cold infusion is drunk	Blood pressure		+	
			Eat it with rice	Sterility		+	
			Make aerosol with the infusion?	Lung cancer		+	
			Drink the infusion	Bloodstream		+	
			Eat it with rice	Ulcer		+	
			Eat it with rice	Gastritis		+	
			Eat it with rice	Kidney problems		+	
			Drink the infusion	Menstrual pain		+	
				Malaria		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
			Topical application of the infusion	Herpes		+	
			Topical application of the infusion	Boil		+	
			Drink the infusion	Fatigue	+	+	
			Drink the infusion	Tuberculosis	+	+	
Adansonia digitata L. (Malvaceae) UNISGSEN20	Baobab (f) Guy (w)	Leaf	Powdered leaf applied to burn and bandaged together with the oil of *Arachis hypogaea*	Burns	+		12
		Seeds	Drink the seed juice together with the flowers of *Hibiscus sabdariffa*	Fatigue	+	+	
			Eat the seeds	Diarrhoea	+	+	
			Eat the seeds together with *Citrus limon* juice	Lack of appetite	+		
			Use it with *Acacia albida, Guiera senegalensis, Parkia biglobosa, Annona senegalensis, Soora* (nonidentified plant), and *Ficus sycomorus*	Headache, sore throat, cold taken as result of wind		+	
Allium cepa L. (Amaryllidaceae)	Oignon (f)	Bulb	Infusion with leaves of *Citrus limon*	Sore throat	+		1
Allium sativum L. (Amaryllidaceae)	Ail (f) Ladji (w)	Bulb	Drink the infusion in the morning	Blood pressure	+		8
			Eat it raw in the morning	Intestinal worms	+		
			Eat it while marabout recites verses of the Koran	Depression		+	
Aloe vera (L.) Burm. f. (Xanthorrhoeaceae)		Leaf gel	Use it with *Vitellaria paradoxa*	Tuberculosis		+	2
			Use it with *Vitellaria paradoxa*	Hair loss	+		
Anacardium occidentale L. (Anacardiaceae)	Pomme-cajou (f) Darkasa (w) Bara diamboo (m)	Bark	Drink the infusion	Toothache		+	3
				Rheumatism	+		
			Put it in cold water for a while and drink it	Toothache		+	
				Blood pressure		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Annona senegalensis Pers. (Annonaceae) UNISGSEN36	Sunkun (m)	Leaf	Drink the infusion	Diabetes		+	3
			Put the powder on the wound	Wounds		+	
			Drink the infusion	Rheumatism		+	
			Drink the infusion	Bloodstream		+	
			Drink the infusion with *Musa paradisiaca* leaves and *Combretum micranthum*	Blood pressure		+	
			Use it with *Piliostigma reticulatum*	Headache		+	
			Use it with *Piliostigma reticulatum*	Tuberculosis		+	
			Use it with *Acacia albida, Guiera senegalensis, Parkia biglobosa, Adansonia digitata, Soora* (nonidentified plant), and *Ficus sycomorus*	Headache, Sore throat, Cold taken as result of wind		+	
		Leaf	Use it with *Acacia albida* and *Parkia biglobosa*	Depression		+	
Arachis hypogaea L. (Fabaceae) UNISGSEN16	Arachides (f) Gerte (w) Jamba katalig (m)	Fruit	Use it with oil of *Elaeis guineensis*' oil	Hair	+		3
		Leaf	Inhale the infusion prepared together with the leaves of *Mangifera indica*	General health		+	
		Seed → oil	Mix peanut oil together with the powdered leaves of *Adansonia digitata* and apply to burns before bandaging	Burns	+		
		Fruit	Eat the fruit fresh, not toasted	Cold	+		
Azadirachta indica A. Juss. (Meliaceae) UNISGSEN63	Cassia, Neem (f) Niim, Ni va (w) Bantare (m)	Leaf	Wrap the leaf around the head	Headache	+		3
			Infuse with hot water and inhale the steam	Fatigue	+		
			Topical application of the infusion	Skin problems	+		
			Use it with *Carica papaya* and *Citrus limon*	Cold	+		

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Bambusa vulgaris Schrad. ex J.C. Wendl. (Poaceae) UNISGSEN54	Bambou (f) Lonk (w)	Leaf	Make an infusion with shade-dried leaves	Diabetes	+	+	3
			Drink the infusion with *Combretum micranthum* leaves	High blood pressure		+	
			Make an infusion, drink some of it, and make aerosol with the resting water	Bloodstream		+	
			Drink the infusion	Obesity		+	
Beta vulgaris L. (Chenopodiaceae)	Betterave (f) Beteraaw (m)	Root	Eat it	Bloodstream	+		1
			Eat it	Anemia	+		
Borassus flabellifer L. (Arecaceae) UNISGSEN89	Ronier (f) Kòoni (w)	Fruit	Burnt and pressed, pour resulting liquid into the ear	Earache		+	1
Calotropis procera (Aiton) W.T. Aiton (Apocynaceae) UNISGSEN55	Pomme de Sodome (f) Poftan (m) Kipampaan (p)	Leaf		Malaria	+		6
				Fatigue	+		
			Warm the leaf up and wrap it around the neck	Sore neck	+		
			Topical application of juice from leaf on tooth	Toothache	+		
			Wrap the leaf around the sore knee	Sore knees	+		
			Wrap the leaf around the head	Headache	+		
		Root	Use it with *Ocimum basilicum*	Rheumatism	+		
		Leaf ?	Use it with *Mànganaso* (unidentified plant) and *Jatropha curcas*. Drink it and vomit everything yellow	Yellow fever		+	
			Use it with *Jatropha curcas* and *Mànganaso* (unidentified plant)	Syphilis		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Cannabis sativa L. (Cannabaceae)	Marijuana	Seeds	Drink the infusion	Asthma	+		1
Capsicum annuum L. (Solanaceae)	Kani (w)	Fruit	Drink the infusion	Lack of appetite			5
			Drink a glass of water with a chili pepper in it	Intestinal worms	+		
			Mix lemon juice (*Citrus limo*) together with a chili pepper and gargle with the solution	Sore throat	+		
			Put in a small pan with *Jatropha curcas*, and drink	Hair loss		+	
			Put it in lemon juice (*Citrus limon*) and drink it	Constipation	+		
Carapa procera DC. (Meliaceae) UNISGSEN43	Tulukuna (m)	Seed → oil	Eat up the oil that comes out of the nut and dab it on the body three times a day with *Vitellaria paradoxa* butter	Sore back	+		9
			Mix it with oil of *Elaeis guineensis* and butter of *Vitellaria paradoxa* and then dab it on hair	Strengthening the hair	+		
			Drink a spoonful every day	Poor memory	+		
			Drink a spoonful of it	Cough		+	
			Drink a spoonful of it	Sore throat	+		
			Topical application of the oil	Eye problems	+		
			Instill oil into the ears	Earache	+		
			Drink a spoonful of it	Fever	+		
			Drink a spoonful of it	Flu	+		
			Dab it on the skin in the area over the kidneys	Kidneys problems	+		
			Drink a spoonful of it	Bellyache	+		
			Use it before breakfast	Tapeworm	+		
			Dab it on affected muscles	Sore muscles	+		
			Peel it and apply to the sore tooth	Toothache	+		8
			Use it with *Citrus limon* and *Azadirachta indica*	Cold	+		
		Root	Drink the infusion, adding salt	Syphilis (2)	+	+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
		Leaf	Drink the infusion	Anemia		+	
			Use it together with *Psidium guajava* leaves	Cystitis		+	
Carica papaya L. (Caricaceae) UNISGSEN21	Papayer (f) Papaayo (w)	Seeds	Dry the seeds in the sun, powder, and add to food	Intestinal worms		+	
		Fruit	Eat a soup with a ripe papaya in it together with chicken and a root of *Tinospora bakis*	Yellow fever	+		
			Boil the unripe fruit with undecorticated rice or simply eat the fruit, raw. Another remedy is to crack an egg over the unripe papaya and eat it	Yellow fever	+	+	
		Leaf	Drink the infusion together with the buds	Yellow fever		+	
			Add the following to water: dry leaves of *Musa paradisiaca*, little unripe fruits and leaves of *Citrus limon*, leaves of *Cassia occidentalis*, leaves of *Mangifera indica*, leaves of *Ziziphus mauritiana* and drink	Malaria		+	
		Fruit	Eat it together with *Parkia biglobosa* leaves	Yellow fever	+		
		Flower	Crumble flower into the water and drink	Headache	+		14
		Leaf	Wrap around the head	Headache	+		

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Cassia occidentalis L. (Fabaceae) UNISGSEN11	Mbanta xobi or Adiana (w) Kasalaa (m) Bentamarè (s)	Leaf	Wrap around the head	Conjunctivitis	+		
		Flower?	Drink the infusion	Menstrual pain	+		
		Leaf	Put it in water for a while and wash yourself with it	Cold (Especially for children)	+		
		Flower?	Drink the infusion	For pregnant women	+		
		Leaf	Drop juice from pressed leaves into the ear	Problems of the eardrum		+	
		Leaf	Add the following to water: dry leaves of *Musa paradisiaca*, little unripe fruits and leaves of *Citrus limon*, leaves of *Mangifera indica*, leaves of *Carica papaya*, and leaves of *Ziziphus mauritiana*	Malaria		+	
Cassia tora L. (Fabaceae) UNISGSEN76	Cassepuante (f) Ndur (w)			Blemishes on scalp which may extend to the whole body		+	2
			Use it with *Ficus umbellata*	Skin fungus		+	
Ceiba pentandra (L.) Gaertn. (Malvaceae)	Fromager, Kapotier (f) Bantau Bentene (w)	Fruit	Eat it	Bellyache	+		3
		Root	Put little plants' roots in water and then drink the water It is going to fizz	Fatigue	+		
		Bark	Use infusion made with the bark as a mouthwash	Toothache	+		
		Root?		Cancer		+	
		Bark?	Pour the infusion on the baby's head during baptism	Infant strength and protection		+	
		Root	Good for the blood because of the red colour	Blood	+	+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
		Leaf	Make an infusion together with leaves of *Allium cepa*	Sore throat	+		9
		Fruit	Drink the juice	Sore throat	+		
			Drink the juice	To lose weight	+		
			Use the juice together with *Capsicum* to gargle	Sore throat	+		
		Leaf and Fruit	Drink a beverage made with lemon leaf and fruit (*Citrus limon*)	Headache	+		
		Fruit	Put the juice on the affected part together with *Panicum miliaceum* flour	Herpes	+		
		Fruit	Drink the infusion with lemon juice (*Citrus limon*) together with two roots of the *Gossypium barbadense*	Sexual weakness		+	
Citrus limon (L.) Burm. (Rutaceae)	Citron (f) Limon (w)	Leaf and Fruit	Drink a beverage made with little lemons and leaves	Cold	+		
		Fruit	Drink the juice	Cold	+		
			Use it with *Carica papaya* and *Azadirachta indica*	Cold	+		
		Leaf and fruit	Add the following to water: dry leaves of *Musa paradisiaca*, little unripe fruits and leaves of *Citrus limon*, leaves of *Mangifera indica*, leaves of *Carica papaya*, leaves of *Cassia occidentalis*, leaves of *Ziziphus mauritiana* and drink	Malaria		+	
		Fruit	Eaten with *Carica papaya*	Malaria Yellow fever	+		
			Use it with *Guiera senegalensis*	Asthma	+		
			Drink the juice	Obesity	+		
			Drink the infusion together with *Gossypium barbadense*	High blood pressure	+		
			Dink the juice with honey	Liver	+		

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Cola cordifolia (Cav.) R. Br. (Malvaceae)	Kaba/Taba	Leaf	Drink the infusion	Malnutrition		+	1
Cola nitida (Vent.) Schott & Endl. (Malvaceae) UNISGSEN85	Ptit cola (f) Kola (w) Goro (p)	Seed	Chew it	Stimulant	+		1
Combretum glutinosum Perr. ex DC. (Combretaceae)	Chigommier (f) Rat (w)	Leaf	Drink the infusion	Cough	+		2
			Drink the infusion	Bronchitis	+		
			Drink the infusion	Sore throat	+		
			Drink the infusion	Cold	+		
Combretum micranthum G. Don (Combretaceae) UNISGSEN10	Kinkeliba (f) Sekhaw (w)	Leaf	Ingested together with *Tamarindus indica* fruit pulp	Blood pressure	+	+	9
		Leaf	Drink the infusion with *Musa paradisiaca's* leaf and *Annona senegalensis*	Blood pressure		+	
			Drink the infusion	Diabetes	+		
			Use it with *Tamarindus indica*	Asthma	+		
				Obesity	+		
			Drink the infusion	Bloodstream	+	+	
			Drink the infusion with these leaves together with *Bambusa vulgaris* leaves	High blood pressure		+	
			Drink the infusion without sugar	Malnutrition		+	
		Flower	Drink the infusion with cloves (*Eugenia caryophillata*) and *Xylopia aethipioca* seeds	Vision problems	+		
		Leaf	Drink the infusion	Bellyache		+	
Dialium guineense Willd. (Fabaceae) UNISGSEN17	Solom (w)	Bark	Make aerosol with the infusion	Asthma	+		1
Datura inoxia Mill. (Solanaceae) UNISGSEN91	Datura (f) Kubejaara	Leaf	Burn the wood and mix the wood ash with powdered leaf ash External Use only—highly hallucinogenic if used internally	Allergies		+	1

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Daucus carota L. (Apiaceae)	Carotte (f)	Leaf	Drink the infusion	Breast cancer	+		1
Dioscorea spp. (Dioscoreaceae) UNISGSEN83	Imuam Igname (f) Yam (w)	Root	Eat it	To gain weight		+	2
		Leaf	Boil the leaves	Asthma		+	
Elaeis guineensis Jacq. (Arecaceae)	Palmier à huile (f) Tiir (w)	Fruit → oil	Put the oil on the hair	Hair	+		6
			Topical application	Toothache		+	
			Pour in the ears	Earache	+		
			Use the palm oil together with *Sooto noir* (*Ficus capensis* Thumb.?) powdered root	Liver problems		+	
			Attach the root of *Moringa oleifera* to the affected area and then cover the sore part with palm oil. Do not leave the root in place too long or it will cause an infection.	Rheumatism		+	
		Seeds	Wear a necklace made out of these seeds	Sore throat	+		
			Break the seed and eat the internal part	Gastritis		+	
		Root	Put them in wine and drink it	Sterility		+	
				Skin fungus	+		
		Fruit → oil	Use the palm oil together with peanuts (*Arachis hypogea*) and dab on hair.	Hair		+	
			Use it together with *Vitellaria paradoxa* butter and *Carapa procera*, dab on hair	Hair	+		
			Apply it on the cuts together with *Hessawane*	Tetanus	+		
Erythrina senegalensis DC. (Fabaceae) UNISGSEN34	Erythrine du Senegal (f) Dolliw fatu	Root	Drink the infusion with *Jatropha curcas*	Cough	+		1
			Drink the infusion	Syphilis		+	
			Drink the infusion	Menstrual pain		+	
Eucalyptus globulus Labill. (Myrtaceae) UNISGSEN88	Eucaliptus (f) Khotta bu tel (w)	Leaf	Drink the infusion	Blood pressure	+		1

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Eugenia caryophyllata Thunb. (Myrtaceae) UNISGSEN38	Girofle (f) Xorompole (w)	Flower bud	Make an infusion and use it as mouthwash	Toothache	+		3
			Drink the infusion	Conjunctivitis	+		
			Make infusion with seeds of *Xylopia aethiopica* and *Combretum micranthum* flower and apply on eyes	Vision problems	+		
Euphorbia balsamifera Ait. (Euphorbiaceae)	Salan Salana Salan Mbechi	Branch	Cut a branch and put the lymph on the wound	Wounds	+		3
				Toothache	+		
Ficus elastica Roxb. ex Hornem. (Moraceae) UNISGSEN59	Yirif asotu	Leaf and bark	Drink the infusion	Low blood pressure		+	2
		Leaf	Drink the infusion	Cold		+	
Ficus sycomorus ssp. *gnaphalocarpa* (Miq.) C.C. Berg (Moraceae) UNISGSEN42	Ficus (f) Sooto (m)	Root	Drink the infusion	Fatigue	+		2
		Leaf	Powder branches and leaves together with *Jamba Saboo* leaves and drink some of it. Wash yourself with the rest of it. Do not eat fish in the meantime.	AIDS		+	
Ficus umbellata Vahl (Moraceae) UNISGSEN68	Ñokolokotò (m)	Leaf	Use it with *Cassia tora*	Skin fungus		+	1
Gossypium barbadense L. (Malvaceae)	Cotonnier (f) Uiten (w)	Leaf		Cough	+		4
		Root	Drink the infusion together with lemon juice (*Citrus limon*)	High blood pressure	+		
			Drink the infusion made with two roots together with lemon juice (*Citrus limon*)	Sexual weakness		+	
Guiera senegalensis J.F. Gmel (Combretaceae) UNISGSEN18	Guiera du Senegal (f) Ngeer (w) Mamakumkoyo (m)	Leaf	Drink the infusion three times a day	Cough	+		13
			Chew it and put it on the sore tooth	Toothache	+		
			Dry it and use it every day	Sores	+		
			Make an infusion together with the lemon leaves (*Citrus limon*)	Asthma	+		
			Drink the infusion with Valda pastille (industrial pastille based on menthol and eucalyptus essential oil)	Cold	+		
			Make infusion and apply to hair	Hair		+	
			Drink the infusion	Insomnia		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
			Apply chewed leaf onto the wound or powder it and put it on	Wounds	+	+	
			Drink the infusion together with *Mànganaso*'s root (unidentified plant)	Intestinal worms		+	
			Infusion prepared with *Adansonia digitata, Acacia albida, Parkia biglobosa*, *Annona senegalensis, Soora Soora* (nonidentified plant), and *Ficus sycomorus*	Headache, sore throat, or cold taken as result of the wind		+	
Hibiscus sabdariffa L. (Malvaceae) UNISGSEN12	Karkadè (f) Bisaab (w)	Leaf and Flower	Drink the infusion	Bloodstream	+		12
		Flower		Flu	+		
		Fruit	Make a juice together with *Adansonia digitata* seeds	Fatigue	+	+	
		Flower		Lack of appetite		+	
			Use it with *Tamarindus indica* and *Acacia nilotica*	Fatigue	+		
		Flower	Use it with *Phaseolus vulgaris* seeds	Anemia	+		
			Use it with seeds of *Phaseolus vulgaris*	Fatigue	+		
		Fruit	Remove the seeds and squeeze the fruit juice into the eyes.	Conjunctivitis		+	
		Leaf	Make an infusion together with the young leaves of *Psidium guajava*, drink it, and eat the leaves	Diarrhoea	+	+	
Holarrhena floribunda T. Durand & Schinz (Apocynaceae) UNISGSEN67	Jarko (m)			Sexually transmitted diseases	+		2
			Drink the tisane	Prostate Abortion		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
			Collect pieces of bark that face east during sunset and then drink it in 5 litres of water	Cancer	+		6
			Collect pieces of bark that face east during sunset and then drink it in 5 litres of water	Syphilis	+		
Jatropha curcas L. (Euphorbiaceae)	Pignon d'Inde (f) Tabanana (w) Tabanano (m)	Bark and Root	Drink the infusion together with roots of *Erythrina senegalensis* in it	Cough	+		
			Put it in a small pan with *Capsicum* and drink	Hair loss		+	
			Powder it together with *Kunjunburun* and eat it on rice	Syphilis		+	
			Use it with *Calotropis procera* and *Mànganaso* (unidentified plant)	Yellow fever		+	
			Drink a tisane made with the bark together with *Acacia tortilis.*	Intestinal worms	+	+	5
			Boil it in the water or put it into cold water for 2 hours and then drink it.	Fatigue	+		
			Make aerosol with it	Fatigue		+	
Khaya senegalensis (Desr.) A. Juss. (Meliaceae)	Cailsedrat (f) Xai, kay (w)	Bark	Put in water and drink it	"Makes blood"	+		
			Make cold infusion and drink	Kidney problems		+	
				Anemia		+	
			Put the bark in a bottle and drink it.	Tuberculosis		+	
Lawsonia inermis L. (Lythraceae) UNISGSEN69	Hennè (f) Fuden (w)	Leaf?	Soak it together with the leaves of *Psidium guajava* and then drink it. The leaves needs to be fresh, not dried.	Stomachache		+	1

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Leptadenia hastata Vatke (Apocynaceae)	Mboom (w) Duto (m)	Leaf	Attach the leaves to the back together with hawk's bones	Kidney problems		+	1
		Root	Scrape at the bark, put it into water, and drink it	Snakebite		+	
Lippia chevalieri Moldenke (Verbenaceae)	Samfitò	Leaf	Drink the infusion	Boils		+	1
Maerua crassifolia Forssk. (Capparaceae)	Sothiou (w) Sothiou suukar	Branch	Rub the stick on the teeth	Clean teeth	+		2
			Chew the branch. Its bark tastes like sugar	Haemorrhoids		+	
Mangifera indica L. (Anacardiaceae) UNISGSEN37	Manguier (f) Màngo joolaa (w)	Leaf	Make an infusion, with 1.5 L water and a handful of leaves (some say to use only the ones on the floor, others to add salt to the infusion)	Tetanus	+	+	13
		Leaf	Drink infusion	Poor memory	+		
		Bark?	Hot infusion and inhale it together with peanut (*Arachis hypogaea*) leaves	General health	+		
		Bark	Make aerosol with it	Toothache	+		
		Leaf		Toothache	+	+	
		Leaf	Add to water: dry leaves of *Musa paradisiaca*, little unripe fruits and leaves of *Citrus limon*, leaves of *Mangifera indica*, leaves of *Carica papaya*, leaves of *Cassia occidentalis*, and leaves of *Ziziphus mauritiana*	Malaria		+	
		Fruit	Eat three fruits	Constipation	+		
Manihot esculenta Crantz (Euphorbiaceae) UNISGSEN07	Manioc (f) Gnambi (w) Mañok (m)	Leaf	Drink the infusion together with milk curdle and then massage the chest	Lung cancer		+	1
			Make aerosol with the infusion	Asthma		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Moringa oleifera Lam. (Moringaceae) UNISGSEN39	Moringa (f) Nebedaay (w) Nebedayo (m)	Leaf	Dry in the shade, powder, and eat with food	Diabetes	+		12
		Leaf	Dry it in the shade and then crush it and eat in on rice	Diabetes	+		
		Seed	Dry the seeds on the fire, powder, mix with water, and drink	Diabetes	+		
		Root	Grind the root and put it on the fire then dab and bandage	Sore knees	+		
		Bark	Soak the root in water for few seconds and then drink	Sore neck		+	
		Leaf	Put the leaf in water and wash your eyes with it	Eye allergies	+		
		Bark	Soak it in warm (not boiling) water and then drink it	Kidney problems		+	
		Root	Attach the root to the affected area, with *Elaeis guineensis* oil. Do not leave it too long or the root will cause an infection on the sore part.	Rheumatism		+	
		Leaf	Dry the leaves in the shade and eat it with *Phaseolus vulgaris*	Blood pressure	+		
		Seed	Put the seeds on the fire, grind into a powder and drink with water	Blood pressure	+		
Musa paradisiaca L. (Musaceae)	Bananier (f)	Leaf	Cut the leaves and dry them in the sun for 24 hours	General health	+		4
		Fruit	Eat it	Stomachache	+		
		Leaf	Infusion with *Combretum micranthum* and *Annona senegalensis*	Blood pressure		+	
			Add to water: dry leaves of *Musa paradisiaca*, little unripe fruits and leaves of *Citrus limon*, leaves of *Mangifera indica*, leaves of *Carica papaya*, leaves of *Cassia occidentalis*, and leaves of *Ziziphus mauritiana*	Malaria		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Ocimum basilicum L. (Lamiaceae) UNISGSEN13	Basilic (f) Ngungun (m)	Leaf	Drink the infusion	Headache		+	3
		Seeds	Put the seed into the eyes and everything comes out	Eye problems		+	
		Leaf?	Use it with *Calotropis procera*	Rheumatism	+		
Panicum miliaceum L. (Poaceae)	Mil (f)	Fruit	Use the powder (pollen) that falls down during the harvest to massage the body with water and salt. Leave it on half an hour and then wash it away.	Allergies		+	2
			Apply millet powder together with lemon juice (*Citrus limon*) on the affected area	Herpes	+		
Parinari macrophylla Sabine (Chrysobalanaceae)	New (w) Tamba	Bark	Cut the bark into pieces, boil, and use the water as mouthwash	Toothache	+		2
			Make an infusion and drink	Sore throat		+	
			Make an infusion and drink it before meals	Helps in digestion		+	
Parkia biglobosa (Jacq.) R.Br. ex G. Don (Fabaceae) UNISGSEN87	Minosa purpre (f) Uul (w) Nete, Nere (m)	Leaf	Put the leaf powder on the burns	Burns	+		5
			Eat the leaves together with *Carica papaya* fruit	Yellow fever	+		
			Drink the infusion with powdered leaf and milk	Ulcer	+		
			Use it together with *Acacia albida* and *Annona senegalensis*	Depression		+	
			Use it with *Acacia albida, Guiera senegalensis, Annona senegalensis, Adansonia digitata, Soora* (nonidentified plant), and *Ficus sycomorus*	Headache, sore throat, and cold taken as result of the wind		+	
		Seed	Cook them with rice	Diabetes	+		

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Phaseolus vulgaris L. (Fabaceae) UNISGSEN35	Harricot blanche (f) Niebè (w) Ñebbe	Seeds	Use with *Hibiscus sabdariffa*	Fatigue	+		3
			Make an infusion with seven seeds and eat them	Breast cancer		+	
			Use it with *Hibiscus sabdariffa*	Anaemia	+		
		Leaf?	Eat it together with *Moringa oleifera*'s sundried leaves	Blood pressure	+		
Piliostigma reticulatum (DC.) Hochst. (Fabaceae) UNISGSEN77	Fara (m) Kankuran (p)	Bark	Put the red liquid inside the bark on the wound then powder the bark and put it on the wound	Wounds	+	+	3
			Use it with *Annona senegalensis*	Tuberculosis		+	
			Drink the infusion	Chronic cough		+	
Piper nigrum L. (Piperaceae)	Poivre noir (f) Mex Pobare (w)	Seed	Drink boiled milk with pepper in it	Sore throat	+		
Prosopis africana (Guill. & Perr.) Taub. (Fabaceae)	Yiir (w)	Bark	Drink the decoction	Anaemia	+		1
Prosopis juliflora (Sw.) DC. (Fabaceae) UNISGSEN26	Banaana golo (w)	Leaf	Make aerosol useful to swat and then drink the water	Vertigo	+		1
		Leaf	Make aerosol useful to swat and then drink the water	Pregnant women	+		
		Leaf	Drink the infusion	Bellyache		+	
Psidium guajava L. (Myrtaceae) UNISGSEN31	Goyave (f) Guyaab (w)	Young leaf	Make an infusion with *Hibiscus sabdariffa* leaves, drink it, and eat the leaves	Diarrhoea	+	+	10
		Leaf	Drink the infusion	Bellyache		+	
			Use it together with *Carica papaya* leaf	Cystitis		+	
		Fruit	Eat the fruit	Bellyache		+	
			Drink the infusion	Diarrhoea		+	
		Leaf	Drink the infusion made with young leaves	Diarrhoea	+		
			Soak the leaves together with *Lawsonia inermis,* and then drink it. The leaves need to be fresh, not dried	Stomachache		+	

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
Saba senegalensis (A.DC.) Pichon (Apocynaceae) UNISGSEN76	Màdd (w) Mat mat (m)	Leaf	Drink the infusion	Intestinal worms	+		2
		Fruit	Boil the fruit	Malnutrition		+	
Solanum lycopersicum L. (Solanaceae)	Tomate (f) Tamaate (w)	Leaf	Make an infusion	Skin fungus	+		5
			Crush the leaf and put the juice and the leaf inside the ear	Earache	+		
		Fruit	Apply tomato sauce on the wound	Wounds	+	+	
			Eat it raw	Smallpox	+		
Solanum tuberosum L. (Solanaceae)	Pomme de terre (f) Pombiteer (w)	Leaf	Make an infusion and give it to the 1-week-old baby to drink	Strong child	+		1
		Fruit	Eat it raw	Menstrual pain	+		
Tamarindus indica L. (Fabaceae)	Tamarin (f) Daqaar (w)	Fruit	Use it with *Combretum micranthum*	Asthma	+		4
			Boil it and wash your eyes with it	Vision problems		+	
			Add salt and rinse your mouth with it	Toothache		+	
		Bark	Karitè butter together with the bark of *Tamarindus indica*	Bruises	+		
			Use it with *Hibiscus sabdariffa* and the bark of *Acacia nilotica*	Fatigue	+		
			Use it with *Combretum micranthum*	Blood pressure	+		
Tinospora bakis (A. Rich.) Miers (Menispermaceae)	Bakis (w)	Root	Eat the root in a soup with a ripe *Carica papaya* and chicken	Yellow fever	+		1

Table 2: Continued.

Botanical taxon, family, and voucher specimen code	Local name(s)	Part(s) used	Preparation and administration	Folk medical use (used against/to regulate)	Healers	Laypeople	Qs
			Massage the neck	Sore neck (2)	+	+	11
			Massage the body	Cold	+		
			Put it on the sore part	Bruises	+		
			Massage the chest with Karitè butter	Chronic cough	+		
			Add salt to the butter and dab on the back	Backache	+		
			Karitè butter together with the bark of *Tamarindus indica*	Bruises	+		
			Massage and dab the sore part of the body	Rheumatism	+		
Vitellaria paradoxa C.F. Gaertn. (Sapotaceae)	Karitè (f)	Seed → butter	Apply on herpes	Herpes	+		
			Use it with *Carapa procera* and *Elaeis guineensis*' oil	Hair loss	+		
			Use it together with *Carapa procera*'s nut oil and dab it on the body three times a day	Backache		+	
			Dab on the hair	Stronger hair	+		
			Use it together with a stick to apply this part	Fractures	+		
			Add coffee and tyr (red oil)	To get rid of the dead blood, against fatigue	+		
			Use it with *Aloe vera*	Tuberculosis		+	
			Use it with *Aloe vera*	Hair loss	+		
Xylopia aethiopica (Dunal) A. Rich. (Annonaceae) UNISGSEN70	Diar (w) Jar	Fruit Seed	The seeds are used to prepare the "Touba Coffee"	Blood pressure	+		3

(f): French; (m): Mandingo; (p): Pulaar; (w): Wolof; Qs: quotations (number of informants, who have quoted a specific taxon); ?: uncertain information.

the ones in charge of TM and "health" foods in the domestic setting.

The issues relevant to primary TM practice in migrant communities are often compounded by a lack of specific health policies, which are able to address migrant needs. This problem is, of course, not isolated to the case of migrants in Italy, but is also relevant to many other Western countries, where the healthcare needs of burgeoning migrant populations are often conspicuously absent in health policy and legislation.

By having a better understanding of both the migrant folk pharmacopoeia and the state of TK transmission with regards to health, more culturally sensitive health policies could be developed. In particular, the increasing occurrence of newcomers in Italy should foster more pluralistic approaches in the management of CAMs by the regional authorities, as well as consequently addressing measures aimed to improve the information on potentialities and risks of "home-made" herbal remedies.

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Research Article

The Relationship between Plants Used to Sustain Finches (Fringillidae) and Uses for Human Medicine in Southeast Spain

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We analyzed plants that are traditionally used by wild bird hunters and breeders to capture and promote captive breeding of *Fringillidae* (finches or songbirds) in the province of Alicante, Spain. The majority of plants used in songbird breeding have medicinal properties in traditional human medicine (48 different uses); thus, another main goal was to show their relationships with human medical uses. We compiled a list of 97 plant species from 31 botanical families that are used to attract finches and identified 11 different use categories for these plants in finch keeping. The most common uses were for trapping birds and as a source of food for birds in captivity. *Cannabis sativa* has the greatest cultural importance index (CI = 1.158), and *Phalaris canariensis* (annual canary grass or alpist) was the most common species used to attract Fringillidae and was used by all informants ($n = 158$). Most of the 97 species are wild plants and mainly belong to the families Compositae, Gramineae, Cruciferae, and Rosaceae and also have medicinal properties for humans. In the study area, the intensification of agriculture and abandonment of traditional management practices have caused the population of many songbirds to decline, as well as the loss of popular ethnographic knowledge.

1. Introduction

Throughout the ages, the human race has used plants for various purposes [1], particularly those that are accessible. In the Iberian Peninsula, several studies have been developed on medicinal plants [2–8] and edible flora [9, 10], as well as some general ethnobotanical studies [11–15], and others about the importance of home gardens and cultivated areas in the evolution of useful flora [16]. However, few studies have described the use of plants in ethnoveterinary medicine [17, 18], or in attracting and maintaining birds of the Fringillidae family in captivity [19, 20]. Plants have been used in traditional medicine for several thousands of years to treat and cure diseases in domestic animals and human populations, especially native ones [21, 22]. Furthermore, in nature, wild birds use particular plant species, which possess insecticidal and bactericidal properties, to build their nests. This practice creates optimal conditions for egg laying and incubation [23].

The ecological knowledge of local traditional uses that depend on the dynamics of natural resources has been reflected in numerous studies [24–26], considering the ecological knowledge of local communities of hunters, anglers, and gatherers [27].

The culture of capturing songbirds was introduced to the Iberian Peninsula by the Romans and had its beginnings, as did other forms of hunting, in the absolute necessity of human nutrition. Thus, these birds were traditionally caught as a source of food in Valencia, at least since the 17th century [28]. Today, following old customs and culinary habits, there are still hunters who hunt this group of birds in order to eat them. On the other hand, the term "*pajareros*" describes people who are dedicated to hunting, breeding, or selling birds [29]. Although these birds are not hunted excessively, it is essential to monitor and control illegal methods of hunting Fringillidae and to conserve this family of birds [30].

The capture of birds using a hinged net assembly is a traditional hunting method that is widespread in the province of Alicante and elsewhere in the Iberian Peninsula. These game nets are made with cotton, hemp, or nylon mesh. They are placed on the ground and have a manual activation system; once a bird enters the net, a rope is pulled to trap the bird inside the net (see Photographic annex). The nets used since the middle ages to capture several species of Fringillidae intended for use as pets are well known among the inhabitants of this zone [31, 32]. These birds are relatively easy to maintain and rear in captivity, and it is easy to train them to participate in singing competitions. Thus, at present, the capture of five species of birds (*Serinus serinus*, "verdecillo", *Carduelis carduelis,* "jilguero", *Carduelis chloris*, "verderón", *Carduelis cannabina*, "pardillo," and *Fringilla coelebs*, "pinzón") is authorized and regulated by law (Council Directive 79/409/EEC and national Laws 4/1989, 62/2006, and 13/2004). What is more, it is an important cultural movement around the Mediterranean Basin [33]. The current trend is to increase breeding in captivity and reduce the capture of wild birds. Therefore, it is important to acquire more knowledge about the traditional use of cultivated and wild plants.

The main aim of this paper is to document the cross-cultural comparison between plant uses for songbirds and humans in Mediterranean environments, relating an ethnoveterinary field study and its eventual link to folk therapies for humans, in order to preserve ethnological knowledge on European folk health. With this purpose in mind, the information on plant uses for songbirds (capturing, feeding, and breeding) gathered here was collected during fieldwork and complemented with ethnobotanical references. Finally, we would like to contribute to the dissemination of results within the scientific community in order to open a door to research in other disciplines.

2. Materials and Methods

2.1. Study Area. The province of Alicante is located in the southeast region of Spain, in the southern part of Valencia. It is geographically located between the coordinates 38°30′N and 0°50′E (Figure 1). The total area occupied by the province is 5,863 km^2, it has a population of 1,783,555 inhabitants, and there are 141 localities. The province has a very mountainous and rugged relief, except for some river valleys. Thus, approximately 60% of the study area is located between elevations of 200 and 1,500 m above sea level.

Due to its geographical location, the province of Alicante has a typical Mediterranean climate with mild temperatures. Thus, the average temperatures are between 6.2° and 16.8° in the coldest month (January) and 20.4° and 30.6° in the hottest (August), with an annual mean of 17.8°. The average annual rainfall is 336 mm, concentrated in spring and autumn, and there is a prominent dry period in summer. However, there are some climatic differences between the coast and the interior of the province, due to its topography [34, 35]. The plant species in the province of Alicante 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 [35, 36]. Considering its bioclimatic and biogeographical conditions, the province of Alicante may potentially give rise to vegetation that can be divided into three main types: evergreen oak forest (*Rubio longifolia-Quercetum rotundifoliae*), ash-maple forest (*Fraxino orni-Aceretum granatensis*), and spiny maquis (*Chamaerops humilis—Rhamnus lycioides*) [37].

2.2. Ethnology. A total of 69 localities were prospected with oral interviews in all regions of the Alicante province (*El Comptat, L'Alcoia, Alt Vinalopo, Vinalopo Mitja, Marina Baixa, Marina Alta, L'Alacanti, Baix Vinalopo*, and *Baix Segura-Vega Baixa*) (Figure 1). Vernacular names of plant species traditionally used were obtained in the field by interviews with the local population. Ethnological information was based primarily on semistructured interviews, in which we gathered information. This ranged from the different plant species used to attract and maintain songbirds, the season of plant collection, traditional uses of the plant species collected, the composition of commercial mixtures used to feed captive birds, and folk remedies used to cure songbird illnesses, to the environmental problems faced by the community.

People with a specific profile were selected in order to obtain high-quality and reliable information. People interviewed were older (50–85 years old), living in a rural environment and from a variety of socioeconomical strata, who had captured and bred birds throughout their lives. We wanted to emphasize the ethnobotanical importance of local variations of plant names and the different applications of these species. We conducted 158 oral interviews; 95.57% ($n = 151$) of the informants were male and 4.43% ($n = 7$) female, and the mean age was 56.7 years. In 48 municipalities, inhabitants speak Valencian (variant of Catalan), and Castilian (standard Spanish) is spoken in the others.

Numerous folk botanical references were examined [38–41], including a variety of local books [35], magazines [7], and festivals, to obtain information on remedies for animal illnesses. Even though the information included in our analysis arose from an array of different spoken and written sources in the study area, the semistructured interviews revealed many important issues previously unidentified [20].

A digital sound recorder was used to record interviews and to create an audio record of the information. 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.

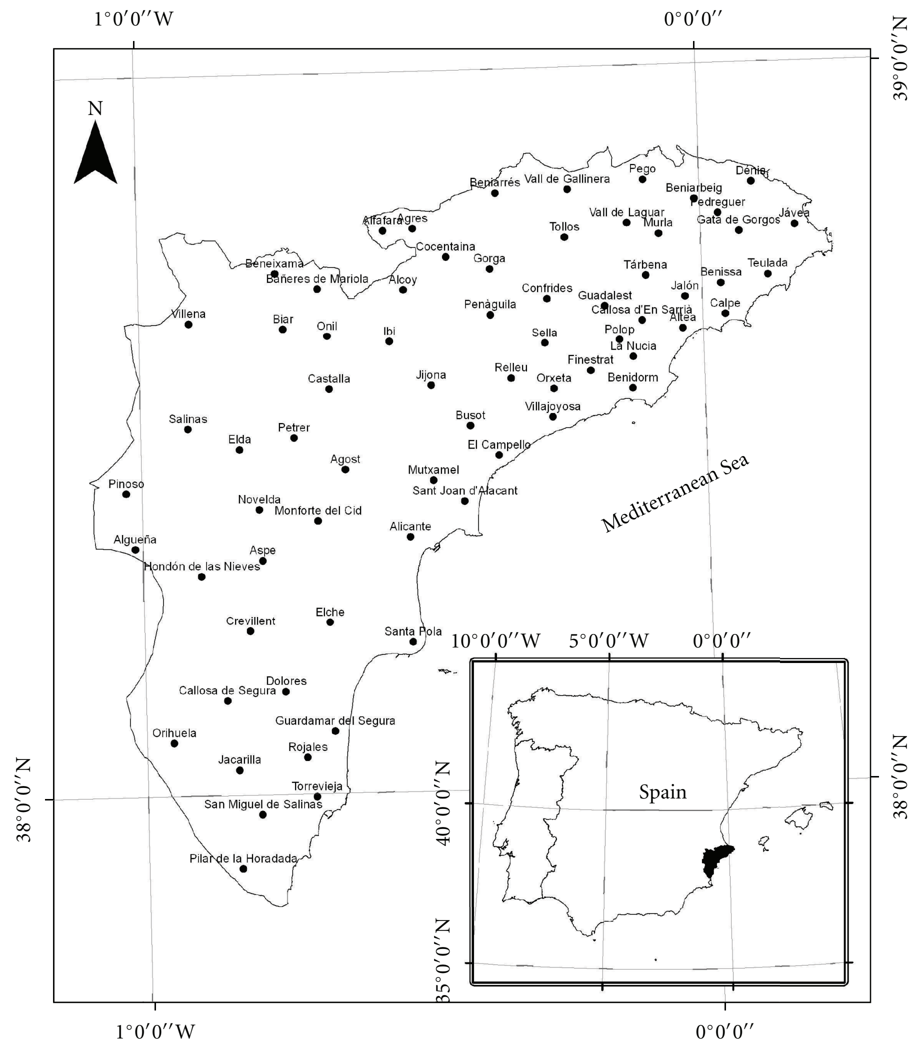

Figure 1: Map showing the location of the province of Alicante (Spain). Dots represent the localities that were prospected ($n = 69$).

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" [42]. In this process, hunters were observed while they prepared for the hunt and during hunting, and their recreational activities were documented. In these field samplings, we also identified species of plants currently used by bird breeders and the techniques used to catch birds.

Plants were collected from various parts of the study area and were identified in the laboratory, using dichotomous keys [43] and registered at the ABH (Herbarium of Alicante University). We used Excel 2003 to perform a simple statistical analysis of the data collected; specifically, we calculated the relative frequency of citation (RFC) [8] at which each species of plant was used to attract birds during hunting and to maintain birds in captivity (in Table 1). Moreover, we calculated a cultural importance index (CI) where each addend is a measure of the relative importance of each plant use [8].

Finally, we related the use of these plants for wild finches with their potential human medical use, by using some important sources of reference for ethnobotanical and alternative medicine for Mediterranean environments in the southeastern part of Spain [7, 35, 39–41, 44]. Plant uses have been grouped according to cures for different ailments [18].

3. Results

We collected 97 species of plants and another variety of one of these species, belonging to 31 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, their main uses in finches, relative frequency of citation, cultural importance, whether wild or cultivated types were used, and their medical properties for humans (Table 1).

Compositae, Gramineae, Cruciferae, and Rosaceae are the families most represented among the plants used to catch and promote breeding of songbirds. In this study, all the species of birds showed a preference for wild species of plants.

Table 1: Plant species in the study area and their traditional uses in finches and humans. Finch uses: 1, facilitate breeding; 2, attract birds; 3, commercial seed mixes; 4, leafy vegetables; 5, birdliming; 6, material for cages and accessories; 7, catching tools; 8, vermifuge; 9, camouflage of capture nets; 10, provide pigments; 11, cure diseases. Medical human uses: 1, alteration of blood pressure; 2, haemorrhoids; 3, depurative; 4, anxiety; 5, diarrhoea; 6, heartburn; 7, indigestion; 8, liver disease; 9, loss of appetite; 10, constipation; 11, helminthiasis; 12, cough; 13, cold; 14, respiratory problems; 15, hyperglycemia; 16, anaemia; 17, hypercholesterolemia; 18, retention of liquids; 19, undefined symptom (tonic); 20, gout; 21, rheumatism; 22, inflammation of bones or joints; 23, undefined symptom (analgesic); 24, injury; 25, burns; 26, kidney stones; 27, menstruation; 28, lack of breast milk secretion; 29, ischocholia; 30, chilblains; 31, pimples; 32, skin diseases; 33, eczema; 34, skin fungus; 35, rubefaction; 36, calluses and skin hardness; 37, warts; 38, bacteria; 39, microbes; 40, headache; 41, inflammation; 42, fever; 43, alopecia; 44, flushing (refreshing); 45, alcoholism; 46, toothache; 47, mineral deficiency; 48, eye infection. Type: W, wild; C, cultivated. RFC: relative frequency of citation. CI: cultural importance index.

Scientific name	Herbarium voucher (ABH)	Family	Finch uses	RFC	CI	Medical human uses	Type	References
Agave americana L.	17879	*Agavaceae*	1	7.59	0.076	—	W	[39]
Allium sativum L.	Seen alive	*Alliaceae*	8	5.06	0.051	41, 13, 5, 21, 30	C	[35, 39, 44]
Amaranthus blitum L.	3989	*Amaranthaceae*	2,3	25.32	0.285	—	W	[41]
Anagallis arvensis L.	22647	*Primulaceae*	4	16.46	0.165	24, 3, 14	W	[40]
Andryala ragusina L.	4430	*Compositae*	5	72.15	0.722	31	W	[41]
Arundo donax L.	32085	*Gramineae*	6,7	58.23	0.810	1, 48, 12, 22, 18, 3	C	[39]
Avena sativa L.	10488	*Gramineae*	3	84.81	0.848	—	W	
Avena sterilis L.	1582	*Gramineae*	3	78.48	0.785	—	W	
Beta vulgaris L.	10652	*Chenopodiaceae*	4	30.38	0.304	37, 10, 18, 44, 1, 41, 6, 2	C	[41]
Bituminaria bituminosa (L.) C. H. Stirt.	50474	*Leguminosae*	2	32.91	0.329	—	W	
Brachypodium retusum (Pers.) Beauv.	31248	*Gramineae*	7	67.09	0.671	1	W	[39]
Brassica napus L.	39373	*Cruciferae*	3	89.87	0.899	—	C	
Brassica oleracea L. subsp. *oleracea*	34847	*Cruciferae*	4	21.52	0.215	24, 28, 45, 41, 21, 18, 10, 48, 4, 7	C	[41]
Brassica oleracea L. var. *italica* Plenck	Seen alive	*Cruciferae*	1,4	62.03	0.924	—	C	
Brassica rapa L.	7969	*Cruciferae*	3	88.61	0.886	—	C	
Cannabis sativa L.	32225	*Cannabaceae*	1,3	92.41	1.158	—	C	
Capsella bursa-pastoris (L.) Medicus	47380	*Cruciferae*	4	16.46	0.165	5, 18, 1, 27	W	[40]
Carthamus tinctorius L.	3894	*Compositae*	3	10.13	0.101	—	W	
Centaurea aspera L.	21338	*Compositae*	2	60.76	0.608	9, 7, 15, 24, 34, 38, 41, 1, 13, 39, 19, 29	W	[7, 35, 40]
Centaurea calcitrapa L.	36097	*Compositae*	2	46.84	0.468	15	W	[40]
Centaurea mariolensis Rouy	13242	*Compositae*	2	10.13	0.101	—	W	
Centaurea melitensis L.	36917	*Compositae*	2	11.39	0.114	—	W	
Chamaerops humilis L.	559	*Palmae*	1	13.92	0.139	9	W	[39]
Chelidonium majus L.	18328	*Papaveraceae*	11	3.8	0.038	—	C	
Chondrilla juncea L.	7142	*Compositae*	5	49.37	0.494	9	W	[39]
Cicer arietinum L.	17633	*Leguminosae*	11	3.8	0.038	31, 18, 13	W	[41]

Table 1: Continued.

Scientific name	Herbarium voucher (ABH)	Family	Finch uses	RFC	CI	Medical human uses	Type	References
Cichorium intybus L.	37547	*Compositae*	3,4	54.43	0.639	18, 19, 10, 9	W	[35, 39, 44]
Cirsium arvense (L.) Scop.	35007	*Compositae*	2	8.86	0.089	9, 2	C	[39]
Cirsium monspessulanum (L.) Hill	51477	*Compositae*	2	10.13	0.101	—	W	
Citrus limon (L.) Burm. Fil.	49856	*Rutaceae*	11	2.53	0.025	24, 5, 3, 18, 13	C	[39]
Conyza bonariensis (L.) Cronq.	17943	*Compositae*	2	12.66	0.127	—	C	
Cynara cardunculus L.	35991	*Compositae*	2	16.46	0.165	37, 27, 29, 32, 9, 3, 8, 18, 15	W	[7, 35, 41, 44]
Cynara scolymus L	31715	*Compositae*	2	44.3	0.443	—	C	
Daphne gnidium L.	10830	*Thymelaeaceae*	6,8	41.77	0.481	37, 13, 8, 11, 35	W	[7, 35, 39]
Daucus carota L.	33104	*Umbelliferae*	4,10	18.99	0.222	18, 37, 9, 19	W	[35, 39]
Diplotaxis erucoides (L.) DC.	47963	*Cruciferae*	2,4	91.14	0.911	—	W	[40]
Dittrichia viscosa (L.) Greuter	39371	*Compositae*	2	68.35	0.684	24, 1, 26, 17, 46	W	[39]
Echinochloa crus-galli (L.) Beauv.	14692	*Gramineae*	2	6.33	0.063	—	W	
Eruca vesicaria (L.) Cav.	41713	*Cruciferae*	4	20.25	0.203	—	W	
Erucastrum virgatum C. Presl	4460	*Cruciferae*	2,4	15.19	0.190	—	W	
Euphorbia characias L.	7226	*Euphorbiaceae*	5	36.71	0.367	8	C	[39, 44]
Foeniculum vulgare Miller	23129	*Umbelliferae*	3	24.05	0.241	18, 33, 10, 14, 48, 13, 9, 8, 39, 28, 7	W	[7, 35, 39, 44]
Fragaria vesca L.	52157	*Rosaceae*	4,10	11.39	0.139	13, 30, 20	W	[44]
Galactites tomentosa Moench	42051	*Compositae*	2	11.39	0.114	—	C	
Guizotia abyssinica (L.f.) Cass.	9666	*Compositae*	3	87.34	0.873	—	W	
Helianthus annuus L.	5220	*Compositae*	3	87.34	0.873	—	W	
Heliotropium europaeum L.	14672	*Boraginaceae*	2	82.28	0.823	24, 29, 42, 27, 20, 37	W	[35, 41]
Hyparrhenia hirta (L.) Staff	41077	*Gramineae*	7	32.91	0.329	—	C	[39]
Lactuca sativa L.	Seen alive	*Compositae*	3,4	58.23	0.728	44, 47, 4, 46	C	[41]
Lactuca serriola L.	47376	*Compositae*	4	22.78	0.228	10, 4	W	[41]
Laurus nobilis L.	43242	*Lauraceae*	8	13.92	0.139	14, 13, 9, 7, 6, 31, 8	C	[35, 39, 44]
Lavandula latifolia Medicus	20246	*Labiatae*	4,11	37.97	0.456	19, 7, 39, 24, 21, 18, 33, 14, 41, 5	W	[7, 35, 39, 44]
Linum usitatissimum L.	32017	*Linaceae*	3	13.92	0.139	10, 33, 21, 31, 24, 14, 13, 41, 4	W	[35, 39]
Lobularia maritima (L.) Desv.	15843	*Cruciferae*	4	35.44	0.354	18, 26, 41, 23, 42	W	[41]
Lygeum spartum L.	8128	*Gramineae*	5	45.57	0.456	—	W	
Malus domestica (Borkh.) Borkh.	37495	*Rosaceae*	4,11	27.85	0.392	7, 37	W	[40]
Mantisalca salmantica (L.) Briq. and Cavill.	5273	*Compositae*	2	13.92	0.139	15	C	[41]

Table 1: Continued.

Scientific name	Herbarium voucher (ABH)	Family	Finch uses	RFC	CI	Medical human uses	Type	References
Nerium oleander L.	46139	*Apocynaceae*	6,8	30.38	0.411	32	C	[39]
Nicotiana tabacum L.	4391	*Solanaceae*	8,11	13.92	0.234	43, 40, 46	W	[39]
Ocimum basilicum L.	Seen alive	*Labiatae*	8	3.8	0.038	7, 4, 8, 13, 10, 5	C	[35, 39, 44]
Olea europaea L.	17212	*Oleaceae*	5	5.06	0.051	36, 10, 1, 41, 7, 29, 37, 24, 19, 25, 23, 8	W	[7, 35, 40, 44]
Onopordum acanthium L.	11328	*Compositae*	2	11.39	0.114	—	W	
Panicum miliaceum L.	36589	*Gramineae*	3	68.35	0.063	—	W	
Papaver rhoeas L.	37589	*Papaveraceae*	3,4	26.58	0.291	14, 12, 46, 23, 9, 18, 13, 4	C	[7, 35, 39, 44]
Papaver somniferum L.	10585	*Papaveraceae*	3,4	17.72	0.203	13, 4, 5, 12, 46	W	[39]
Paronychia argentea Lam.	13044	*Caryophyllaceae*	1	6.33	0.063	18, 24, 1	C	[35]
Perilla frutescens L.	Seen alive	*Labiatae*	3	60.76	0.608	—	C	
Phagnalon saxatile (L.) Cass.	49631	*Compositae*	2	10.13	0.101	—	W	
Phalaris canariensis L.	14955	*Gramineae*	3	100	1.000	—	W	
Phoenix dactylifera L.	14303	*Palmae*	1	10.13	0.101	9	W	[39]
Phragmites australis (Cav.) Steudel	40289	*Gramineae*	6,7	64.56	0.918	—	W	
Picris echioides L.	47438	*Compositae*	2	7.59	0.076	—	W	[40]
Pinus halepensis Miller	37506	*Pinaceae*	2,5,9	51.9	0.791	14, 13, 41, 19, 37, 24, 39	W	[35, 40, 44]
Pinus pinea L.	32768	*Pinaceae*	3,5,9	7.59	0.120	—	C	
Piptatherum miliaceum (L.) Coss.	6843	*Gramineae*	3	27.85	0.278	—	C	
Pistacia lentiscus L.	10319	*Anacardiaceae*	11	6.33	0.063	37	C	[39]
Portulaca oleracea L.	36619	*Portulacaceae*	2,3	72.15	0.759	41, 38, 15, 44, 33, 23, 18, 11, 4, 25	W	[40]
Punica granatum L.	46140	*Punicaceae*	9	8.86	0.089	11, 15	W	[40]
Raphanus sativus L.	51395	*Cruciferae*	3,4	49.37	0.741	29, 12, 3, 21, 13,	W	[41]
Rosa agrestis Savi	51473	*Rosaceae*	11	6.33	0.063	18, 41, 24, 4	W	[35, 44]
Rubus ulmifolius Schott	40230	*Rosaceae*	4,10	11.39	0.133	24, 46, 15, 5, 39, 9, 3, 31	W	[7, 35, 39, 44]
Scolymus hispanicus L.	20754	*Compositae*	2	40.51	0.405	—	W	
Scolymus maculatus L.	20114	*Compositae*	2	10.13	0.101	—	W	
Scorzonera hispanica L.	4557	*Compositae*	4	16.46	0.165	—	W	
Senecio vulgaris L.	7527	*Compositae*	4	7.59	0.076	—	W	
Setaria italica (L.) P. Beauv.	16519	*Gramineae*	3	46.84	0.468	—	C	
Silybum marianum (L.) Gaertner	32020	*Compositae*	2	73.42	0.734	21, 8, 9, 3, 36, 37, 27, 29, 32, 15, 1, 42, 12, 13, 40	C	[7, 35, 41, 44]
Sonchus oleraceus L.	47365	*Compositae*	4	44.3	0.443	9	W	[39]

Table 1: Continued.

Scientific name	Herbarium voucher (ABH)	Family	Finch uses	RFC	CI	Medical human uses	Type	References
Sonchus tenerrimus L.	37483	*Compositae*	4	40.51	0.405	9	W	[39]
Sorghum halepense (L.) Pers.	3298	*Gramineae*	3	53.16	0.532	46	W	[41]
Spinacia oleracea L.	Seen alive	*Chenopodiaceae*	4	43.04	0.430	—	C	
Stellaria media (L.) Vill.	10674	*Caryophyllaceae*	4	11.39	0.114	—	W	
Stipa tenacissima L.	44375	*Gramineae*	5	92.41	0.924	37	W	[39]
Taraxacum vulgare (Lam.) Schrank	1808	*Compositae*	4	49.37	0.494	33, 8	W	[44]
Thymelaea hirsuta L.	41262	*Thymelaeaceae*	2	27.85	0.278	11, 10	C	[41]
Urtica dioica L.	40147	*Urticaceae*	1,4	26.58	0.316	1, 20, 5, 41, 16, 13	W	[7]
Urtica urens L.	33640	*Urticaceae*	1,4,11	34.18	0.424	21, 13, 41, 3, 30, 9, 18, 37, 1, 12, 16	W	[35, 39, 44]
Viscum album L.	49508	*Viscaceae*	7	60.76	0.608	—	W	

3.1. Uses in Finches. The most important plant species used by bird breeders are *Phalaris canariensis, Cannabis sativa, Stipa tenacissima, Diplotaxis erucoides,* and *Brassica napus,* representing more than 90% of relative citation frequency (RFC). Among the species with the greatest cultural importance, two species with values higher than 1 for the CI index are striking: *Cannabis sativa* (CI = 1.158) and *Phalaris canariensis* (CI = 1). In contrast, the lowest CI are in *Citrus limon* (CI = 0.025), *Chelidonium majus, Cicer arietinum, Ocimum basilicum* (CI = 0.038), *Allium sativum*, and *Olea europaea* (CI = 0.051).

Most of the plant species (24.75%) identified were placed inside nets to attract and capture wild birds in the field (Figure 2). Thus, once birds have entered the nets, the hunter pulls a rope, and the birds are trapped (Figures 3 and 4). The stems of some plants (e.g., Lygeum spartum, Olea europaea and Stipa tenacissima) are spread with an adhesive substance called birdlime ("envisque" or "liga" in local Spanish), obtained from a mixture of resins (e.g., resin from *Pinus halepensis* and *Pinus pinea*), olive oil (from *Olea europaea*), and some plants (e.g., *Andryala ragusina, Chondrilla juncea,* and *Euphorbia characias*). Birds that land on these stems while frequenting feeders or watering points are captured in this way. Catching tools include plants that are used to construct hunter refuges (e.g., *Arundo donax, Phragmites australis,* and *Viscum album*) or decoys that are used to attract other birds to the nets (e.g., *Brachypodium retusum* and *Hyparrhenia hirta*). Capture nets must blend in with the terrain conditions; therefore, they are dyed a matte colour that is as close as possible to the surrounding environment. Hunters use an infusion of certain plants (e.g., *Punica granatum, Pinus halepensis,* and *Pinus pinea*) to produce these dyes.

Furthermore, many of the species were used to produce the seeds and wild vegetables (18.81%) used to feed birds in captivity. Plants that facilitate breeding include the ones that are used by birds in captivity to build nests (e.g., *Agave americana, Cannabis sativa, Chamaerops humilis, Paronychia argentea*, and *Phoenix dactylifera*), feed their offspring (e.g., *Brassica oleracea* var. *italica*), and stimulate mating (e.g., *Urtica dioica* and *Urtica urens*). Breeders used the fruits and roots of some plants (e.g., *Daucus carota, Fragaria vesca*, and *Rubus ulmifolius*) to enhance the natural red factor in some species of birds, providing natural pigments, particularly in *Carduelis cannabina* and *Carduelis carduelis*. Currently, the cages are made principally from metal or synthetic materials; however, informants can identify the specific natural materials that are used to be used to build cages and cage accessories (e.g., *Arundo donax, Daphne gnidium, Phragmites australis*, and *Nerium oleander*).

Birds in captivity may suffer from certain diseases, and breeders often try to cure these birds by using natural, plant-based remedies. Thus, there are some vulnerary plants (e.g., *Chelidonium majus* and *Rosa agrestis*) and others that stop haemorrhages (e.g., ash of *Nicotiana tabacum*). Some species have antibacterial properties (e.g., *Cicer arietinum,* vinegar of *Malus domestica,* and *Citrus limon*), or they promote moulting (e.g., *Lavandula latifolia*), have disinfectant functions to eliminate microbes (e.g., *Pistacia lentiscus*), or can host beneficial probiotic bacteria or tonic (e.g., vinegar of *Malus domestica*). Some plants have been used as vermifuge, placed in the breeding carrier, in order to expel parasites (e.g., worms) from the intestines, such as mites (especially *Syringophilus* sp., *Dermoglyphus* sp., and *Dermanyssus* sp.) and lice (*Menacanthus* sp. and *Goniocotes* sp.) that affect this group of birds. Leafy vegetables are used as a laxative treatment, the juice of *Urtica urens* to prevent anaemia, and *Cicer arietinum* is used to stop diarrhoea. To sum up, we show the number of species that are used with specific bird veterinarian uses in Table 2.

3.2. Human Medicine Uses. According to the ethnobotanical references consulted, we found 57 plants used in finches that have medical properties in humans. These species are used to cure some ailments related to each pathological group (Table 2). Thus, 48 human uses have been detected in the 97 plant species collected in the study area. *Silybum marianum* (15), *Olea europaea* (12), and *Centaurea aspera* (12) are the species with greater therapeutic uses. We found that 48 uses were related to medical properties: alteration of blood pressure ($n = 9$), haemorrhoids ($n = 3$), depurative ($n = 9$), anxiety ($n = 9$), diarrhoea ($n = 9$), heartburn ($n = 2$), indigestion ($n = 8$), liver disease ($n = 9$), loss of appetite ($n = 19$), constipation($n = 11$), helminthiasis ($n = 8$), cough ($n = 7$), cold ($n = 16$), respiratory problems ($n = 8$), hyperglycemia ($n = 9$), anaemia ($n = 2$), hypercholesterolemia ($n = 1$), retention of liquids ($n = 16$), undefined symptom (tonic) ($n = 7$), gout ($n = 3$), rheumatism ($n = 5$), inflammation of bones or joints ($n = 11$), undefined symptom (analgesic) ($n = 4$), injury ($n = 13$), burns ($n = 4$), kidney stones ($n = 2$), menstruation ($n = 5$), lack of breast milk secretion ($n = 2$), ischocholia ($n = 6$), chilblains ($n = 3$), pimples ($n = 5$), skin diseases ($n = 3$), eczema ($n = 5$), skin fungus ($n = 1$), rubefaction ($n = 1$), calluses and skin hardness ($n = 3$), warts ($n = 11$), bacteria ($n = 2$), microbes ($n = 5$), headache ($n = 2$), inflammation ($n = 11$), fever ($n = 3$), alopecia ($n = 1$), flushing (refreshing) ($n = 3$), alcoholism ($n = 1$), toothache ($n = 8$), mineral deficiency ($n = 1$), and eye infection ($n = 2$).

We only found three vulnerary plants for finches; however, there are 13 species of the total used for this use in humans. There are three antibacterial plants in birds, while in humans we found two different species (*Portulaca oleracea* and *Centaurea aspera*). One plant is disinfectant for finches, while in humans there are 5 antiseptics to eliminate microbes (*Foeniculum vulgare, Centaurea aspera, Pinus halepensis, Lavandula latifolia,* and *Rubus ulmifolius*) and fungal species (*Centaurea aspera*). Twenty eight species are used as a laxative treatment in birds, whereas only eleven have the same medical use for humans. Conversely, we found no plants that are probiotic or that stop bleeding in humans.

4. Discussion

Traditionally, nutritive uses [45] and curative applications [46] of ethnobotanical knowledge have been linked to women. They have demonstrated a high knowledge of both

Figure 2: Local bird breeder.

Figure 3: Traditional hunting method using nets.

wild and cultivated species [47, 48], especially in rural areas [7]. In contrast, wild bird hunting is traditionally a male-dominated pastime. Therefore, we want to highlight that the stakeholders have high know-how, which reflects their identification of different species and their applications. The names and traditional uses can vary depending on geographical location, as vernacular names serve as intangible heritage. Thus, it is necessary to preserve this heritage and promote educational and awareness programmes [20].

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, ethnobotanical 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 [8]. This additive index takes into account not only the spread of use (number of informants) for each species, but also its versatility, that is, the diversity of its uses [17]. Thus, *Cannabis sativa* and *Phalaris canariensis* have the greatest CI, being the principal commercial seed and, moreover, *Cannabis sativa* has other uses. In contrast, the lowest CI are in plants that are used to cure or have no typical uses and are not used by informants to breed songbirds.

Various mixes of dried seeds, composed of seeds from different species, both wild and cultivated, are used to feed birds in captivity [49]. Each bird breeder uses the mixture

Figure 4: Goldfinch claim in *Centaurea aspera.*

of seeds that he/she deems most appropriate. However, some breeders use leafy vegetables to feed birds and supplement their diet of dried seeds. These plants are used mainly in summer, during the birds' moulting period and as a laxative. Other species not cited in this study, such as *Ilex aquifolium*, *Viscum cruciatum,* or *Onopordum nervosum* [11–13, 50–52], are used to capture birds in other areas. Moreover, some plants also have different veterinary uses in other Mediterranean regions. Thus, some authors show that several species, such as *Stellaria media*, *Avena sativa,* and *Urtica dioica,* are used to increase fertility and egg production in chickens. *Urtica urens* is mixed with feed for hens so that they lay eggs earlier in their lifespan and as a result, the eggshells will be harder. *Cirsium arvense*, *Daphne gnidium*, *Phragmites australis,* and *Linum usitatissimum* are antidiarrhoeal and have been used to favour digestion. *Allium sativum, Daphne gnidium*, *Nerium oleander,* and *Nicotiana tabacum* are useful against parasites on farms, and *Cicer arietinum* is used to facilitate the expulsion of the placenta and for purgation in goats and sheep. *Olea europaea* is used to treat mastitis or to detoxicate, and latex from *Chelidonium majus* and *Pinus halepensis* is used to treat wounds [17, 19, 21, 53]. With these data, we can verify that there is a popular tradition for the use of ethnoveterinary plants in Mediterranean areas.

Furthermore, some species identified without human medicine use in the study area have them in other Spanish regions [5, 54–57], such as *Avena sativa* (toothache and quitting smoking), *Bituminaria bituminosa* (vulnerary), *Brassica oleracea* var. *italica* (vulnerary, remineralizing, headache, and anthelmintic), *Brassica rapa* (culinary), *Cannabis sativa* (refreshing and relaxing), *Chelidonium majus* (anticholagogue, hepatoprotective, anti-inflammatory, antiseptic, warts, laxative, and vulnerary), *Conyza bonariensis* (digestive), *Helianthus annuus* (febrifuge), *Phagnalon saxatile* (carminative, analgesic, and cholesterol levels), *Phalaris canariensis* (cholesterol), *Scorzonera hispanica* (diuretic, uric acid, and cholesterol), *Senecio vulgaris* (anti-inflammatory and antiseptic), and *Viscum album* (anticatarrhal, antiseptic, antivariolous, parasiticide, salutiferous, and sedative). Other species, such as *Carthamus tinctorius*, *Centaurea mariolensis*, *Centaurea melitensis*, *Guizotia abyssinica*, *Panicum miliaceum*, *Perilla frutescens*, *Setaria italica,* and *Spinacia oleracea,* do not present other applications in humans, according to

Table 2: Number and frequency of plants used for a specific human use.

Pathologic group	Human use	Medical code	No. of species	Frequency	Bird veterinarian
Circulatory system	Alteration of blood pressure	1	9	9.28	
	Haemorrhoids	2	3	3.09	
	Undefined symptom (depurative)	3	9	9.28	
Mental illness	Anxiety	4	9	9.28	
Digestive system	Diarrhoea	5	9	9.28	1
	Heartburn	6	2	2.06	
	Indigestion	7	8	8.25	1 probiotic
	Liver disease	8	4	4.12	
	Loss of appetite	9	19	19.59	
	Constipation	10	11	11.34	28
	Helminthiasis	11	8	8.25	6
Respiratory system	Cough	12	7	7.22	
	Cold	13	16	16.49	
	Respiratory problems	14	8	8.25	
Metabolism, nutrition, and so forth	Hyperglycemia	15	9	9.28	
	Anaemia	16	2	2.06	1
	Hypercholesterolemia	17	1	1.03	
	Retention of liquids	18	16	16.49	
	Undefined symptom (Tonic)	19	7	7.22	1
Bones, joints, and so forth	Gout	20	3	3.09	
	Rheumatism	21	5	5.15	
	Inflammation	22	1	1.03	
	Undefined symptom (analgesic)	23	4	4.12	
Traumatic injuries and poisoning	Injury	24	13	13.40	3
	Burns	25	4	4.12	
Genital urinary	Kidney stones	26	2	2.06	
	Menstruation	27	5	5.15	
	Lack of breast milk secretion	28	2	2.06	
	Ischocholia	29	6	6.19	
Skin and subcutaneous tissues	Chilblain	30	3	3.09	
	Pimples	31	5	5.15	
	Skin problems	32	3	3.09	
	Eczema	33	5	5.15	
	Skin fungus	34	1	1.03	
	Rubefaction	35	1	1.03	
	Calluses and skin hardness	36	2	2.06	
Infectious and parasitic diseases	Warts	37	11	11.34	
	Bacteria	38	2	2.06	3
	Microbes	39	5	5.15	1
Symptoms, signs, and poorly defined morbid states	Headache	40	2	2.06	
	Inflammation	41	11	11.34	
	Fever	42	3	3.09	
	Alopecia	43	1	1.03	
	Flushing	44	3	3.09	
	Alcoholism	45	1	1.03	
	Toothache	46	8	8.25	
	Mineral deficiency	47	1	1.03	1 molting
Nervous system and sensory organs	Eye infection	48	2	2.06	

these references. This may be due to the rarity of these species or that they are not traditionally cultivated species in the area.

However, 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* (antinostalgic, anthelmintic, anti-inflammatory/antalgic, antiverrucose, and antibronchitic), *Foeniculum vulgare* (carminative, cold, intestinal anti-inflammatory, laxative, gastralgia, diuretic, and antihalitosis), and *Olea europaea* (antihypertensive, hyperglycemia, hernia, food poisoning, heartburn, warts, cough, erysipelas, sores, psoriasis, burns, hoarseness, baldness, rheumatism, antipyretic, antiseptic, laxative, and antinostalgic) [18, 58].

On the other hand, bird populations have declined, mainly due to the abandonment of crops, the use of pesticides, predation of nests, poaching, increased predation due to changes in their natural habitat, uncontrolled development, and in general socioeconomic changes in recent decades [59]. In this aspect, the mechanization of agricultural practices has changed the structure of these agrarian ecosystems, accompanied by a steady degradation and loss of landscape elements with important ecological functions [60]. To preserve bird populations, it is essential to maintain fields active. There are many plants linked to these environments that birds use daily, such as for food or other purposes.

5. Conclusions

In conclusion, data obtained in this research are scarcely known and show many details of plants related to songbirds, facilitating access to interesting and novel information. This allows recovery of forgotten uses and traditions, highlighting the utilization of different species to attract and cure birds and their relation to human medicine, and resulting in a very interesting contribution to ethnobotanical bibliography.

We found that the majority of the plant species related to songbirds were wild, reflecting that the wild bird hunters are aware of this preference and exploit this knowledge of wild flora in their hunting. This demonstrates that informants have great knowledge of the plants used in traditional medicine and finch keeping. Also, the majority of species have medicinal properties that can be used for informants to cure different pathologies.

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