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Comparison of Lamiaceae medicinal uses in eastern Morocco and eastern Andalusia and in Ibn al-Baytar's Compendium of Simple Medicaments (13th century CE)

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ABSTRACT

Ethnopharmacological relevance: Transmission of traditional knowledge over time and across culturally and historically related territories is an important topic in ethnopharmacology. Here, we contribute to this knowledge by analysing data on medicinal uses in two neighbouring areas of the Western Mediterranean in relation to a historical text that has been scarcely mentioned in historical studies despite its interest.

Aim of the study: This paper discusses the sharing of popular knowledge on the medicinal uses of plants between eastern Morocco and eastern Andalusia (Spain), focusing on one of the most useful plant families in the Mediterranean area: Lamiaceae. Moreover, we used the classical work of Ibn al-Baytar (13th century CE) *The Compendium of Simple Medicaments and Foods* as a basis to contrast the possible link of this information, analysing the influence of this historical text on current popular tradition of medicinal plant use in both territories.

Materials and methods: For data collection, we performed ethnobotanical field research in the eastern part of Morocco, recording current medicinal uses for the Lamiaceae. In addition, we systematically reviewed the ethnobotanical literature from eastern Andalusia, developing a database. We investigated the possible historical link of the shared uses and included in this database the information from Ibn al-Baytar's *Compendium*. To compare the similarity and diversity of the data, we used Jaccard's similarity index.

Results: Our field work provided ethnobotanical information for 14 Lamiaceae species with 95 medicinal uses, serving to treat 13 different pathological groups. Of the total uses recorded in Morocco, 30.5% were shared by eastern Andalusia and found in Ibn al-Baytar's work. There was a higher similarity when comparing current uses of the geographically close territories of eastern Morocco and eastern Andalucía (64%) than for eastern Morocco and this historical text (43%). On the other hand, coincidences between current uses in eastern Andalusia and the ones related in the *Compendium* are lower, 28%.

Conclusions: The coincidence of the current ethnobotanical knowledge in the two territories is high for the Lamiaceae. Probably the shared historical background, recent exchanges, information flow, and the influence of the historical herbal texts have influenced this coincidence. In this sense, there is a high plant-use overlap between Ibn al-Baytar's text and both territories: nearly half of the uses currently shared by eastern Morocco and eastern Andalusia were included in the *Compendium* and are related to this period of Islamic medicine, indicating a high level of preservation in the knowledge of plant usage. The study of 14 species of Lamiaceae suggests that this classical codex, which includes a high number of medicinal plants and uses, constitutes a valuable bibliographical source for comparing ancient and modern applications of plants.

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1. Introduction

1.1. Historical studies on medicinal plants

The need for an interdisciplinary approach to understand the relationship between plants and human societies has been argued many times (Balick and Cox, 1996; Heinrich et al., 2006; Leonti, 2011). The study of the knowledge transmission regarding drugs and *materia medica* from native areas through history is fundamental for ethnopharmacological research (Touwaide and Appetiti, 2013). Knowledge from written tradition cannot simply be taken from any point in history without checking its antecedents. Transmission or, conversely, loss of knowledge as well as the development of new knowledge carry important information for ethnopharmacology, helping to optimise the therapeutic uses of the available resources among populations. The relevance of the historical methods in the context of ethnobotany and ethnopharmacology has been highlighted (Heinrich et al., 2006; Leonti et al., 2009, 2010), and historical studies dealing with the link of the traditional plant uses have recently been developed. For example, Leonti et al (2010) argued that one of five plant uses from the modern ethnobotanical literature in Campania comes directly from Matthioli's *Materia Medica*. Pollio et al. (2008) compared Hippocrates' medicinal uses and contemporary ones throughout the Mediterranean region for the genus *Ruta* in order to analyse their continuity from the ancient antiquity to the present. Vos (2010) stated: "the written historical record becomes increasingly important, not only for information about potential medicines but to address issues of ownership and intellectual property rights for traditional medical knowledge".

To provide a context for this work, we should mention that in the Iberian Peninsula the first written documents on traditional knowledge came from historical figures such as Strabo (64 or 63 BCE–c. 24 CE) or Collumela (4-c. 70 CE) (Pardo-de-Santayana et al., 2014). From 711 to 1492 CE, the Muslims dominated the areas previously known by the Roman name Hispania, and the territory was named "Al-Andalus". It occupied a variable number of territories of Spain and Portugal, leaving a vast legacy in culture and knowledge reflected by the fact that nearly 8% of Spanish words are of Arabic origin (Quintana and Mora, 2002). During this period, the Spanish-Muslim agronomists, botanists, and physicians expanded their therapeutic arsenal, developing vast knowledge on medicinal plants and employing a large number of species. This time of advancement for medicine was shaped by names such as Ibn Zhur (1094–1162 CE), Averroes (1126–1198 CE), Maimonides (c.1138–1204 CE) or Ibn al-Baytar. The so-called "Andalusian Agricultural School" (10th to 15th centuries) was analysed by Hernandez-Bermejo and García (2000), considering it "an unknown world heritage". One of the most important works from this time is Ibn al- Baytar's *Kitab al-Yami' li-mufradat al-adwiya wa*-l.-*aghdiya* (the *Compendium of Simple Medicaments and Foods*, hereafter the *Compendium*).

1.2. Ibn al-Baytar, an overview of his life and work

"Diya al-Din Abu Muhammad Abdullah Ibn Ahmed Ibn al-Baytar", hereafter referred to as "Ibn al-Baytar", was a physician, pharmacologist and botanist, probably born in Benalmádena (Malaga, Spain) in 1197 CE. Called "the Spanish Dioscorides" by the historian Menéndez Pelayo, he was probably the foremost botanist among the Moors of this age (Álvarez-de-Morales, 2008). He studied the works of Dioscorides and Galen as well as those from the main physicians from Persia, eastern Arabia, and Al-Andalus. He focused on botany and pharmacology as the complementary disciplines for medicine (Cabo-González, 1999). He has also been recognized as the first author to give a written description of distillation and essential oils (Pavela, 2015). Although his biography is not completely clear, it is thought that in 1219, after his studies, he left Malaga to travel the Islamic world to collect plants, even reaching Syria, Anatolia, Palestine, and Arabia. He died in Damascus in 1248 AD, leaving a large collection of botanical and pharmacological works (Cabo-González, 1997). The most important, the *Compendium*, is one of the major works in Arabic on this issue (Álvarez-de-Morales, 1986). It is considered a pharmacopoeia where some 1400 simple medicaments and foods are described and alphabetically listed, mostly medicinal plants, but also animal and mineral derivatives. To write the work, apart from including his own observations, he consulted about 150 works from previous Arab authors and 20 Greek ones (McNeil, n/d,). The value of the work is manifold: he added 300–400 new simple medicaments to the previous pharmacological works, systematized the discoveries of earlier Arabs, and gave plant names in different languages (Arabic, Persian, Indian, Greek, Latin, and Romance languages) (Álvarez-de-Morales, 1986; Navarro, 1997). Some of the studies on his life and work include Álvarez-de-Morales, (1986, 2008), Cabo-González (1997), Carrillo and Torres-Palomo (1982), Navarro (1997) and Cabo-González (1999), but a historical overview can be found in some general Islamic Medicine books (Akhmisse, 1985; Sterpellone and El sheikh, 1995; Bellakhdar, 1997; Guardi, 1999). This medical tradition, shaped in the 10th century and developed in the 11th to 12th, reached its peak in the 13th to 16th centuries and later declined during the 17th to 19th centuries (Hamarneh, 1991; Lev, 2002). Medical literature and healing methods that had been the core of traditional medicine for over a thousand years were marginalized by the advent of Western medicine in the 19th to 20th century, becoming the exclusive domain of folk medicine and traditional healers (Lev, 2002; Lev and Amar, 2000).

1.3. Modern ethnobotany in Morocco and Andalusia

Ethnobotanical scientific studies in Morocco are relatively young, starting with works by Bellakhdar during the 1970s, 1980s, and 1990s (Bellakhdar, 1978, 1984, 1997; Bellakhdar et al., 1982, 1991). Since then, many works have appeared, with special attention to those of Boulos (1983), Kahouadji (1995), Hmammouchi (1999), Merzouki et al., (2000, 2003), Jouad et al. (2001), Eddouks et al. (2002), El-Hilaly et al. (2003), and Tahraoui et al. (2007). However, only two references focus on the neglected eastern part of the country (Ziyyat et al., 1997; Fakchich and Elachouri, 2014). The bibliographic research concerning classical Arabic texts on *Materia Medica*, by authors from Andalusia and the Maghreb, indicate that the current Moroccan pharmacopoeia has a remarkable historical continuity with respect to the nature of the remedies: 77.7% of simple medicaments employed (including medicinal plant parts) were mentioned in the texts consulted (Bellakhdar, 1997).

Similarly, modern ethnobotanical studies in Andalusia started with the work of González-Tejero (1985), pursuing a research line with several local works (Muñoz-Leza, 1989; González-Tejero, 1990; González-Tejero et al., 1995; Martínez-Lirola et al., 1996, 1997; Mesa, 1996; Triano et al., 1998; Guzmán-Tirado, 1997; Fernández-Ocaña, 2000; Benítez, 2009; Benítez et al., 2010a) and some comprehensive analyses (Benítez et al., 2010b, 2012), focused mainly on the eastern part of the region. As in other Iberian territories where ethnobotanical studies were undertaken during the last two decades (e.g. some of the most recent ones being Carrió and Vallès, 2012; Menendez-Baceta et al., 2012; Alarcón et al., 2015; Rigat et al., 2015), eastern Andalusia can be now considered a region with noteworthy literature on traditional knowledge. However, even with some historical studies (Hernández-Bermejo and García, 1998, 2000), this topic still lacks in-depth studies on the origin of the current traditional knowledge on the use of plants.

This research is part of a more comprehensive study comparing Morocco and Andalusia in terms of the current medicinal uses of species from several botanical families. Several classical texts were used in order to analyse the similarities between territories and the influence of classical texts in the accumulation of ethnobotanical knowledge in each territory. As the importance of the family Lamiaceae in ther-

apeutics has been highlighted many times (Heinrich, 1992; González-Tejero et al., 1992; Benítez et al., 2010b, 2012; Carrió and Vallès, 2012; Parada et al., 2009), we here present the most important findings regarding this group of plants.

1.4. Importance of Lamiaceae in Mediterranean traditional medicine

Lamiaceae is a cosmopolitan botanical family which comprises about 186 genera and 5600 species (Morales et al., 2010), rising to 7200 according to other authors (Harley et al., 2004). It is highly represented in the Mediterranean basin, where it contains about 1000 wild species grouped in 48 genera (Morales, 2000). Of these, 293 species were listed as growing in the Iberian Peninsula (Morales, 2000), but modern treatment of some genera led to the final number of 271 species (not counting subspecies) from 37 genera (Morales et al., 2010). More than half of these occur in eastern Andalusia: 158 species in 33 genera (Blanca et al., 2009), including several species-rich genera such as *Salvia*, *Scutellaria*, *Teucrium* or *Thymus*, and some genera present disagreements in their taxonomic treatment. Northern Morocco has a total of 127 species in 24 genera (Valdés et al., 2002), while numbers for the whole country rise to 204 species in 28 genera (Fennane et al., 2007).

As is commonly known, many of these species are used for as food seasonings or as medicine in many parts of the world (Heinrich, 1992). In general, members of this family are rich in essential oils contained in glands in epidermal cells, with a high variety of phenolic compounds in addition to polyphenols, tannins, iridoids, quinones, coumarins, diterpenoids, triterpenoids, saponins and, in some cases, pyridine and pyrrolidine alkaloids (Evans, 1996). The family has organoleptic properties and general antioxidant and antimicrobial activities (Kuhnt et al., 1995; Guillén and Manzanos, 1999). The importance of this family in eastern Andalusian ethnobotany has previously been highlighted (Benítez et al., 2012), being the most widely used family of plants (561 different applications for 61 species) and showing a high diversity of treated conditions (60% of total ones for this area, representing 122 of the 203 disorders noted). Similarly, it is the most important family for different circum-Mediterranean areas studied comparatively (González-Tejero et al., 2008).

1.5. Aim of the study and research questions

Southern Spain and Morocco have a shared cultural past spanning more than seven centuries (Watt, 1967), but currently cultural, religious, and socio-economic distances make a clearly different lifestyle in the two territories. These differences can be also reflected on in the traditional uses of plants. While Andalusian ethnobotany seems to be quite developed with a number of publications mentioned above, the eastern part of Morocco needs more ethnobotanical field studies.

The aim of this study is threefold. Firstly, we compile ethnobotanical knowledge of eastern Morocco focusing on one of the most useful plant families in the Mediterranean: the Lamiaceae. Secondly, we compare the current uses of the family species between eastern Morocco and eastern Andalusia, in order to analyse the possible links and the level of shared popular knowledge of these plants between the two neighbouring territories. For this, we undertook a literature review of the ethnobotanical works of eastern Andalusia. Moreover, given the importance of Ibn al-Baytar's works for the early development of the medicine in both territories, we used his main work on medicinal plants to establish a historical standpoint for the comparison. Therefore, the third and central aim of the study compares Lamiaceae uses for both territories using the *Compendium*. A precedent for this kind of comparison of three sources of information can be found in Leonti et al. (2009, 2010).

Our first hypothesis is that due to the historical past and the centuries of shared culture and language, as well as a similar flora and vegetation, there must be a high overlap in plant use between these geographically close territories which are currently socio-culturally distant. A second research hypothesis is that, since Ibn al-Baytar has had a great influence on the traditional medicines of both territories, there must be a high plant-use overlap between his texts and use found in Morocco and Andalusia. In this regard, we investigate in which territory this heritage has persisted more. To test these hypotheses, we focused both the fieldwork and the bibliographical comparison on the most useful plant family in the Mediterranean area, Lamiaceae.

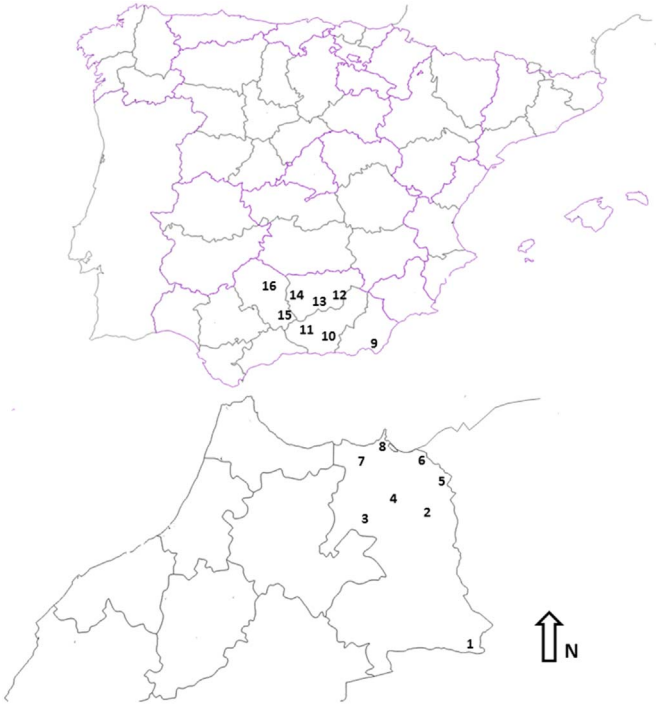

Fig. 1. Map of the study area in East Morocco and the East Andalusian territories used for bibliographical comparison. Numbers 1–8: main localities for the field study. 1. Figuig, 2. Yerada, 3. Guercif, 4. Taourirt, 5. Oujda, 6. Berkhane, 7. Driouch, 8. Nador. Numbers 9–16: Andalusian territories for bibliographical comparison. 9. Martínez-Lirola (1993), 10. González-Tejero, 1989, 11. Benítez (2009), 12. Fernández-Ocaña (2000), 13. Guzmán-Tirado (1997), 14. Casado-Ponce (2003), 15. Triano et al. (1998), 16. Galán-Soldevilla (1993).

2. Materials and methods

2.1. Study area and ethnobotanical field methods

The field study was made in eastern Morocco from April 2008 to July 2013. The study area included the districts of Driouch, Nador, Berkane, Oujda-Angad, Guercif, Taourirt, Jareda, and Figuig (Fig. 1.), covering a total area of about 82,820 km^2 and confined in the north by the Mediterranean Sea and in the east by Algeria. The main localities studied appear in Fig. 1. Eastern Morocco has a population of more than two million, but major differences can be highlighted according to the spatial distribution of the population, with the most densely inhabited areas in Nador and the northern cities. A demographic shift since the 1980s reflects the main rural to urban migrations occurring throughout the country. The territory is characterized by a mountainous region with an average precipitation from 100 to 400 mm per year and vegetation consisting mainly of typical semiarid Mediterranean plant communities.

Surveys were conducted in order to preselect informants. Other conventional methods of informant location, such as the snowball method and participant observation were also followed. Surveys were focused on marketed plants in the study due to their importance for the local population. Several authors (Westermarck, 1926; Doutté, 1984; Bellakhdar et al., 1991; Bellakhdar, 1997) report that herbalists sell the

ingredients prescribed by healers (*Fkih*), and add that they frequently also prescribe medicinal plants. As Bellakhdar (1989) stated, people use plants from markets for socio-economic reasons: a greater cultural identification with the herbalist, and sometimes the inability to afford modern medicine. In the surveys, we asked people if they knew medicinal plants, their use, and common names. With the informants selected, we later held open and semi-structured interviews (Alexiades and Sheldon, 1996; Cotton, 1996; Martin, 2004). Informants gave their prior verbal informed consent. No plant species, plant names or medicinal uses were suggested beforehand. Interviews were usually held individually, although later group discussions and team interviews were organized. All informants lacked academic education, as we preselected with the premise of orally acquired knowledge on medicinal plants. Interviews were made in *Darija*, the Moroccan Arabic dialect. A total of 153 persons were interviewed, ranging from 20 to 70 years of age (10% aged 20–30; 13% 31–40; 23% 41–50; 24% 51–60; 30% 61–70), mostly females (56%) and living mainly in small villages. Their professions included farmers, shepherds, medicinal plants sellers (*Fkih*), as well as wise women (popularly known as *Kablat*), and those men known as wizards.

The plant material was collected from our informants (i.e. dry plants from markets, most donated and others bought from our informants who were also plant sellers) in order to identify the species used. In all cases, we obtained all the needed structures for the proper identification of the species: leaves, calices, corollas, etc. Vouchers were deposited in the University of Tétouan Herbarium, and their codes are included in the results. Several floras were used to identify the plant material (Fennane et al., 1999, 2007, 2014; Valdés et al., 2002; Castroviejo, 1986–2015).

2.2. Ethnobotanical review of Andalusian works

A review was made of the ethnobotanical literature for eastern Andalusia, including the provinces Granada (González-Tejero, 1985; Benítez, 2009), Almería (Martínez-Lirola, 1993), Jaén (Guzmán-Tirado, 1997; Fernández-Ocaña, 2000; Casado-Ponce, 2003), and Córdoba (Galán-Soldevilla, 1993; Triano et al., 1998; see Fig. 1). Most of the works consulted were performed by our research group following the ethnobotanical methods described in the previous section. Data of medicinal uses for the same species used in the study area were included in a database.

2.3. The Compendium of Simple Medicaments and Foods

For the historical analysis of the ethnobotanical information gathered, we focused on a complete edition of the aforementioned *Compendium* by Ibn al-Baytar. We used the French edition (Leclerc, 1877–1883) with the author's comments, providing information on the correlation of the plants included (originally named in several languages by Ibn al-Baytar, e.g. Arabic, Berber, Syrian, and Latin) and their scientific and common French names, according to several previous works based on his extensive knowledge on plants used in North Africa during his lifetime. Moreover, different editions were also consulted in order to clarify some particular paragraphs, including a complete modern Arabic version of the *Compendium* (Ibn al-Baytar, 1992) and several partial Spanish translations (Cabo-González, 1996, 2011, 2009, 2012; Cabo-González and Merino, 2010; Navarro, 1997).

2.4. Data treatment

A database was created in Microsoft Access® with information on the ethnopharmacological fieldwork data for eastern Morocco, the data reviewed for the same plants in eastern Andalusia, and the uses included for them in the work of Ibn al-Baytar. Standard classifications are a valid tool for cross-cultural comparisons (Staub et al., 2015). In the present study, conditions and their classification in pathological groups were included according to the classification of Adjanohoun et al. (1989). This categorization includes a number of conditions in the pathological group "undefined symptoms", which can be interpreted as a bias. Some of these conditions are included in other groups in different classification such as those proposed by Staub et al. (2015): The International Classification of Diseases (ICD) by the WHO (http://www.who.int/classifications/icd/en/) or the International Classification of Primary Care (ICPC) (http://www.who.int/classifications/icd/adaptations/icpc2/en/). Nevertheless, we follow this classification in this research in order to standardize data with some of the previous works (González-Tejero, 1990; Martínez-Lirola, 1993; Benítez et al., 2010a) used in the ethnobotanical review.

Jaccard's similarity index was generated in order to compare the similarity and diversity of the data, as some other comparative ethnobotanical analyses (González-Tejero et al., 2008; Sõukand and Pieroni, 2016) according to the formula

$$JI = (C/(A + B - C)) \times 100$$

where A is the number of taxa of the sample A, B is the number of taxa of the sample B, and C is the number of taxa common to A and B. The index can range from 0 (no coincidence) to 100. It was calculated for comparing the three information sources, i.e. current eastern Moroccan ethnobotany (original fieldwork data), current eastern Andalusian ethnobotany and historical uses in both territories on the basis of *The Compendium*. It was generated by comparing the coincidence of the use of a certain species for any condition of each pathological group, without considering the specific condition for which the plant is used in the pathological group. In this way, we sought to avoid some of the bias regarding the different names of the conditions included in the three sources of information (see below). The main data were also presented as a Venn diagram.

2.5. Nomenclatural and taxonomical comments and bias

The correlation of the current scientific names with ancient Latin, Arabic or other languages is not easy, as pointed out by many authors (Holmes, 1888; Font Quer, 1961; De Vos, 2010), including the Ibn al-Baytar translator (Leclerc, 1877–1883). Moreover, all ethnopharmacological research needs to refer unambiguously to the plant species under study (Rivera et al., 2014). Some works in this issue do not include the binomial Latin name for cases in which the complete identification was inconclusive, preferring a more conservative use of the genus (De Vos, 2010). In our opinion, this correlation can be similarly more conservative using the name of the genus, even comparing the current use of some plants known in different territories, where species of a genus should not be the same due to high speciation, especially when they are used in an unspecific manner. In this sense, we preferred to include some plants with their scientific genus names only, such as *Thymus, Salvia*, and *Lavandula*, and explain those cases in the results. The species used can be related but different, as in many cases to our knowledge local people do not appear to differentiate between species of these genera for some widely known uses, and these uses can be associated with more than one species. This does not mean that there are cases of specific uses for particular species. Moreover, as the Moroccan fieldwork was focused on marketed plants and the Andalusian fieldwork on wild gathered plants (although most of the included ones are also marketed there), particular species should not always be the same, but uses can be properly compared for the genus, especially if the comparison includes classical texts where the correlation problem is evident.

Two illustrative examples are that in this study we used the genus name *Lavandula* to designate several species from the section *Lavandula* (according to Suárez-Cervera and Seoane-Camba, 1986): *L. latifolia*, *L. angustifolia*, *L. lanata* as well as the hybrid *L.* x *intermedia*. The reason is, on the one hand, that the marketed plants in Morocco correspond to *L. x intermedia*, a crop plant not known in

the wild in Morocco and probably introduced during the French colonial period. On the other hand, the species referred to in the Andalusian literature are *L. latifolia* and *L. lanata*. Moreover, we cannot be sure of the identity of the lavender in al-Baytar's *Compendium* but Leclerc assigned to it the scientific names *L. spica* and *L. officinalis*, which are currently interpreted as synonyms for the accepted *L. angustifolia* Mill. (Morales, 2010). Therefore we established the correlation with all these names for the medicinal lavender in the bibliographical comparison, explaining the case. In the case of *Thymus*, the species marketed in our study area of Morocco is *T. vulgaris*, but in Leclerc's comments to his translation, he associated Ibn al-Baytar's uses for thyme with *T. zygis*, the most frequent taxon in Andalusia, as well as the one most referred to in ethnobotanical studies for this territory (currently named *T. zygis* ssp. *gracilis)*. Therefore, we established the correlation considering both species. It is important to highlight that, even though *Thymus* is a genus with 15 taxa in eastern Andalusia (Blanca et al., 2009) and 10 in northern Morocco (Valdés et al., 2002), we included in the database Andalusian ethnobotanical uses only for *T. zygis* ssp. *gracilis* and *T. vulgaris*, and not for the rest of the plants, which are generally recognized as different species with a different common name. The rest of the scientific names included in the results corresponding to the taxa identified from vouchers in Morocco. When the related species (or name) used differs in the *Compendium* or Andalusian ethnobotany, different names are also included.

3. Results

3.1. Ethnobotanical fieldwork in Morocco

Although this fieldwork was not focused on Lamiaceae, this proved to be the family with the highest number of plants included, 14 taxa. Most are well-known medicinal plants, with a long tradition of use and more or less in-depth phytochemical studies. Eight also appear in the European Pharmacopoeia (2013) as well as in the commission E monographs (Blumenthal et al., 2000), and only six in the ESCOP monographs (ESCOP, 2003–2009).

A sum of 95 medicinal uses have been recorded for these plants in the study area, serving to treat afflictions from 14 pathological groups (Table 1). Undefined symptoms, digestive and respiratory, are the notable pathological groups in use numbers in Morocco for the Lamiaceae (Table 2). On the other hand, *Rosmarinus officinalis* is the most diversely used plant in the study area, with 14 different medicinal uses, as well as for eastern Andalusia, where it has been declared a panacea (Benítez et al., 2010a; Guzmán-Tirado, 1997). *Thymus vulgaris* and *Marrubium vulgare* are also diversely used (10 uses each), and it is noteworthy that *Thymus* is used for 4 different digestive conditions in the study area. The distribution of medicinal uses quoted for each plant in the study area, in eastern Andalusia, and in the *Compendium* can be seen in Fig. 2.

3.2. Al-Baytar's work and bibliographical comparison

Table 1 also includes the comparison data for the two bibliographical sources: eastern Andalusian ethnobotany and ancient uses according to al-Baytar's work. Grouping all the data, the 14 taxa have been described to treat 125 conditions in 14 pathological groups. The table includes a total of 540 mentions for 395 uses, many being recorded in more than one source.

These mentions are sorted by pathological group in Table 2 for the three sources of information used. As the bibliographical framework for Andalusia included a number of field studies, and data from Morocco were from only one field survey, it is not surprising that the number of uses was higher for this latter territory in all pathological groups, apart from birth and pregnancy complications, as well as for the total ones.

A brief analysis of Ibn al-Baytar's *Compendium* for these Lamiaceae indicates the vast amount of information in this text: 193 uses for only 14 taxa. It bears highlighting the importance of these plants in former times for treating conditions included in pathological groups "Undefined symptoms" (such as asthenia, headache, nervousness, fever or general inflammation, included in this group in the followed classification), "Digestive" and "Respiratory" (Table 2). As analysed below, examples of the conserved uses in both territories also appearing in the *Compendium* are the infusion of *Melissa officinalis* and *Mentha pulegium* for gases, *Mentha spicata* against headache, *Ocimum basilicum* to avoid vomits and/or *Teucrium polium* against fever. Moreover, analyses of the uses not described in modern ethnobotanical research from Morocco and Andalusia revealed that 104 uses from the *Compendium* (55% of the total) are not currently known in these areas. On the other hand, 41 of the 95 included uses for Morocco (44%) and 71 of 257 uses for Andalusia (28%, Table 4) were described in the *Compendium*, and their precedence can be placed at least in this historical text if not even before, as Ibn al-Baytar also quoted many previous authors, as commented in the Introduction of the present work. To clarify the links between the three sources of plant usage, we drew a Venn diagram (Fig. 3).

To analyse the use similarities in each pathological group, we calculated Jaccard's index (Table 3). The groups "Respiratory", "Undefined symptoms", "Digestive", "Genital-urinary", "Traumatic injuries", and "Infectious" showed higher levels of similarity. This is not surprising since groups Respiratory and Digestive are the main medicinal uses for the family in many of the works consulted for different Mediterranean territories (Martínez-Lirola, 1993; Benítez, 2009; González-Tejero et al., 2008).

To delve into the coincidence analysis for the three sources, we have included two tables. Table 4 reflects shared uses and percentages for each taxa. Table 5 lists the uses (17 conditions and the cosmetic use) for which at least one taxon is mentioned in the three sources, including the number of coincidences and the coincidence percentages. It was calculated by the coefficient between the total number of taxa mentioned for a given condition and the number of coincident taxa in the three sources for this condition.

4. Discussion

4.1. Comparison between sources

4.1.1. General comparison of the three sources

Fig. 3 shows that 29 uses coincide in the three sources; therefore, 30.5% of the total uses recorded for Lamiaceae in the study area of Morocco (95, Table 2) are also known to be practiced in Andalusia and were also described by the medieval physician eight centuries earlier. Most of the plants have coinciding uses (those in bold in Table 1). It is worth underscoring the 5 same uses in the cases of *Thymus*, for three digestive conditions (stomach disorders, liver disease, and halitosis) as well as for sore throats and as a cosmetic, while *Rosmarinus officinalis* is used for asthma, cold or cough, liver disease and menstruation disorders. *Origanum vulgare,* which serves for stomach disorders, colds or cough, menstruation disorders, and loss of appetite, is the third most used plant in number of coinciding uses. The remaining plants have only one or two coinciding uses in the three sources, but *Ballota nigra*, *Lavandula*, and *Origanum majorana* do not coincide in uses. Table 5 lists the most coinciding conditions among the three sources. Cold or cough, stomach disorders, and menstruation disorders most coincide regarding the taxa used. Nevertheless, when the percentages are compared while taking into account the total number of taxa used in each condition, gallbladder disorders become striking.

4.1.2. Eastern Morocco, eastern Andalusia and probable links in uses

There are 61 coinciding uses for both territories (Fig. 3, Table 4), representing some 64% of coincidence for the recorded uses in Morocco. All plants apart from *Ballota hirsuta* and *Origanum major-*

Table 1
Scientific names of the plants used in the study area, with specifications of the different names in the study area and the bibliographical consulted works and the parts used. Vernacular names, pathological groups, conditions and quotations through the three sources for plant uses. Conditions in bold coincide for the three sources. IB: Ibn al-Baytar; M. Morocco; A: Andalusia.

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
***Ballota nigra* L.** **MP-Lam-001 FP** Flowered aeral parts	**IB**: (n° 341, 1245, 2123) Ballouti, marrouba banthoucha, sindiyân al- ârd **(**بلوطى، مروبة بنثوشة، سنديان الارض**).** **M**: Farrasyûn (فرسيون**).** **A**: Manrubio negro, Manrubio fétido.	Circulatory system	Hemorrhoids	+	–	–
		Digestive system	Toothache	–	–	+
		Genito-urinary	Menstruation disorders	–	+	–
		Traumatic injuries	Animal bites	+	–	–
			Wounds / ulcers / sores	+	–	–
		Undefined symptoms	Nervousness	–	+	–
***Lavandula* spp.** **M. *Lavandula x intermedia* Emeric. ex Loisel.** **MP-Lam-002 FP** *A.Lavandula latifolia* Medicus; *L. lanata* Boiss. IB. *Lavandula spica* L. (=*L. angustifolia* Mill.) and *L. officinalis* Chaix (=*L. angustifolia* Mill.) Flowered aeral parts or flowers	**IB:** (n° 791) *Al- khozâma* **(**الخزامى**).** **M:** *ı-khzâma (*لخزامى*).* **A**: *Alhucema, Alucemón, Lavanda, Espliego.*	Circulatory system	Blood pressure disorders	–	–	+
			Varicose veins	–	–	+
			Cardiac disorders	–	–	+
		Digestive system	Toothache	–	–	+
			Liver disease	+	–	–
			Spleen disease	+	–	–
			Stomach disorders / pain / dyspepsia	–	–	+
		Complications of pregnancy and childbirth	Infertility	+	–	–
		Genito-urinary	Affections of the matrix	+	–	–
		Bones and articulations	Rheumatism	–	+	+
			Sciatica	–	+	–
		Traumatic injuries	Contusion	–	–	+
			Wounds / ulcers / sores	–	–	+
			Animal bites	–	–	+
		Metabolism and nutrition	Diabetes	–	–	+
			Hypercholesterolemia	–	–	+
		Skin and subcutaneous tissue	Alopecia	–	+	+
			Eczema	–	–	+
		Respiratory System	Asthma	–	+	+
			Sore throats	–	–	+
			Rhinitis	+	–	–
			Cold / cough	–	+	+
		Nervous system and sense organs	Migraine	–	–	+
		Mental Illness	Depression	–	–	+
		Undefined symptoms	Aphrodisiac	–	–	+
			Pain	–	+	+
			Insomnia	–	–	+
			Nervousness	+	–	–
			Frailty	+	–	+
			Flatulence	–	–	+
			Anorexy/Loss of appetite	–	–	+
			Sweat	–	–	+
***Lavandula stoechas* L.** **MP-Lam-003 FP** Flowered aeral parts	IB: (n° 62, 1437, 1944, 2182) Astoukhodos, muwaqef l-ârwâh, dhirm, kicha, momsik el-ârwâh *(*اسطوخودوس، ضرم، كشة، موقف الارواح، ممسك الارواح*).* **M**: Halhal *(*لحلحال*).* **A**: Cantuezo, Tomillo, Cantueso basto.	Circulatory system	Cardiac disorders	+	–	–
			Circulatory disorders	–	–	+
		Digestive system	Liver disease	+	–	+
			Spleen disease	+	–	–
			Gallbladder disorders	–	–	+
			Intestine disorders	–	–	+
			Gastric ulcer	–	–	+
			Stomach disorders / pain / dyspepsia	+	–	+
		Genito-urinary	Kidney disease	+	–	+
			Diuretic	–	–	+
		Bones and articulations	**Rheumatism**	**+**	**+**	**+**
			Sciatica	–	–	+
		Traumatic injuries	Contusion	+	–	+
			Wounds / ulcers / sores	–	+	+

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
			Animal bites	+	–	–
		Metabolism and nutrition	Diabetes	–	–	+
			Hypercholesterolemia	–	–	+
			Obesity	–	–	+
		Respiratory System	**Cold / cough**	**+**	**+**	**+**
		Nervous system and sense organs	Apoplexy	+	–	–
			Epilepsy	+	+	–
			Nervous disorders	+	+	–
		Mental Illness	Melancholia	+	+	–
		Undefined symptoms	Asthenia	+	–	–
			Headache	+	–	+
			Colics	+	–	–
			Queasiness	+	–	–
			Anorexy/Loss of appetite	+	–	+
***Marrubium vulgare* L.** **MP-Lam-004 FP** Flowered aeral parts	**IB**: (n° 1316, 1347, 1674) Farâssyûn, chennâr, cherbet, merriw (فراسيون، شربت، شنار، مروي**).** **M:** Marrîwa **(**مريوة**)**. **A:** Malrrubio, Marubío, Mastranzo, Matroncho, Marubio negro.	Circulatory system	Blood pressure disorders	–	–	+
			Blood purifyer	–	–	+
		Digestive system	Constipation	–	–	+
			Toothache	–	–	+
			Liver disease	–	–	+
			Intestine disorders	+	–	+
			Spleen disease	+	–	–
			Stomach disorders / pain / dyspepsia	+	–	+
		Genito-urinary	Diuretic	–	+	+
			Menstruation disorders	–	+	+
			Dysuria	+	–	–
		Bones and articulations	Rheumatism	–	–	+
		Infectious and parasitic diseases	Helminth	–	+	–
			Herpes	–	–	+
			Brucellosis	–	–	+
			Infection	–	–	+
			Lymph node alterations	+	–	–
		Traumatic injuries	Wounds / ulcers / sores	+	–	+
		Metabolism and nutrition	Diabetes	–	+	+
			Hypercholesterolemia	–	–	+
			Hyperuricemia	–	–	+
			Obesity	–	–	+
		Skin and subcutaneous tissue	Abscess	+	–	+
			Erysipelas	–	–	+
			Eczema	–	–	+
		Respiratory System	Asthma	+	–	+
			Dyspnoea	+	–	–
			Cold / cough	**+**	**+**	**+**
			Ulcer in the lung	+	–	–
		Nervous system and sense organs	Eye disease	+	–	–
		Tumors	Malignant sores	+	–	–
			Cancer	–	–	+
		Undefined symptoms	Asthenia	–	–	+
			Colics	+	–	+
			Fever	–	+	+
			Insomnia	–	+	–
			Nervousness	–	–	+
			Flatulence	–	–	+
			Anorexy/Loss of appetite	–	+	+
			Jaundice	–	+	+
			Cosmetic	–	+	–
***Melissa officinalis* L.** **MP-Lam-005 FP** Aereal parts	**IB**: (221, 326, 592, 1928, 2082) *Baklat el-atrodjîa, toroufjân, turunjân, badrendjouya, kezouân, habaq torondjâny, mâlissofulon (*بادرنجوية، ترنجان، بقلة الاثرجية، مفرج القلب، كزوان، حبق ترنجاني، مالسوفلن*).*	Circulatory system	Cardiac disorders	+	–	+
		Digestive system	Diarrhea	+	–	+
			Constipation	+	–	+

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
	M: Na'nâ ssoufi **(**نعناع صوفى**).**		Halitosis	+	–	+
	A: *Melissa, Citronela, Torongil, Té de calazo.*		Liver disease	+	–	–
		Infectious and parasitic diseases	Scabies	+	–	–
		Respiratory System	Dyspnoea	+	–	–
		Nervous system and sense organs	Epilepsy	+	–	–
			Cerebral obstruction	+	–	–
		Mental Illness	Depression	+	–	+
		Undefined symptoms	Insomnia	–	–	+
			Queasiness	+	+	–
			Nerviosism	–	–	+
			Flatulence	**+**	**+**	**+**
			Anorexy/Loss of appetite	+	–	+
			Hiccup	+	–	–
***Mentha pulegium* L.** **MP-Lam-006 AP** Aereal parts	**IB**: (1639, 1712): *Foudendji, ghlichon, bolaïa qoboria, foulaïa, tikothan, foutendj berry* **(**فودنج، فلية، غليجون، تيكوثان، فوتنج بري، بلاية قبورية).	Circulatory system	Blood purifyer	–	–	+
			Circulatory disorders	–	–	+
	M: *Fliyyo* **(**فليو**).**	Digestive system	Diarrhea	–	–	+
	A: *Poleo, Menta poleo.*		Constipation	–	–	+
			Toothache	–	–	+
			Liver disease	–	+	+
			Stomach disorders / pain / dyspepsia	–	+	+
		Complications of pregnancy and childbirth	Pregnancy (abortive)	–	–	+
		Genito-urinary	Kidney disease	–	–	+
			Affections of the matrix	–	–	+
			Diuretic	–	–	+
			Menstruation disorders	–	+	+
		Bones and articulations	Rheumatism	–	–	+
		Infectious and parasitic diseases	Helminth	–	–	+
		Metabolism and nutrition	Diabetes	–	–	+
			Hypercholesterolemia	–	–	+
			Obesity	–	–	+
		Respiratory System	Asthma	–	+	–
			Cold / cough	**+**	**+**	**+**
		Undefined symptoms	Aphrodisiac	–	–	+
			Headache	–	+	+
			Queasiness	–	–	+
			Inflammation	+	–	–
			Flatulence	**+**	**+**	**+**
			Anorexy/Loss of appetite	–	–	+
***Mentha spicata* L.** **MP-Lam-007 AP** Aereal parts	**IB**: (n°: 2227), *Na'na'(*نعنع*).*	Circulatory system	Hemorrhoids	+	+	–
	M: *Na'na' (*نعناع*), Liqama (*لقامة*).*		Circulatory disorders	–	–	+
	A: *Hierba buena, Menta.*		Cardiac tonic	+	–	–
		Digestive system	Constipation	–	–	+
			Toothache	+	–	–
			Stomach disorders / pain / dyspepsia	**+**	**+**	**+**
		Complications of pregnancy and childbirth	Childbirth difficulties	+	–	–
			Breast swelling	–	+	–
			Galactogen	–	+	–
		Genito-urinary	Testicular diseases	+	–	–
		Infectious and parasitic diseases	Helminth	–	+	+
			Lymph node alterations	+	–	–
		Traumatic injuries	Animal bites	+	–	–
			Burns	**+**	**+**	**+**
		Metabolism and nutrition	Diabetes	–	–	+
			Hypercholesterolemia	–	–	+

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
		Skin and subcutaneous tissue	Abscess	+	–	–
			Corns and calluses	–	–	+
		Respiratory System	Cold / cough	+	–	+
		Undefined symptoms	Aphrodisiac	+	–	+
			Headache	**+**	**+**	**+**
			Fever	–	–	+
			Anorexy/Loss of appetite	+	–	+
			Hiccup	+	–	–
			Thirst	–	+	–
			Vomits	+	–	+
			Tonic	–	+	–
***Ocimum basilicum* L.** **MP-Lam-008 L & F** Leaves or aereal parts	**IB**: (n° 205, 223, 511, 589, 593, 704, 726, 892, 897, 1075, 1077, 1268, 1441) Habaq nabaty, Badroudj, El-houc, Rîhân Soleyman, Habaq sa'tarî, Habaq kermâny, Rihan hamahîm, Djemserfrem, Habaq rîhâny (حبق نباتي، بادروج، ريحان سليمان ،الحوك، حبق كرماني، حبق صعتري، شاهسفرم، ريحان الحماحم**).** **M:** Lahbaq **(**لحبق**).** **A:** Albahaca.	Circulatory system	Hemorrhoids	+	+	–
			Syncope	+	–	–
			Cardiac disorders	+	–	–
		Digestive system	Oral thrush	+	–	–
			Diarrhea	+	–	–
			Constipation	–	–	+
			Halitosis	–	–	+
			Toothache	+	–	–
			Stomach disorders / pain / dyspepsia	**+**	**+**	**+**
		Complications of pregnancy and childbirth	Galactogen	–	+	+
		Genito-urinary	Affections of the matrix	+	–	–
			Diuretic	–	–	+
		Bones and articulations	Rheumatism	–	–	+
			Obstruction of joints	+	–	–
		Infectious and parasitic diseases	Helminth	–	–	+
		Traumatic injuries	Wounds / ulcers / sores	+	–	+
			Animal bites	+	–	+
			Burns	+	–	–
		Metabolism and nutrition	Obesity	–	–	+
			Gout	+	–	–
		Skin and subcutaneous tissue	Alopecia	–	–	+
			Erysipelas	+	–	–
		Respiratory System	Sore throats	–	–	+
			Dyspnoea	+	–	–
			Bloody sputum	+	–	–
			Cold / cough	+	–	+
		Nervous system and sense organs	Eye disease	–	–	+
			Earache	+	–	–
			Cerebral obstruction	+	–	–
			Facial tic	+	–	–
			Pituitary tumor	+	–	–
		Mental Illness	Depression	–	+	–
		Undefined symptoms	Aphrodisiac	–	–	+
			Headache	–	–	+
			Insomnia	+	+	–
			Flatulence	+	–	+
			Anorexy/Loss of appetite	+	–	+
			Vomits	**+**	**+**	**+**
			Tonic	–	+	–
			Obstruction	+	–	–
***Origanum majorana* L.** **MP-Lam-009 FP** Flowered aeral parts	**IB**: (n° 178, 586, 587, 891, 1230, 1598, 2100) *Andjouk, merzendjouch, hebak el - qana, dohne el merzendjouch, merdadouch, Merdaqûch, Semsak, 'Anqar* **(**عنجوق ، مرزنجوش، دهن المرزنجوش، حبق القنا، سمسق، مردقوش، مرددوش، عنقر**).** **M:** *Merdeddouch* **(**مرددوش**).**	Circulatory system	Palpitation	+	–	–
		Digestive system	Stomach disorders / pain / dyspepsia	+	+	–
		Genito-urinary	Diuretic	+	+	–
			Menstruation disorders	–	–	+

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
	A: *Mejorana, Mayorana, Orégano.*	Bones and articulations	Pain lumbar	–	–	+
		Traumatic injuries	Scarification	+	–	–
		Metabolism and nutrition	Allergy	–	–	+
		Respiratory System	Sore throats	–	–	+
			Dyspnoea	+	–	–
			Rhinitis	+	–	–
			Cold / cough	–	+	–
		Nervous system and sense organs	Eye disease	+	–	–
			Migraine	+	–	–
			Facial tic	+	–	–
		Mental Illness	Melancholia	+	–	–
		Undefined symptoms	Headache	+	+	–
			Fever	–	+	–
			Insomnia	–	+	–
			Flatulence	+	–	–
			Hiccup	+	–	–
			Drunkenness	+	–	–
***Origanum vulgare* L.** **MP-Lam-010 AP** *A.Origanum vulgare* L. ssp. *virens* (Hoffmanns. & Link) Ietsw. IB. *Origanum vulgare* L. Flowered aeral parts	**IB**: (n° 1398), *Sa´tar: (صعتر).* **M**: *Za'tar (الزعتر).* **A**: *Orégano.*	Circulatory system	Blood pressure disorders	–	–	+
			Circulatory disorders	+	–	–
		Digestive system	**Toothache**	**+**	**+**	**+**
			Liver disease	+	–	–
			Stomach disorders / pain / dyspepsia	**+**	**+**	**+**
		Genito-urinary	Affections of the matrix	+	–	–
			Diuretic	+	–	–
			Bladder conditions	+	–	–
			Menstruation disorders	**+**	**+**	**+**
		Bones and articulations	Articular pain	+	–	–
		Infectious and parasitic diseases	Helminth	+	–	–
		Traumatic injuries	Animal bites	+	–	–
			Burns	–	–	+
			Poisoning	–	–	+
		Skin and subcutaneous tissue	Skin conditions	–	–	+
		Respiratory System	Flu	–	–	+
			Sore throats	–	–	+
			Cold / cough	**+**	**+**	**+**
		Nervous system and sense organs	Eye disease	+	–	–
		Undefined symptoms	Headache	–	–	+
			Colics	+	–	+
			Flatulence	+	–	+
			Anorexy/Loss of appetite	**+**	**+**	**+**
			Cosmetic	+	+	–
			Purgative	+	–	–
			Dropsy	+	–	–
			Obstruction	+	–	–
***Rosmarinus officinalis* L.** **MP-Lam-011 FP** Flowered aeral parts	**IB**: (n° 129): Îklîl al-jabal (إكليل الجبل). **M**: Azîr (أزير). **A**: Romero, romero blanco.	Circulatory system	Blood pressure disorders	–	–	+
			Varicose veins	–	–	+
			Circulatory disorders	–	–	+
			Palpitation	+	–	–
		Digestive system	Diarrhea	–	–	+
			Toothache	–	–	+
			Liver disease	**+**	**+**	**+**
			Spleen disease	**+**	–	–
			Intestine disorders	–	+	+
			Gastric ulcer	–	–	+
			Stomach disorders / pain / dyspepsia	–	–	+
		Complications of pregnancy and	Pregnancy (abortive)	–	+	–

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
		childbirth				
		Genito-urinary	Prostatism	–	–	+
			Kidney disease	–	–	+
			Diuretic	+	–	+
			Menstruation disorders	**+**	**+**	**+**
		Bones and articulations	Rheumatism	–	–	+
			Muscle pain	–	–	+
		Infectious and parasitic diseases	Herpes	–	–	+
		Traumatic injuries	Contusion	–	–	+
			Wounds / ulcers / sores	**+**	**+**	**+**
		Metabolism and nutrition	Diabetes	–	+	+
			Hypercholesterolemia	–	+	+
			Hyperuricemia	–	–	+
			Obesity	–	–	+
		Skin and subcutaneous tissue	Alopecia	–	+	+
			Eczema	–	–	+
			Skin conditions	–	–	+
		Respiratory System	**Asthma**	**+**	**+**	**+**
			Bronchitis	–	–	+
			Cold / cough	**+**	**+**	**+**
		Nervous system and sense organs	Eye disease	–	–	+
			Migraine	–	–	+
			Nervous system tonic	–	–	+
		Mental Illness	Depression	–	–	+
		Tumors	Leukemia	–	–	+
		Undefined symptoms	Asthenia	–	–	+
			Headache	–	–	+
			Pain	–	–	+
			Fever	–	+	+
			Insomnia	–	+	+
			Spasms	–	+	–
			Flatulence	+	–	+
			Jaundice	–	–	+
			Cosmetic	–	+	–
			Dropsy	+	–	–
***Salvia* spp**. **M. *Salvia officinalis* L. MP-Lam-012 FP** A.*Salvia lavandulifolia* Vahl IB. *Salvia officinalis* L. Flowered aeral parts or leaves	**IB**: (n° 140, 1274, 1387) *Elelisfakon, sâlbya, nâ'ama, Châlbîa* **(**ألالسفاقن، سلبية، ناعمة، شالبية**)**. **M*:*** Sâlmiya **(**السالمية**)**. **A*:*** Salvia, savia, balsamina.	Circulatory system	Varicose veins	–	–	+
			Blood purifyer	–	–	+
			Haemorrhages	+	–	–
			Circulatory disorders	–	–	+
		Digestive system	Oral thrush	–	+	+
			Liver disease	–	–	+
			Gallbladder disorders	**+**	**+**	**+**
			Stomach disorders / pain / dyspepsia	–	–	+
		Complications of pregnancy and childbirth	Pregnancy (abortive)	+	–	–
		Genito-urinary	Kidney disease	+	–	+
			Diuretic	+	–	–
			Menstruation disorders	**+**	**+**	**+**
		Bones and articulations	Rheumatism	–	–	+
			Frailty muscular	+	–	–
		Traumatic injuries	Contusion	–	–	+
			Wounds / ulcers / sores	+	–	+
			Animal bites	+	+	–
		Metabolism and nutrition	Diabetes	–	+	–
		Skin and subcutaneous tissue	Alopecia	–	–	+
			Skin conditions	–	–	+

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
			Pruritus	+	–	–
		Respiratory System	Asthma	–	+	+
			Sore throats	–	–	+
			Bloody sputum	+	–	–
			Cold / cough	+	–	+
		Traumatic injuries	Tongue / other members paralysis	+	–	–
		Tumors	Malignant sores	+	–	–
		Undefined symptoms	Headache	–	–	+
			Fever	–	–	+
***Teucrium polium* L.** **MP-Lam-013 FP** Flowered aeral parts	**IB**: (n° 488) Djâ'da, Boulion: **(**جعدة، بوليون). **M:** Ja'ada **(**جعدة). **A:** Zamarrilla, Zamarrita, Tomillo blanco.	Circulatory system	Blood purifyer	–	–	+
			Circulatory disorders	–	–	+
		Digestive system	Liver disease	+	–	–
			Stomach disorders / pain / dyspepsia	–	+	+
		Genito-urinary	Kidney disease	+	–	–
			Diuretic	+	–	+
			Menstruation disorders	–	–	+
		Infectious and parasitic diseases	Helminth	+	–	–
			Infection	–	–	+
			Rabies	–	+	–
		Traumatic injuries	Animal bites	+	–	–
		Metabolism and nutrition	Obesity	–	–	+
		Respiratory System	Cold / cough	–	+	+
		Mental Illness	Memory loss	+	–	–
		Undefined symptoms	**Fever**	**+**	**+**	**+**
			Flatulence	+	–	–
			Anorexy/Loss of appetite	–	–	+
			Jaundice	+	–	–
			Flank pain	+	–	–
Thymus* spp.** **M.*Thymus vulgaris* L.** ***MP-Lam-014 FP *A.T. zygis* Loefl. ex L. ssp. *gracilis* (Boiss.) R.Morales IB. *Thymus zygis* Loefl. ex L. Flowered aeral parts	**IB**: (n° 456, 548, 2233) Sa'tar lahmir, Thoumoch, Hacha, Nemmâm **(**نومش، الحشا، صعتر الحمير، نمام**).** **M**: Z'îtra **(**زعيترة**).** **A**: Tomillo, Tomillo aceitunero, Tomillo blanco.	Circulatory system	Hemorrhoids	–	–	+
			Circulatory disorders	–	–	+
		Digestive system	Diarrhea	–	–	+
			Halitosis	**+**	**+**	**+**
			Toothache	+	–	+
			Liver disease	**+**	**+**	**+**
			Intestine disorders	+	+	–
			Stomach disorders / pain / dyspepsia	**+**	**+**	**+**
		Complications of pregnancy and childbirth	Pregnancy (abortive)	+	–	–
		Genito-urinary	Kidney disease	+	–	–
			Diuretic	–	+	+
		Bones and articulations	Rheumatism	–	–	+
		Infectious and parasitic diseases	Helminth	+	–	+
			Pediculosis	+	–	+
			Whooping cough	–	–	+
		Traumatic injuries	Wounds / ulcers / sores	–	+	+
			Animal bites	+	–	–
		Metabolism and nutrition	Diabetes	–	–	+
			Hypercholesterolemia	–	–	+
			Hyperuricemia	–	–	+
			Obesity	–	–	+
		Skin and subcutaneous tissue	Corns and calluses	–	–	+
			Furuncle	–	–	+
			Eczema	–	–	+
		Respiratory System	Asthma	–	–	+

(continued on next page)

Table 1 *(continued)*

Scientific name (s), Vouchers. Part used	Vernacular names	Pathological group	Condition	IB	M	A
			Sore throats	+	+	+
			Rhinitis	+	–	–
			Cold / cough	–	+	+
		Nervous system and sense organs	Eye disease	+	–	+
		Mental Illness	Melancholia	+	–	–
		Undefined symptoms	Aphrodisiac	+	–	–
			Pain	+	–	+
			Nervousness	–	–	+
			Flatulence	–	+	+
			Anorexy/Loss of appetite	+	–	+
			Cosmetic	+	+	+
			Depurative	–	–	+
			Horripilation	+	–	–
				188	**95**	**257**

ana have some shared uses, in particular *Rosmarinus officinalis* (11 shared uses), *Thymus* (9), *Marrubium vulgare* (7), *Mentha pulegium* (5), *Origanum vulgare,* and *Lavandula* (5 each). Table 4 includes the number and percentages of these shared uses, with high percentages for *Mentha pulegium,* Lavandula, *Origanum vulgare*, *Thymus*, *Rosmarinus officinalis,* and *Teucrium polium*. Of the 14 taxa included, 10 had more than 50% coincidence in the current medicinal uses for both territories.

Hence, considering 64% as a high coincidence, we can state that our first hypothesis is supported according to the medicinal uses of the Lamiaceae: current coincidence of the ethnobotanical uses in the two territories is high. This can be partially explained by the shared historical background, probably by recent exchanges and information flow, and by historical herbal texts which may have influenced both traditions. Among these uses, 29 were also included in al-Baytar's *Compendium*, and therefore nearly 48% of the uses are directly related to this period of Islamic medicine in both territories, implying a high level of preservation and stability in terms of knowledge of plant use, as well as the aforementioned probable ancient link of these uses. As mentioned in the introduction of the present work, Ibn al-Baytar studied the main previous Islamic physicians' texts but also the classical Greek ones, and although we have not analysed this topic, it is probable that many of these shared uses come from this period, as some authors have pointed out in other territories and comparative studies (Leonti et al., 2010).

Rosmarinus officinalis had the most shared uses on both sides of the Mediterranean Sea (Table 4), which is not surprising because its importance has been highlighted many times in both territories. Nearly half of these uses (4/9) were also described by al-Baytar, and hence they can be said to be ancient uses preserved through history and across cultures.

4.1.3. Ibn al-Baytar and eastern Morocco

Shared use of 43% (Table 4) is high, but far from the 77.7% of Bellakhdar (1997) review of the traditional Moroccan pharmacopoeia, which involved a higher number of plants, uses, and historical texts.

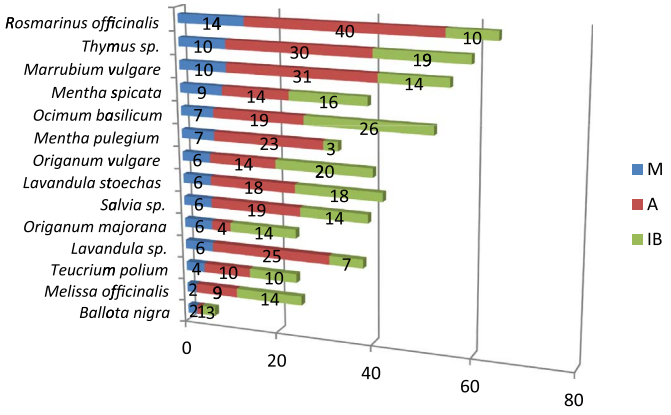

Fig. 2. Number of medicinal uses for the included Lamiaceae species in the studied area of Morocco (M), East Andalusia (A) and Ibn al-Baytar´s work (IB).

Origanum vulgare, Thymus, Rosmarinus officinalis, and *Lavandula stoechas* are the plants with best preserved uses (6, 5, 5, 5, respectively) but, taking into account the percentages between total and shared uses, *Origanum vulgare* and *Melissa officinalis* are outstanding since all the current uses for the Moroccan study area were included in the *Compendium*, followed by *Lavandula stoechas* with 83% of uses and *Ocimum basilicum* with 57% (Table 3).

4.1.4. Ibn al-Baytar and eastern Andalusia

Coincidences between current uses in eastern Andalusia and the ones related in the *Compendium* are lower, 28% (Table 3). This may be partially because in recent decades, a number of ethnobotanical field studies have been made in Andalusia, and the database covers a high number of local uses. Again, *Thymus* had the highest total shared uses, but the percentage was only 33%. Plants with the highest shared use percentages were *Melissa officinalis, Origanum vulgare*, and *Mentha spicata*, with more specific uses and therefore a lower number of uses. For plants such as *Rosmarinus*, the one most diversely used in

Table 2
Quotations of the uses included in each pathologic group (following Adjanohoun et al., 1989). IB: Ibn al-Baytar´s work; M: Morocco; A: Andalusia. CIR: circulatory; DIG: digestive; RES: respiratory; Birth: birth, complications in pregnancy; GU: genitor-urinary; BA: bones and articulations; INF: infectious; TI: traumatic injuries; MN: metabolism and nutrition; SS: skin and subcutaneous tissues; NS: nervous system; M: mental; T: tumor; US: undefined symptoms.

Pathological group	CIR	DIG	RES	Birth	GU	BA	INF	TI	MN	SS	NS	M	T	US	Total
IB	12	31	21	4	18	4	8	14	1	4	16	6	2	47	188
M	2	16	14	4	9	3	3	5	4	2	2	2	0	29	95
A	22	44	24	2	20	12	11	15	25	16	6	3	2	55	257
Total	36	91	59	10	47	19	22	34	30	22	24	11	4	131	540

Table 3
Jaccard´s index for pathological groups analysing the use of a given species for a given condition in the three sources.

		Res		
		IB	M	A
US	IB		69.2	84.6
	M	84.6		83.3
	A	84.6	71.4	
		Dig		
		IB	M	A
GU	IB		61.5	78.6
	M	46.2		57.1
	A	75	63.6	
		TI		
		IB	M	A
INF	IB		45.5	66.7
	M	50		55.6
	A	44.4	42.9	
		Cir		
		IB	M	A
BA	IB		22.2	42.9
	M	20		8.3
	A	30	22.2	
		SS		
		IB	M	A
Birth	IB		0	50
	M	16.7		25
	A	0	25	
		NS		
		IB	M	A
MN	IB		12.5	20
	M	0		0
	A	10	18,2	
		M		
		IB	M	A
T	IB		16.7	14.3
	M	0		0
	A	33.3	0	

Andalusia, only 18% of the uses are described in the *Compendium* (7 of 40), indicating that its popular recognition as a panacea might have occurred after the Al-Andalus period.

4.2. Notable results by pathological group

Table 3 includes Jaccard's index for each pathological group. Indexes shown for some of the main pathological groups, i.e. Respiratory, Digestive and Genital-urinary, indicate a higher similarity between al-Baytar and Andalusia. This may be due to the higher number of uses included for these sources (see Table 2). These cases are discussed more in depth below. Nevertheless, it is difficult to draw a single conclusion, and the similarities between the information sources consulted vary according to the pathological groups. As the explanation of the similarities for all the conditions included would be cumbersome, we mention only the most significant ones, and more in-depth consultations can be made from the data in Tables 1–3.

Regarding the Respiratory System, all plants except *Ballota nigra* are used to treat 8 conditions, combined in 30 medicinal uses (Table 1) with 59 total references (Table 2). This represents the highest similarity index of all (Table 3). In the analysis of the specific uses in this group, up to 11 of the 30 uses proved to be the same in Morocco and Andalusia: the use for colds or cough of *Lavandula*, *Lavandula stoechas*, *Marrubium vulgare, Mentha pulegium*, *Origanum vulgare*, *Rosmarinus officinalis*, *Teucrium polium* and *Thymus*, as well as the use of *Lavandula*, *Lavandula stoechas* and *Salvia officinalis* against asthma (Table 1). The high values of Jaccard's index for al-Baytar and both territories can be explained on the basis that most of these uses are included in the *Compendium*, as well as rosemary to treat asthma. The high coincidence of traditional remedies for colds also appears in Table 5: 41% of the uses coincide among the three sources. Nevertheless, the greater similarity in this group is also supported by the high polyvalence of the plants: 8 are used for more than three respiratory conditions. Again, the importance of rosemary in Mediterranean ethnobotany is demonstrated, being the only plant with coinciding uses in the three sources for two respiratory conditions.

Regarding the Digestive System, which also has high similarity indexes (Table 3) the 14 taxa are used in 12 conditions, with 58 different medicinal uses (Table 1) and 91 mentions (Table 2). The polyvalence of these plants is even higher in this group: *R. officinalis, L. stoechas, M. vulgare, O. basilicum*, and *Thymus* are used in six different digestive conditions. Some of them showed a high number of possible resources: for instance stomach conditions (12 plants, 7 of them in Morocco, 11 in Andalusia and 7 included in al-Baytar), hepatic afflictions or toothache. Stomach disorders ranked third according to the use coincidence among the three sources (Table 5): one third of the described uses come from the Moorish period and are also currently used in both Morocco and Andalusia. The first one is the use of *Salvia officinalis* for gallbladder affections in the three sources. A particular case is the treatment of diarrhea: four Lamiaceae are used in Andalusia and six were included in al-Baytar's *Compendium* (with three coinciding ones), but none is currently used in Morocco.

Eight genital-urinary conditions are included, treated with 13 plants performing 32 different medicinal uses in this pathological group, with 47 mentions (Table 2). The similarity in this group is due to the number of species used to promote diuresis and to treat menstrual disorders (sixth condition in coincidence; Table 5) highlighting, in this case, the use of *Mentha pulegium*, *Rosmarinus officinalis* and *Salvia officinalis* in the three sources.

Some other notable similarities according to Table 3 are the use of some Lamiaceae in the group Traumatic injuries for several conditions, with two coinciding uses in all the sources: *Mentha spicata* for burns (fifth condition in Table 5), and *Rosmarinus officinalis* for contusions. The rest of the calculated indexes were generally moderate, even with several coinciding uses among the sources, as for example the use of *Lavandula stoechas* for rheumatism. Other coinciding uses for Morocco and Andalusia are the leaves of *Ocimum basilicum* as galactogenic, *Mentha spicata* against helminths, *Marrubium vulgare* and *Rosmarinus officinalis* for diabetes, and *Lavandula* spp. and *Rosmarinus officinalis* for alopecia.

Finally, in the miscellaneous group of Undefined symptoms, 14 taxa are used for 25 conditions, amounting to 90 medicinal uses in the three sources (Table 1), with 131 total mentions (Table 2). This may represent a bias of the study (as commented on in Section 2.4), and therefore we do not to discuss this group in detail. As can be seen in Table 3, it shows a high coincidence index for al-Baytar and both Morocco and Andalusia.

5. Conclusions

Our field work provided ethnobotanical information for 14 Lamiaceae with a number of different medicinal uses, serving to treat conditions from 14 pathological groups, particularly the digestive, respiratory, and genital-urinary systems. This agrees with other studies

Table 4
Coincident uses for each plant in the three sources with total of recorded uses for Morocco and Andalusia, number of coincident ones and percentages.

		Shared M-IB		Shared M-A			Shared A-IB	
Plant	**Uses for M**	**Shared**	**%**	**Shared**	**%**	**Uses for A**	**Shared**	**%**
Ballota nigra	2	0	0	0	0	1	0	0
***Lavandula* spp.**	6	0	0	5	83	25	1	4
Lavandula stoechas	6	5	83	3	50	18	8	44
Marrubium vulgare	10	1	10	7	70	31	7	23
Melissa officinalis	2	2	100	1	50	9	7	78
Mentha pulegium	7	2	29	6	86	23	2	9
Mentha spicata	9	4	44	4	44	14	7	50
Ocimum basilicum	7	4	57	3	43	19	7	37
Origanum majorana	6	3	50	0	0	4	0	0
Origanum vulgare	6	6	100	5	83	14	7	50
Rosmarinus officinalis	14	5	36	11	79	40	7	18
Salvia officinalis	6	3	50	4	67	19	5	26
Teucrium polium	4	1	25	3	75	10	2	20
***Thymus* spp.**	10	5	50	9	80	30	10	33
TOTAL	**95**	**41**	**43**	**61**	**64**	**257**	**71**	**28**

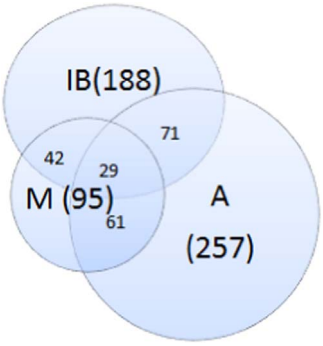

Fig. 3. Venn´s diagram with number of total uses and coincident uses.

Table 5
Coincident uses and percentages amongst the three sources. First column indicates the total number of taxa quoted for the condition and second column the number of coincident taxa, i.e., quoted in the three sources for this condition.

Uses	Quoted taxa	Coincidences	%
Gallbladder disorders	2	1	50
Cold / cough	12	5	41.7
Stomach disorders / pain / dyspepsia	12	4	33.3
Halitosis	3	1	33.3
Burns	3	1	33.3
Menstruation disorders	11	3	27.3
Cosmetic	4	1	25
Sore throats	6	1	16.7
Fever	6	1	16.7
Flatulence/gases	12	2	16.7
Liver disease	13	2	15.4
Asthma	7	1	14.3
Vomits	7	1	14.3
Headache	8	1	12.5
Wounds / ulcers / sores	8	1	12.5
Rheumatism	8	1	12.5
Loss of appetite	10	1	10
Toothache	10	1	10

(e.g. González-Tejero et al., 2008; Saslis-Lagoudakis et al., 2011) where the Lamiaceae are commonly used for digestive and respiratory conditions.

Regarding our first research question, bibliographical analysis shows a high similarity between Morocco and Andalusia (64% of coincident uses) according to the medicinal uses of the Lamiaceae. Current coincidence of the ethnobotanical uses in both territories is high but, nevertheless, no general conclusions concerning the similarity of medicinal flora should be drawn from a single family study and thus more in-depth research is needed to test this hypothesis. Other studies have not demonstrated a common ethnobotanical heritage throughout this part of the Mediterranean region (Pieroni et al., 2006; González-Tejero et al., 2008).

Concerning our second hypothesis, we can confirm extensive overlap in plant use between Ibn al-Baytar's text and both eastern Morocco and eastern Andalusia. Nearly half of shared uses between the two territories were included in al-Baytar's *Compendium* and are related to this Moorish period in both territories, implying a high level of preservation in the knowledge of plant use. However, comparisons with other medieval authors are needed to verify this conclusion. The importance of the family Lamiaceae in the treatment of respiratory and digestive conditions has been shown once again in folk-medicine contexts, with considerable overlapping use between Morocco, Andalusia, and the *Compendium*. Furthermore, uses appear to have been relatively well preserved over time.

The Ibn al-Baytar's *Compendium* represents a valuable bibliographical source for comparison, including a high number of different uses for these plants. Its analysis confirms the strong influence in the current traditional medicine of both territories, especially in eastern Morocco. If, as mentioned in the Introduction, Leonti et al. (2010) argued that 20% of plant uses from the modern ethnobotanical literature in Catania originated directly from Matthioli's *Materia Medica*, we can infer that for eastern Morocco, 43% of plant uses for the Lamiaceae may have derived directly from Ibn al-Baytar's *Compendium*, although it is also possible that these uses have a common cultural ancestry. Nevertheless, many of the uses included in the *Compendium* are not mentioned in modern ethnobotanical studies, which could be interpreted as a loss in the knowledge of plant use. It may reflect that this text does not seem to have been such an important reference for this territory as, for example, *Materia Medica* of Dioscorides for Europe.

Finally, we would like to highlight the importance of the analysis of historical texts on plant use that helps in the search for the link of current uses and confirming possible loss, modification or incorporation of traditional knowledge of plants.

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