The evolution of medicinal floras: Insights from Moroccan medicinal plant knowledge transmission

A thesis submitted by

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To the people of Imegdale and the Marrakshis

To my family sensu lato

Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

IRENE

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Abstract

Why some plants are used medicinally, and others not, is not yet totally understood; intrinsic, cultural and floristic factors may be important and their interactions are complex. Plants' morphological, organoleptic and ecological traits have been evaluated elsewhere. This thesis focuses on the role of cultural transmission of knowledge across generations, societies and floristic environments. Using Morocco as a case study, this thesis describes medicinal plant use among understudied Tashelhit speakers in the High Atlas and specialist healers called *ferraggat*. The role of knowledge transmission is evaluated in a context of cultural change. Processes of transmission are also inferred from patterns of medicinal plant use regionally; a checklist for Moroccan medicinal plants is compiled and a new method based on biogeographic data is used to test a hypothesis about the influence of the Arab knowledge due to historical migrations into Morocco.

Aspects of Ishelhin ethnobotanical knowledge are described through 254 vernacular plant names, which reflect local livelihoods and biodiversity values; 151 vernacular names for medicinal plants correspond to 159 botanical species and are found to treat 36 folk ailments. Men and women listed significantly different medicinal plants; herbal medicine is a women's domain characterized by low specificity of herbal remedies and widespread use of mixtures. Medicinal plant use is guided by local concepts of health and illness including supernatural aetiologies, which also determine healthcare seeking behaviour. Belief in supernatural causes of illness and difficult access to biomedicine result in preference for *ferraggat* to treat childrens' ailments in the High Atlas by a practice called *frigg*. Seventy plants were documented for this treatment, but emphasis on plants may be a recent substitute for remedies that used primarily wool and blood two generations ago. This is a shift in the objects of cultural meaningfulness in response to the increasing influence of orthodox Islam and state-sponsored modernisation, including public healthcare and schooling. Transmission of knowledge is underpinned by the prestige and legitimacy of alternative remedies and healing systems, which shift during socioeconomic and religious change. With biomedicine available, herbal remedies may not be preferred treatments, unless local explanatory models of illness are maintained. Meta-analysis of the Moroccan medicinal flora supports this view. Although I hypothesised that Saharo-Arabian plants would be overrepresented in the Moroccan medicinal flora, overrepresentation was not significant. Nonetheless, Arabic influence is evidenced through the Moroccan syncretic health system. The combination of pattern and process observation in the field and from macroscale analysis contributes to the understanding of how knowledge transmission shapes medicinal floras.

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Chapter 1 General introduction

1.1 Medicinal plants

1.1.1 The global importance of medicinal plant research

Traditional medicine is defined by the World Health Organisation (2000) as “knowledge, skill and practices based on the theories, beliefs and experiences indigenous to different cultures that are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental illness”. Local healthcare strategies and medicinal plant knowledge, along with other local knowledge systems and aspects of local cultures, are being lost to acculturation around the world (Benz et al., 2000; Geck et al., 2016; Gómez-Baggethun et al., 2010; Maffi, 2002). This has concerned ethnobotanists, anthropologists and conservation ecologists alike in recent decades (Maffi, 2001). From an etic perspective, the erosion and loss of local medicinal plant knowledge entails loss of information for the biological sciences, notably biotechnology (Hayden, 2003) and biodiversity conservation (Berkes et al., 2000). But importantly, it is detrimental for indigenous communities around the world and can erode social resilience (Vandebroek et al., 2011).

Local and indigenous medicine is a healthcare resource contributing to the goals of the World Health Organization (2013). Up to 80% of the population in some developing countries depend directly on local medicines for medical care; indigenous and local medicinal systems are recognized as the primary healthcare resource for many rural communities (Alves & Rosa, 2007; Vandebroek et al., 2004; WHO, 2013). Local medicinal systems can be adaptive: in various communities around the world, maternal medicinal plant knowledge correlates with children’s health (McDade et al., 2007; Reyes-García et al., 2008; Salali et al., 2016). Hence, the loss of this knowledge can have negative consequences for community health, weakening local resilience. Accessibility of biomedical resources may account for the erosion of local medicinal knowledge (Quinlan & Quinlan, 2007; Saethre, 2007; Vandebroek et al., 2004), but many societies choose to continue to use traditional medicine even when biomedicine is available (Perry & Gesler, 2000; Thomas, 2013), often developing pluralistic, syncretic medical systems (Bussmann et al., 2007; File & McLaws, 2015; Mateo Dieste, 2010; Soldati & Albuquerque, 2012; van Andel & Westers, 2010). Ethnomedicinal and ethnobotanical research contributes to understanding of the culture-specific experiences of illness that shape healthcare seeking behaviour, including self-treatment with herbal remedies and use of local healers, and this is essential to develop appropriate public health care in culturally diverse contexts (Kleinman et al., 1978; Stephens et al., 2006).

According to the World Health Organisation (2003), 25% of the drugs of modern pharmacopoeias are derived from plants and many others are synthetic analogues of plant compounds (Balandrin et al., 1993; Fabricant & Farnsworth, 2001). Local medicinal plant knowledge has proven to be a source of plant-based medicines (Balunas & Kinghorn, 2005; Cox & Balick, 1994; Lewis, 2003), but only a small percentage of plants have been screened for bioactivity (Gurib-Fakim, 2006; Soejarto et al., 2005) and there is controversy about whether local and indigenous medicinal knowledge can guide drug discovery (Araújo et al., 2008; Fabricant & Farnsworth, 2001; Farnsworth et al., 1985; Gertsch, 2009; McClatchey et al., 2009; Newman & Cragg, 2013; Reyes-García, 2010; Siqueira et al., 2012; Soejarto et al., 2005). Plant candidates for the discovery and development of more effective drugs are still sought in local medicinal floras (Ernst et al., 2016; Heinrich et al., 1998; Leonti et al., 2013; Rønsted et al., 2008; Saslis-Lagoudakis et al., 2012; Zhu et al., 2011). However, rational approaches to the interpretation of local medicine for drug discovery are much needed. Culture influences the experience and expression of illness, and herbal medical treatments do not need to be bioactive in order to be effective (De Craen et al., 2000; Moerman & Jonas, 2002). The spread of medical treatment knowledge does not necessarily result from the efficacy of the treatments (Lenaerts, 2006); maladaptive practices may spread even quicker than those that are efficacious (Tanaka et al., 2009). Understanding the processes driving the assemblage and evolution of medicinal floras can inform phytotherapeutic research.

1.1.2 Medicinal plant knowledge: Some key terminology

The widespread use of the terminology “traditional plant knowledge” or “traditional medicine” in ethnobotany can be misleading. These phrases imply that something is conserved, ancient and authentic (Leonti, 2011; McClatchey, 2005), but knowledge systems in every culture are constantly evolving. The terms “indigenous” or “local” are more appropriate in this context (McClatchey, 2005). Due to the controversies in defining “indigenous” (see for example Stephens et al., 2006), especially in Morocco (Crawford, 2002; Mateo Dieste, 2012), the term local knowledge is used throughout this thesis. Local knowledge is understood here *sensu* Berkes et al (2000: p.1252), who define it as “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment”. Being highly situational, local knowledge involves not only objects and subjects, on which science normally focuses, but also “movements and events that are profoundly historical and relational” (Escobar, 1995: p.204). However, comparative studies on medicinal plant knowledge often study but one of its dimensions: the list of plants used medicinally by a community (Moerman et al., 1999; Leonti et al., 2003; Saslis-Lagoudakis et al., 2014).

Similarly, the term “medicinal flora” may be more appropriate than “ethnopharmacopoeia” to refer to the compilation of medicinal plants used by a community in a particular moment. Although often used interchangeably, pharmacopoeias are written compendia of medical remedies, including animal and mineral drugs, and the term may suggest that medicinal plant use is relatively stable through time, as remedies listed in *Materia Medicae* would be (Leonti, 2011). The term “medicinal flora” does not carry such implication and refers exclusively to plant resources.

1.1.3 The assemblage and evolution of medicinal floras

The assemblage of medicinal plant resources used by a particular community, or their medicinal flora, is a result of medicinal plant selection and the cultural transmission of knowledge. As well as being dynamic and adaptive, medicinal plant selection is complex and dependent on human cognition and behaviour, ecology and cultural history. In order to understand the evolution and development of local medicinal floras it is key to understand the dynamic nature of local medicinal plant knowledge, mediated through its transmission.

1.1.3.1 Medicinal plant selection

Since Moerman (1979) observed that medicinal plants are not randomly distributed amongst plant families, much research has been carried out to disentangle the complex factors driving medicinal plant selection. Research has focused on the floristic composition and characteristics of the environment (Ladio et al., 2007; Lucena et al., 2007; Saslis-Lagoudakis et al., 2014) and plants’ organoleptic properties (Ankli et al., 1999; Geck et al., 2017; Leonti et al., 2002) as medicinal plant selection drivers. Plants' conspicuousness results in the dominance of woody and weedy species in some pharmacopoeias (Albuquerque & Oliveira, 2007; Endara & Coley, 2011; Lucena et al., 2007; Marshall & Hawthorne, 2012; Stepp, 2004; Voeks, 2004). Organoleptic properties enable medical ideas to be linked to medical materials (Shepard, 2004), resulting in evaluation and classification systems based on sensory cues like smell, taste, colour and texture (Ankli et al., 1999; Gewali, 2008; Leonti et al., 2002; Molares & Ladio, 2009a) that reflect cultural configurations of efficacy and illness. Plants' organoleptic properties can reflect their chemistry, for example, bitterness is used to identify alkaloids and other secondary compounds (Brett & Heinrich, 1998; Johns, 1990; Leonti et al., 2002), and organoleptic properties also have an important mnemonic function, helping users to retain and transmit knowledge (Bennett, 2007; Shepard, 2002). Such cognitive aspects of medicinal plant selection are constrained by availability in specific floristic environments (Coe & Anderson, 1999; Inta et al., 2008; Ladio et al., 2007; Saslis-Lagoudakis et al., 2014). However, within a floristic environment, cultural ancestry can influence medicinal plant use (de Boer & Lamxay, 2009; Lamxay et al., 2011; Saslis-Lagoudakis et al., 2014). Culture-specific constructions of illness and efficacy as well as isolation can lead to significant differences in plant use (Ghufran et al., 2010; Quave & Pieroni, 2015; Shepard, 2004).

1.1.3.2 Medicinal plant knowledge transmission

Continuity in medicinal floras through time is mediated by processes of transmission of medicinal plant knowledge, which are embedded in social systems (Berkes et al., 2000). Transmission is often studied across generations in order to assess current trends of knowledge erosion and loss (Ohmagari & Berkes, 1997; Reyes-García et al., 2009; Ross, 2002; Zarger, 2002; Zarger & Stepp, 2004; Zent, 1999, 2009), but in addition to intergenerational knowledge flow, transmission across communities and cultures is also important to understand the evolution of medicinal floras (Saslis-Lagoudakis et al., 2014; Touwaide & Appetiti, 2013).

Through cultural transmission people acquire knowledge, behaviours, language and beliefs (Cavalli-Sforza & Feldman, 1981; Hewlett & Cavalli-Sforza, 1986). Cultural transmission takes place through conditioning and imprinting, imitative learning, interacting with knowledgeable relatives, neighbours and elders and the natural environment, through active teaching and learning, or a combination of these (Cavalli-Sforza et al., 1982). Unlike biological traits, which are largely transmitted genetically, cultural traits can be transmitted vertically (from parents to children), horizontally (between peers) and obliquely (from elders other than parents; Cavalli-Sforza & Feldman, 1981) and these transmission pathways are not mutually exclusive. The relative importance of these pathways in the transmission of medicinal plant knowledge varies according to socio-environmental context and will shape the evolution of medicinal floras, since they allow for the reproduction of knowledge in more or less conservative ways (Cavalli-Sforza & Feldman, 1981).

Medicinal plant knowledge is often passed from parents to offspring (vertically; Lozada et al., 2006; Ohmagari & Berkes, 1997; Reyes-García et al., 2013; Soldati et al., 2015), but there is evidence that oblique mechanisms are also important for transmission of medicinal plant knowledge. Selective and centralized oblique transmission, which is acquired from knowledgeable individuals (Cavalli-Sforza & Feldman, 1981), is found to determine medicinal plant knowledge transmission in Fijian villages (Henrich & Broesch, 2011) and among the Tsimane' in the Bolivian Amazon (Díaz-Reviriego et al., 2016). The role of the mentor or teacher is central to learning about medicinal plants in various cultures, especially for the training of specialists (Cox, 1991). Local medicinal knowledge systems that are exclusive to a few specialists are likely to have a different evolutionary trajectory to other ethnobotanical knowledge systems (Guest, 2002), such as non-specialist knowledge about home remedies. Moreover, the presence of written pharmacopoeias has a homogenising effect on popular medicinal plant knowledge, as has been observed in America, Europe and China (Brown et al., 2014; Leonti et al., 2009, 2010, 2015; Weckerle et al., 2009). Leonti (2011) discussed the role of texts as a special case of oblique or one-to-many knowledge transmission.

1.2 Cultural and environmental context of this thesis

1.2.1 Morocco: Plants and people

The Kingdom of Morocco is the westernmost country in the Maghreb (the North African region west of Egypt), lying between 21º-36ºN and 1º-17ºW. It neighbours Algeria in the east and north-east and Mauritania in the south and south-east, and has both Atlantic and Mediterranean coastlines. Morocco has the widest plains and highest peaks of North Africa; four mountain ranges, the Rif, the Middle Atlas, the High Atlas and the Anti-Atlas, form a semi-circle around the coastal and middle plains separating them from the Saharan desert (Figure 1.2). Topographic and climatic variability, as well as its long history of human activity, favour botanical diversity in Morocco (Thompson, 2005), and mountainous areas are considered biodiversity hot-spots within the Mediterranean (Médail & Quézel, 1997). Morocco has more than 3913 native vascular plants species according to Fennane and Ibn Tattou (2012) of which 879 are thought to be endemic (Rankou et al., 2013), thus having the richest flora of any North African country and one of the most diverse of the Mediterranean region (Rankou et al., 2013). The country lies in the Holarctic Kingdom and its territory belongs to the Tethyan (Ancient Mediterranean) Subkingdom and the Southwestern Mediterranean and Saharo-Arabian Provinces (Takhtajan, 1986). According to the biomes classification that integrates floristic and zoological data as well as environmental features (Olson et al., 2001), the same two areas are identified in Morocco: "Mediterranean forests, woodlands and scrub" and "deserts and xeric shrublands", with boundaries coinciding with those delimited solely by floristic analysis.

Figure 1.1 Map of Morocco (administrative provinces delimited and mountain ranges shaded) including the non-internationally recognised Southern Provinces (see Ethics). The location of the rural commune of Imegdale indicated by a black dot.

Historically, Morocco has been at the cross-roads of ancient trade routes and its current population is the result of several waves of migration from Southern Europe, Arabia and Sub-Saharan Africa and mixing with the indigenous North African populations (Henn et al., 2012). The most important immigration event was the arrival of the Arabs, who first brought Islam and then the Arabic language and aspects of their culture. The Arabo-Muslim world, which has been open to the influences of Greek, Persian, Hindu, Judaic and Christian cultures, has influenced this region culturally for more than nine centuries, marking the social behaviour of the Moroccan population (Ennaji, 2005). Most Moroccans share ancestry with the Near East, and to a lesser extent, with sub-Saharan African and European populations (Henn et al., 2012). Even Amazigh people, the indigenous people of Morocco, are of mixed ancestry and often are genetically indistinguishable from their Arab-speaking compatriots (Bosch et al., 2000; El Ossmani et al., 2010) with whom they have intermarried for centuries (Mateo Dieste, 2012).

The Maghreb appeared as a cultural and political community prior to 215 BC, during the Amazigh era (Chafik, 2005). The coast of Maghreb was dominated by the Romans until 440 AD, and by the Byzantine Empire from 534 to 647 AD (Chafik, 2005; Laroui, 1977), but these early invasions did not have a strong cultural or genetic influence (Laroui, 1977). The Muslim expansion by Islamic missionaries first, and armies later, began in the 7th century and was the start of a continuous migration movement from the Near East (Ennaji, 2005). It was not until the 12th and 13th centuries that these immigration events of Bedouin people from Arabia had a strong cultural and linguistic influence in the Maghreb (Ennaji, 2005), with the arrival of the Beni Hilal tribe from Arabia, who reached the Northwest of Morocco and spread in the Atlantic plains and plateaus (Laroui, 1977). In the 13th century, the Ma'qil Arabs also emigrated from Arabia through Egypt and reached south-eastern Morocco from the Sahara (Laroui, 1977). Arab migrants moved from and through the Saharo-Arabian into the Mediterranean floristic region.

Besides Arab populations, peoples from southern Europe and sub-Saharan Africa, and Jews from North Africa and the Middle East, also contributed to the current genetic makeup of Moroccans (Henn et al., 2012; Plaza et al., 2003; Rando et al., 1998). During the late-15th and 16th century during the decline of the Al-Andalus caliphate in the Iberian Peninsula, Morocco received Muslim and Jewish refugees that were escaping the political intolerance of the Catholic kings. Jewish people had previously also migrated into the south of the country from Yemen (Laroui, 1977). Henn et al (2012) suggest that sub-Saharan migrations into South Morocco occurred through slave trading between the Ghana Empire and the Amazigh kingdoms in Morocco.

Recent history is shaped by European colonialism, which triggered Morocco's incorporation into the modern globalised world. French colonialism brought Western technology to Morocco at the beginning of the 20th century to promote economic development, impacting agricultural and industrial production methods, and human and veterinary medical care. Economic development continued after independence, especially in urban areas since the government viewed rural societies as highly conservative, hindering the strategic modernising goals of the new country (Lagnaoui, 1999). Since the 1970s, the gross national income per person has quadrupled, the life expectancy increased by almost 20 years, the number of births per women decreased from six to two, approximately, and primary school net enrolment now reaches 95% (Open data of the Moroccan Administration, 2016). Currently, the rise of a more orthodox form of Islam and compulsory state schooling are influencing a generational cultural change (Terem, 2014).

1.2.2 The rural community of Imegdale

Located approximately 75km south of Marrakech, the Rural Commune of Imegdale lies in the High Atlas and neighbours the National Park of Toubkal (31.12 N, 8.14 W; altitudes ranging from 900 to 2500m). The commune has an area of approximately 274 sq km with an approximate population of 5537 people in 1156 households (Haut Commissariat au Plan, 2014) dispersed in 28 small villages. Besides the paved road that runs by the N'Fiss river, connecting Marrakech with the Sous valley south of the High Atlas, dirt roads reach most but not all of the villages in Imegdale.

Despite the prevalence of Arabic as the dominant language in Morocco, Tashelhit, an Amazigh language from the Afroasiatic family indigenous to the northwest of Africa (Múrcia & Zenia, 2016), is the first language spoken in the commune. Most of Imegdale's inhabitants self-identify as Ishelhin (sing. Ashelhi), the southern Moroccan Amazigh or Berber ethnic group. At least 10% of the men are also fluent in Moroccan Arabic, whereas most have basic communication skills in this language (Haut Commissariat au Plan, 2014). Younger generations are increasingly bilingual because they learn Moroccan and Classic Arabic through television and in the local schools, established in the 1980s, and are more likely to participate in the market economy, where Moroccan Arabic is prevalent.

Imegdale is representative of the disadvantaged position of many rural communities in the High Atlas. In 2004, fewer than 15% of the homes had running water and electricity, the degree of schooling after primary school was extremely low (1.3% overall and 0.1% for women) and 25% of the homes lived under the relative poverty line (Haut Commissariat au Plan, 2014). Much like other rural communities in the High Atlas, the inhabitants of Imegdale base their livelihoods in subsistence agriculture and farming, and did not engage substantially in other economic activities until recently (Crawford, 2008). Most households rear livestock, mainly cows, sheep and goats. Crops such as carob, apples, walnuts and other nuts and fruits, marginal crops such as orris root (*Iris germanica*) and livestock are sold in local markets. Two medicinal plants collected from the wild are also sold, thyme (mostly *Thymus saturejoides*) and lavender (mostly *Lavandula dentata*). Bellaoui (1989) estimated that the agropastoral sector contributes 75% of the local income. Currently, outmigration of men into urban areas is an important source of local revenue, and specialized local occupations, including mining, also contribute to the local economy. The inhabitants of Imegdale have a limited access to public healthcare; there is one health centre in the commune with a fulltime nurse, but no permanent doctor. The closest health center with a doctor is in the neighbouring commune of Ouirgane, which can be over three hours away from the most isolated villages, and the nearest hospital another half hour away from there.

In Imegdale, as in other Moroccan rural communities, increased availability of mass media, spread of state institutions and the increased consumption of market commodities, as well as migration and engagement wage labour economy, are having a profound impact in the lives and livelihoods of rural inhabitants (Crawford, 2008; Hoffman, 2002).

1.2.3 Note on the Amazigh and Arabic transcription

Plant names and other terms in Tashelhit included in this thesis are written in italics using a transcription of Tashelhit into the Roman alphabet. I used the IRCAM (*Institut Royal de la Culture Amazighe*) guidelines as in the Catalan-Amazigh dictionary to the best of my knowledge (Múrcia & Zenia, 2016, p.LXXVI). The Greek letter epsilon (ε) is used for the phoneme /ʕ/ corresponding to the Amazigh letter yaε and the Arabic letter ‘ayn (ع), and the Greek letter gamma (γ) for the phoneme /ʁ/ corresponding to the Amazigh letter yaγ (Múrcia & Zenia, 2016, p.LXXVI). Unfortunatly, due to my lack of fluency in Tashelhit, other language-specific phonemes were not identified. A glossary of Tashelhit terms mentioned can be found in Appendix 1.1. This does not include plant names, which are identified by their scientific names throughout the text.

1.3 Ethical considerations

1.3.1 Ethical guidelines and approval

In 1992, the Convention on Biological Diversity (CBD) established international protocols for protection and sharing of national biological resources and specifically addressed issues of traditional knowledge (UN, 1992). These protocols bound the signatory nations to respect, preserve, and maintain traditional knowledge, to promote its wide application and to encourage equitable sharing of benefits from traditional knowledge (UN, 1992). During this research, core obligations on equitable benefit sharing set out by the Nagoya Protocol (within the frame of the CBD, of which Morocco is a party) were negotiated with local communities through Prior Informed Consent and Mutually Agreed Terms, including permission for publication and ensuring Privacy, Anonymity and Confidentiality of the informants and the information retrieved, when appropriate (CBD, 2011). Methodological procedures also comply with the guidelines of the American Anthropological Association (2012), the code of ethics of the International Society of Ethnobiology (2006), and the Declaration of Helsinki (World Health Association, 2013).

Prior Informed Consent was obtained from local authorities including the region's caid, who were informed about the purpose of the research project and its timeframe. The research aims were also explained to community members before all interviews. Prior Informed Consent was not recorded since most informants were illiterate and uncomfortable with both paperwork and audio recording, but oral permission to conduct and publish this research was obtained. Permission for publication was also obtained orally, and in written form from the Chabab Ighrem association, a locally important institution for medicinal plant trade in the rural commune of Imegdale. Unique codes were used to identify informants, whose names were not recorded in the survey to ensure anonymity.

Fieldwork for this research was carried out in the context of the Global Diversity Foundation's Darwin Initiative project "Medicinal plant trade, conservation and local livelihoods in southern Morocco" (Darwin Initiative Project Number 20-013), a community-based development and conservation project addressing sustainable harvest of vulnerable medicinal plant resources in the High Atlas. Thus, I benefited from pre-established relations and agreements with the community. Rapport with local inhabitants was built through the extensive family and social networks of employees of the Global Diversity Foundation. Moreover, a collaboration with the Marrakech

Regional Herbarium (MARK, Faculty of Sciences Semlalia, University Cadi Ayyad, Marrakech) facilitated acquiring plant collection and export permits in Morocco. To respect these institutions and Moroccan collaborators, I have used maps acknowledged by the Moroccan government, which include Western Sahara. Western Sahara is administrated by the Moroccan government since 1991, but its territory is not recognised to be under Moroccan sovereignty by the United Nations.

These ethical considerations, as well as the interview sheets and questionnaires prepared prior to conducting fieldwork (Appendix 1.2), were evaluated and approved by the Ethics Committee of the School of Biological Sciences, University of Reading (Research Ethics Project Submission SBS14-15 05) as well as the research funding body. This project has received funding from the European Union's Seventh Framework Programme (grant agreement no. 606895), therefore it was evaluated by the funding body according to the ethical standards and guidelines of the FP7 (European Commission, 2013), which have been carefully applied.

1.3.2 Returning knowledge: Editing a pedagogic medicinal plants' booklet

Adequate compensation of local communities should be an integral part of the research process in ethnobotany (CBD, 2011). No monetary benefits were expected from this study, but locally relevant ways to share research outputs were sought with the community in a collaborative way while being at field. A process of enquiry and discussion with informants ensured that knowledge regarding local medicinal plant use was returned in ways responding to local preferences and needs. Informants expressed interest in a pedagogic publication about medicinal plants for children. Publications of local knowledge are a common way to return knowledge that can also serve as a statement of knowledge ownership (Fundación Sabiduría Indígena & Kothari, 1997). Therefore, a booklet about locally important medicinal plants was edited and published. The most salient medicinal plants were selected and a short morphological description and a summary of the local uses was written for each of them (Appendix 1.3). A hundred copies were printed and distributed in two local schools and the publication of another 1000 booklets is underway. Although publication in the local language (Tashelhit) was not possible initially, it will be a key improvement in the second edition. Results from this research, especially chapters 2 and 3, are also being used by the Global Diversity Foundation to inform further rural development projects in the High Atlas and duplicate herbarium specimens were deposited in the Marrakech Regional Herbarium (MARK), contributing to their local collection for the study of the High Atlas flora.

1.4 Aims and thesis structure

This thesis aims to contribute to the documentation of medicinal plant knowledge and use in Morocco focusing on understudied areas (*i.e.*, the High Atlas) and aspects of local herbal medicine (*i.e.*, the practice of *frigg*), and to evaluate the processes of transmission of knowledge contributing to the development of local and regional medicinal floras. Transmission of knowledge is studied at two different time depths and geographical scales. Ethnographic and ethnobotanical methods are used to study the processes of medicinal plant knowledge flow across interviewees locally and currently, and biogeographic methods are used for the first time to assess the effects of knowledge transmission regionally and historically, across cultures and resulting from demic expansions (migration events). Such an interdisciplinary approach may provide new insights on the evolution of cumulative culture.

This thesis includes five data chapters (Figure 1.1). The first four chapters are based on data collected during ethnobotanical fieldwork in Morocco from November 2014 to June 2015; the last one includes data collected through literature review of medicinal plant use in Morocco. Starting from a description of the natural and cultural context of the Ishelhin inhabitants of the High Atlas through the analysis of vernacular plant names (Chapter 2), I proceed to present their medicinal flora and describe the culture-specific ways in which medicinal plants are used (Chapter 3). The next two chapters are concerned with the local processes of transmission of knowledge about medicinal plants among lay people (Chapter 4) and specialists (Chapter 5), using both qualitative ethnographic and quantitative ethnobotanical methods. Chapter 5 also provides an ethnographic description of the practice of *frigg* that treats culturally bound syndromes affecting children. Chapter 6 evaluates the regional medicinal flora of Morocco as a whole, and investigates processes of cross-cultural transmission of knowledge at deeper time scales.

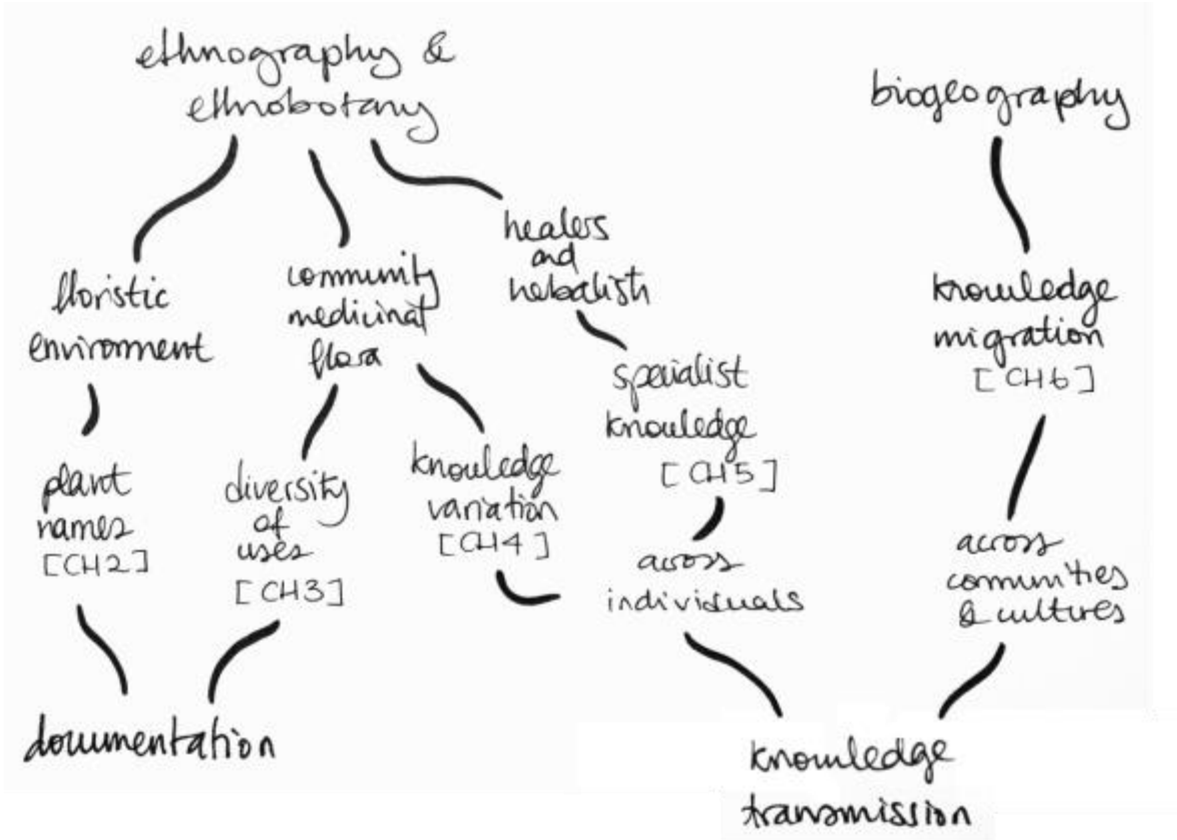

Figure 1.2 Concept map for this thesis placing the five data chapters in relation to the two main aims of the thesis (at the bottom) and the methods used (at the top); chapters indicated as [CH].

Chapters 3 and 5 have been published in peer-reviewed journals within the disciplines of ethnopharmacology (Teixidor-Toneu et al., 2016a) and ethnomedicine (Teixidor-Toneu et al., 2017), respectively. The comprehensive dataset including the list of the medicinal plants used among Tashelhit speakers in the rural commune of Imegdale (High Atlas), along with herbarium specimen details and a glossary of medicinal Tashelhit terms, was published separately in a data journal following the recommendation of the editor of the Journal of Ethnopharmacology (Teixidor-Toneu et al., 2016b).

Chapter 2 The High Atlas cultural landscape through Tashelhit plant names

2.1 Introduction

Plant names are revealing about people's histories and their relations with natural and social environments. In 1962, Lévi-Strauss argued that the ways in which species are named and classified in vernacular languages vocalise local perceptions of the environment. Hunn (2006) reiterated that folk botanical names are rich in cultural nuance and folk classification systems express "what is seen most clearly by Native eyes" (Hunn, 2006: p.181). Various studies have investigated how folk taxonomies express plant ecological characteristics perceived as important (Khasbagan & Soyolt, 2008), reflect local livelihoods (Soyolt et al., 2013) and cultural values of biodiversity (Bjorå et al., 2015). Plant names can also reveal aspects of history and sociocultural context. Van Andel et al (2014) showed that folk plant taxonomy is informative of migrant populations' interactions with new floras. Similarly, Chirkova et al (2016) observed patterns in cognate and loaned plant names in the Shuiluo Valley (China) that shed light on the migration history of the ethnic groups living in the area. In linguistically diverse environments, plant names reflect the socioeconomic relationships between different ethnic groups; names in the dominant language replace names in minority languages when plants are traded (Otieno et al., 2015). Recently, researchers have started using plant names to understand present-day areas of distribution of both cultivated and non-cultivated plants (Bostoen et al., 2013; Rangan et al., 2015; Smith, 2011). However, most research on folk taxonomy has focused so far on describing its empirical basis and structure, discussing and refining the model proposed by Berlin et al (1973).

Folk taxonomy is an integral part of traditional ecological knowledge and can have an intellectual or utilitarian basis, or both (Berlin et al., 1973; Boster & Johnson, 1989; Hunn, 1982). Vernacular names label various ethnobiological taxonomic categories, which are arranged hierarchically in ranks, including unique beginners, life forms, generics, specifics and varietals (Berlin et al., 1973; Berlin, 1973, 1976). However, some of these categories are not necessarily expressed lexically, becoming what Berlin et al (1968) called 'covert categories'. A unique beginner includes all other taxa, which are further grouped in life forms. Folk life forms represent encompassing groupings that reflect gross morphological patterns (Berlin, 1973; Atran, 1985). Generic names are the basic units of ethnobiological classification and refer to groupings recognized by discontinuities in many morphological characteristics (Diamond, 1966; Berlin, 1973). Most folk generic taxa (also called ethnospecies or generic complexes) are monotypic, except when specifics and varietals of culturally important organisms are distinguished (Berlin, 1973). Taxa within each rank often exhibit comparable degrees of differentiation from one another, as in scientific classifications (Berlin, 1976), but are not always mutually exclusive (Alcántara-Salinas et al., 2016). Ethnospecies can have one-to-one correspondence with scientific taxa, refer to multiple scientific taxa, or one scientific taxon can be perceived and named as multiple folk taxa (under- and over-differentiation respectably; Berlin, 1973). Plant names can be primary (semantically unitary), even if composed of more than one lexeme (primary complex names), or secondary, formed by adding a modifying epithet to primary names, which further describe the taxon (Berlin et al., 1973; Martin, 1995). Secondary names label ethnospecies that are part of a set, contrasting them with each other (Martin, 1995). Primary complex names can be 'productive' when include the life form to which the taxon belongs, or 'unproductive', when it does not (Berlin et al., 1973; Martin, 1995). Ultimately, although there are universal principles of folk classification, the ways in which diversity is represented in folk taxonomy are culture-specific.

No ethnotaxonomy study has been carried out in the southern Mediterranean so far, where local people and the environment are especially interrelated. Mediterranean ecosystems have co-evolved with people (Blondel, 2006; Thompson, 2005) and many Mediterranean environments require human management to sustain biodiversity (Bugalho et al., 2011). Mediterranean biodiversity often results from ecological heterogeneity, shaped by diverse climatic and geographical conditions as well as traditional agricultural practises and livelihoods (Atauri & Lucio, 2001; Thompson, 2005). This is also the case in the High Atlas, where Ishelhin people live. They are sedentary agro-pastoralists that still rely on their cultural landscapes for subsistence needs. Local inhabitants hold a large body of ecological knowledge including fodder and veterinary uses of plants for animal husbandry, and ecological knowledge which guides rational decisions on resource use (Davis, 1996). This knowledge, widely shared through exchange networks, enhances the population's resilience and adaptation to local environments (Blanco & Carrière, 2016). In recent years, people living in rural areas of Morocco are increasingly exposed to globalization, which induces changes in local livelihoods (Crawford, 2008) and knowledge (Blanco & Carrière, 2016).

In their review paper, Wilder et al (2016) stress the importance of documenting of folk names to contribute to the conservation of biocultural diversity, which is endangered by social change and economic development (Maffi 2001, 2002). The goal of this study is to document and analyse the lexicon used to name plants among Tashelhit speakers in the High Atlas and explore how language expresses the relationship between Tashelhit speakers and their natural and sociocultural environments. Since place and use terms are often expressed in names (Martin, 1995; Paso y Troncoso, 1886, in Berlin et al., 1973), data on folk environments and plant uses were also collected.

2.2 Methods

2.2.1 Data collection

This study was carried out in the rural commune of Imegdale between May and June 2015. Data from the labels of voucher specimens from the rural herbarium of Imegdale were collected, and structured interviews and focus discussions were carried out with community members.

2.2.1.1 The rural herbarium of Imegdale

In order to collect a checklist of plant names in Tashelhit, voucher specimens of local herbarium of the rural commune of Imegdale were used. In May 2015, 480 herbarium specimens were available, which had been collected and mounted by community researchers from June 2014 to April 2015 during the Global Diversity Foundation's Darwin Initiative "Medicinal plant trade, conservation and local livelihoods in southern Morocco". Plant names and botanical identifications were recorded for all of them (Appendix 2.1).

Specimens were identified at the Regional Herbarium MARK (University Cadi Ayyad, Marrakech) by local and international specialists during a workshop (April 2015) in which I collaborated. The *Flore Pratique du Maroc* (Fennane et al., 1999, 2007, 2015) was used, and nomenclature and family assignments were updated following The Plant List (2013). Duplicates of the specimens have been deposited in the Regional Herbarium at Cadi Ayyad University (MARK), the National Herbarium at the Institut Scientifique, Rabat (RAB) and in Imegdale.

2.2.1.2 Interviews

To collect further ethnobotanical information, 19 structured interviews were carried out with 27 community members from seven different villages. Informants were selected haphazardly and by snowball sampling (Appendix 2.2; Bernard, 2011). Although individual interviews would have been preferable, this was not always possible: family members or passers-by would join in and contribute with their knowledge to the exercise. Interviews were conducted in Tashelhit with a French-speaking translator and recorded with pen and paper, since most informants did not feel at ease with audio recording the sessions. Herbarium specimens (n=119) were selected from the Imegdale rural herbarium to be used as visual cues in structured interviews (Appendix 2.3). Due to the scope of the study, it was not possible to use fresh materials. Not all informants felt equally at ease identifying plants from herbarium specimens, but these were better cues to identify plants than plant photos. Specimens were selected to represent all the available medicinal plants reported in Teixidor-Toneu et al (2016b), as well as common plant species in the community, including crops, plants with diverse botanical habits (trees, climbers, shrubs and herbs) and plants growing in different habitats. For each herbarium specimen, informants were asked to name the plant and describe (1) the plant's uses (and the plant parts used), (2) the environment where each plant grows and (3) what kind of plant it is. Moreover, five focused, non-structured interviews were carried out to elucidate the local plant classification system. Informal discussions and participant observation provided complementary data and were crucial to understand the nuances of how plant names and other terms to describe plants are regularly used (Martin, 1995).

2.2.2 Data analysis

Plant names were translated when possible with the help of community researchers and Amazigh linguists, identifying those that refer to habitats, uses and morphology. Loaned plant names from Moroccan Arabic were also identified. Once the terms for folk life forms were elucidated, plant names were classified as primary simple, primary complex (productive and unproductive) and secondary (Martin, 1995). The terms referring to folk habitats were described and compared with academic classifications of Moroccan vegetation (Fennane, 2006). Plant uses and plant parts were coded following the Level 1 use codes in the "Economic botany data standard" (Cook, 1995) and a separate "veterinary" category was added.

2.3 Results and discussion

2.3.1 Plant names for ethnospecies

In total, 254 plant names and descriptive expressions were recorded of which 211 had been recorded on the labels of the 480 herbarium specimens (Appendix 2.1); 169 names are primary simple, 55 are primary complex productive, 16 are primary complex unproductive and 14 are secondary names (Appendix 2.4). Through structured interviews, 130 generic vernacular names were reported for 84% of the 119 botanical species. Almost half of the species (42%) were referred to by more than one name (Appendix 2.3).

Sometimes the same name was used to refer to more than one botanical species or multiple names were used for one same botanical taxa, revealing ethnospecies (generic complexes, under-differentiation of botanical species), or multiple terms were used for a botanical species by different informants (Appendix 2.4), which may reflect degrees of knowledge and identification skills depending on the informants' idiosyncratic experience (Mathez-Stiefel & Vandebroek, 2012). When informants were not familiar with a plant or could not remember its name, they would often use a "descriptive phrase" such as *ankash n wamen* ("*ankash* of the water"), *ifski n targa* ("*ifski* of the irrigation canal") or *touga n wulli* ("*touga* of the sheep"). These descriptive expressions can be used to name multiple ethnospecies and are constructed in the same way as primary complex productive names; by the addition of a modifier to a higher category name (Berlin, 1973; Martin, 1995). Diversity of names given by different informants also stems from lexical variation across neighbouring watersheds. Different synonyms and plant name variations are used between villages that are close to each other geographically. Plant name differences were observed across villages in mountain valleys separated by just one or two hours' drive. *Cladanthus scariosus* is mostly called *ifski n warras*, but people in the north of the commune name it *itzγi*. *Tlir, tlirin* and *tinirin,* are synonyms for *Dittrichia viscosa* used in adjacent watersheds.

Plant names frequently refer to salient perceptual features (Berlin et al., 1973). Some plant names recorded revealed aspects of the plant's morphology, often through comparison with other plants or locally important animals. Others made reference to the plant's distribution in the local environments, or its uses. The use of loaned plant names provided cues about local history (especially in relation with imported plants) and trade.

2.3.1.1 Taxonomic relationships between plants

Names can describe plants' morphology directly, using adjectives or by highlighting similarity to other plants. Cognate sets, modifiers in complex productive names (Table 2.1), feminine forms or explicit kinship terms are used to express similarity between plants.

Table 2.1 Glossary of common modifiers in binomial plant names (secondary or primary complex).

Colours and morphologic characteristics	
Tazgzawt	Green
Tumlilt	White
Ijjan	Fragrant, perfumed
Amjjud	Bald
N tazart	Fig-like
Animals	
N igdad (N ugdide)	Of the birds (of the bird)
N uγyul	Of the donkey
N ubnkal	Of the snake
N imugayn	Of the cows
N wuccn	Of the jackal
N wudad	Of the mouflon
N wulli	Of the sheep
N uzgr	Of the bull
N uγrda	Of the mouse
Environment / habitats	
N wamen	Of the water
N lεin	Of the water source
N uasif	Of the stream or river
N targa	Of the irrigation canal
N udrar	Of the mountain
N yigran	Of the fields
N uzru	Of the rock
N uγulid	Of the cliff
N ugdal	Of the *agdal* (area protected by customary law)
N umdduz	Of the small hill
N lbour	Of the dry slope
Uses	
N warras	Of the rubbish (for sweeping the floor)
N uzbar	Of the pain (to treat pain)
N ssabun	Of the soap (for washing)

The plants *igg* (*Pistacia atlantica*), *imitgg* (*Pistacia lentiscus*) and *ouingg* (*Searsia tripartita*) are phylogenetically related plants; and their names are formed from one lexical root. Many complex productive names express morphological similarities, through the construction "generic name + modifier" (Berlin et al., 1973; Table 2.1). For example, *tirkamt n tazart* ("turnip of the fig tree", *Bryonia cretica*) is formed of two words that express different aspects of the plant morphology in relation to other species; *tirkamt* notes that roots are similar to turnips and *tazart* illustrates the similarity of its leaves and those of fig trees.

Morphological similarity between named species and a more common plant is often expressed by the use of feminine terms, created by adding a t- as a prefix and -t, -in or –yin as a suffix in Tashelhit. *Azukni* (*Thymus saturejoides*) and *ifzi* (*Marrubium vulgare*) are masculine words, whereas *tazuknit* (*Thymus maroccanus, T. willdenowii*) and *tifziyin* (*Salvia taraxicifolia*) are feminine. Feminine terms are also diminutives, as in other cultures (*e.g.*, by the use of similar prefixes and suffixes in the Arabic spoken in Dhofar; Miller & Morris, 1988). Plants named by feminine terms are of less cultural value or smaller in size; *tazuknit* is used for all local thyme species that are not the most abundant *Thymus saturejoides*. Another example is *tawazkont* (*Bromus sterilis*), which resembles *waskon* (*Avena sativa*), but does not produce edible grains. Resemblances to edible or useful species are also expressed by using animal and place epithets, as discussed in the next sections.

The dichotomy *beldi* ("local") and *romi* (or *arrom*, "foreign") can also elucidate contrast between similar species, as in *sfsaf* (*Populus alba*) and *sfsaf romi* (*Populus nigra*; "foreign poplar"). The use of *romi* indicates that the species is not native, less valuable or less abundant than the *beldi* one.

Finally, kinship terms are also used to express similarity; *khalis n ifzi* (*Ballota hirsuta*) literally means "uncle of *ifzi*" (*ifzi* being *Marrubium vulgare*) and is also called *tifziyin*. *Khalis n ushdir*, "uncle of *ashdir*" (*Parietaria* sp.) was described as similar to *ashdir* (*Rubus ulmifolius*) but without prickles.

2.3.1.2 Locally important animals

Complex names can also convey similarity between plants and animals; references to animals in plant names can highlight their cultural salience (Khasbagan, 1996). According to Tashelhit speakers in Imegdale, *Sedum* species resemble snakes (*abankal*) resulting in names such as *tabnkalt* (*Sedum acre*) and *taknerit n ubnkal* (*Sedum sediforme*; "small succulent of the snake"). Other examples are *ils n uzgr* (*Plantago major*; "tongue of the bull") or *lhbaq n uγyul* (*Mercurialis annua*; "basil of the donkey", presumably because it looks like basil, but does not smell as good). Name modifiers that refer to animals can also mean “wild” or “fake” in relation to a cultivated or culturally more important species; the modifiers *n igdad* (“of the birds”) and *n wulli* (“of the goats”) are used in such way.

2.3.1.3 Environments and localities where plans grow

Names can situate plants geographically; *arshkak n Taghzout* (*Verbascum* sp.; “*archkak* from Taghzout”), grows locally around the village of Taghzout. More often though, plants are situated in overall local habitats or environments rather than specific locations; *touga n lɛin* (*Adiantum capillus-veneris*; “weed of the water source”) or *ankash n waman* (*Sonchus aquatilis*; “*ankash* of the water”), vocalise the affinity of these plants to water. A plant’s affinity for one particular habitat will often be used as a descriptive modifier when people don’t know the exact plant’s name; *touga n waman* (“weed of the water”) was mentioned for over ten plant species that grow along streams, irrigation canals, and other humid environments and *touga n yigran* (“weed of the fields”) refers to weedy plants that grow in the fields or around them.

Over ten distinct folk habitats or environments were identified during interviews (Figure 2.1; Appendix 2.3). Many of these environments are man-made or carefully managed, and their local classification integrates aspects of management and governance. *Yigran* (fields)*, targa* (irrigation canals), *lbour* (dry slopes) and *igdalen* (protected montane areas) are all environments where agriculture is practiced, managed though customary law, resulting in a poor fit with habitat classifications (Fennane, 2006). This is especially important regarding *igdalen*, community managed and protected montane areas where biodiversity conservation is achieved through costumary law and sustainable use of natural resources (Auclair & Alifriqui, 2012). In Imegdale, *igdalen* correspond to humid, high-altitude valleys with creeks fed by seasonal snowmelt, where a tree cover of *Juglans regia* is managed by the community and fodder is collected from the understorey, only harvested during late summer when other resources have dried out or have been depleted.

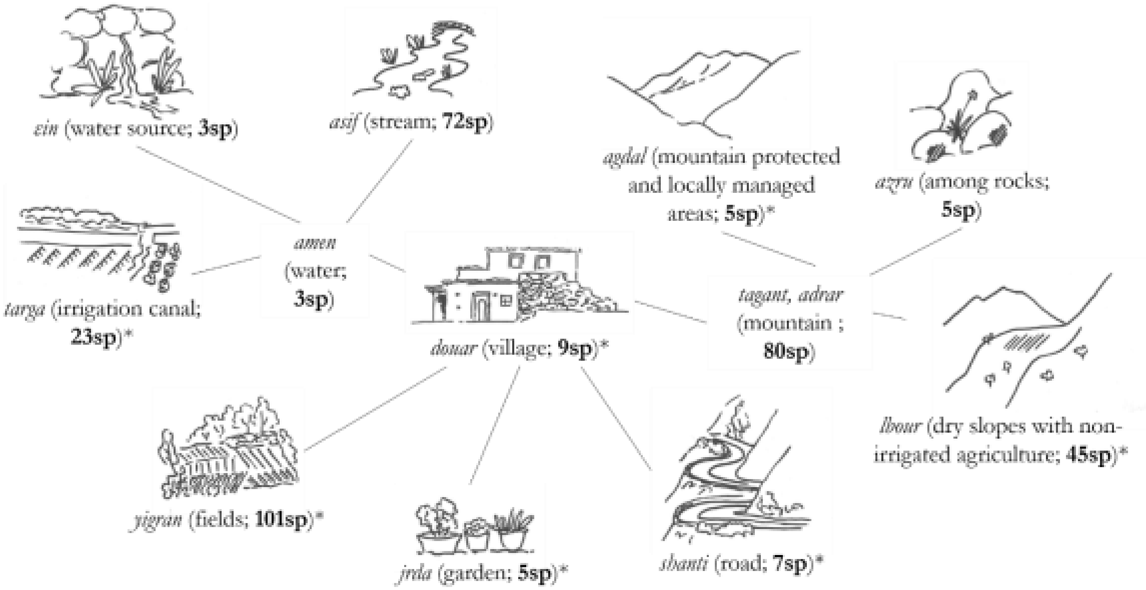

*Figure 2.1 Diagram of habitats with number of species that informants associated to each of them. Half are more or less anthropogenic (*targa, yigran, jrda, shanti, agdal*; highlighted by *).*

References to space also indicate morphological similarity between a wild or less valued plant and a culturally important one, for example in *tswig n yigran* (*Plumbago europaea*; "walnut of the fields") and *matisha n yigran* (*Solanum americanum*; "tomato of the fields"). The weedy *Asphodelus tenuifolius* can be called *azalim n yigran, azalim n lbour* or *azalim n udrar* ("onion of the fields", "onion of the dry slopes", or "onion of the mountain"), in contrast with *azalim*, which is the edible onion. Like some references to animals, *n yigran, n lbour* and *n udrar* can be used as an equivalent of "wild" or "fake". This suggests that, these three environments can represent a single metaphorical attribute although they are clearly distinguished by locals in terms of the vegetation they hold and the traditional practices carried in each of them.

2.3.1.4 Plant names that recall their use

The utilitarian nature of traditional knowledge is rarely encoded in plant names through the use of feminine words and modifiers in complex names, but references to uses are less frequent than those to animals or environments in Tashelhit plant names; only three plant names expressed the plant's use. *Tatait* (*Micromeria* sp.; "little tea") is used in a similar manner as *atay* ("tea"), and *tahleebin* (*Pulicaria* sp.; "little milk") is used to enhance lactation in cows (*hleeb* being "milk"). *Ifski* *n warras* (*Cladanthus scariosus*; "*ifski* to sweep") and *touga n ssabun* (not identified; "*touga* of soap") are used as brooms and soap, respectively.

Descriptive expressions that make reference to use are also common when people don't know the plant's name. The expression *touga n uzbar* ("weed of the pain") is used to refer to some medicinal plants such as *touga n lɛin* (*Adianthus capillus-veneris*) and *tiqi n uzru* (*Thymus willdenowii*). *Grz ɣyiel* (*Lavandula maroccana* or *L. multifida*) was referred as *ifski lqhwa* ("shrub of the coffee") by one informant as it is often used to flavour coffee.

2.3.1.5 History and trade though plant names

Local plant histories leave traces in vernacular languages, especially by loaned words when a new plant is incorporated to the local repertoire (Wild, 1970; Williamson, 1970). Most loanwords in Tashelhit are borrowed from or through Arabic, and they can point to deep historical events such as the arrival of new crops into the Maghreb, or reflect current socioeconomic relationships between the Tashelhit-speaking minority and the Arabic-speaking majority. Loanwords in Tashelhit included many cultivated plants such as *matisha* (*Solanum lycopersicum*) from the Nahuatl *tomatl*, *tini* (*Phoenix dactylifera*) from the ancient Egyptian *bjn* or *azalim* (*Allium cepa*) from the Punic *bsl* through the Moroccan Arabic *bsla* (Múrcia & Zenia, 2016). These loaned words then are used to form primary complex unproductive names such as *matisha n igdad* (*Solanum americanum*; "tomato of the birds") or *azalim n udrar* (*Asphodelus tenuifolius*; "onion of the mountain") to refer to native plants. In culturally and linguistically diverse social landscapes, it is common for binomial plant names to combine lexical items from different languages (van Andel et al., 2014). Names for cultivated aromatic species not native to the High Atlas such as *mrdedush* (*Origanum majorana*) and *latarsha* (*Pelargonium odoratissimum*) are loaned from Moroccan Arabic, possibly because they might have started being planted and used by Tashelhit-speakers in contact with the Arabs. Moroccan Arabic names for traded species were also mentioned by informants.

Plant names are likely to change along trade chains when traders and consumers belong to different ethnicities. Nomenclature used for traded plant products will vary at different points of the trade chains, with the dominant language being used in market places (Otieno et al., 2015; Williams et al., 2001). This dynamism in naming adds complexity to folk taxonomies, hampering plant identification in market places (de Boer et al., 2014; Otieno et al., 2015). Two wild herbs part of

Imegdale's medicinal plant consensus model (Teixidor-Toneu et al., 2016a), *Thymus saturejoides* and *Lavandula dentata*, are traded from Imegdale. Locally called *azukni* and *timzurri*, they reach the markets as *zɛter* and *khzema*, respectively. However, neither *zɛter* nor *khzema* are solely *Thymus saturejoides* and *Lavandula dentata*. *Zɛter* includes other local thyme species such as *tiqi n uzru* (*Thymus willdenowii*), also called *tifskit n tazuknit* ("small *ifski* of *tazuknit*"), and the various species of the *tazuknit* generic complex (*Thymus saturejoides, T. maroccanus, T. willdenowii, Micromeria hochreutineri*). *Thymus saturejoides* can be considered part of the *tazuknit* generic complex when flowers are white (uncommon variety) in which case it is also named *azukni tumlilt* ("white thyme"). Similarly, *khzema* does not only include *timzurri* (*Lavandula dentata*), but also the less common *khzemt* (*Lavandula pedunculata* or *L. stoechas*) and *grz ɣyiel* (*Lavandula maroccana* or *L. multifida*), as well as other Moroccan species not present in the High Atlas. Whereas locals will always differentiate between these three ethnospecies, middle men use solely the name *khzema*, adapting the nomenclature to optimise trade with Moroccan Arabic speakers in the urban areas. In urban markets, *timzurri* (*Lavandula dentata*) is distinguished by its smell from other lavanders and called *khzema beldia* ("local lavander") or *khzema lhalhalia* or even *lhalhal* will be used by Moroccan Arabic speaking sellers (pers. obs.). The name *tahalhalt* (a Berberised word from the Moroccan Arabic *halhal*) has also been recorded for *Lavandula dentata* in Imegdale, but it is never used in daily talk, and may just show that some locals are familiar with the commercialised names.

2.3.2 Plant names for higher rank plant categories

Fifteen Tashelhit words that describe plants were identified, of which twelve label folk categories of plants (Table 2.2). The unique beginner for plant is a covert category in Tashelhit, as common also in other cultures (Berlin et al., 1968, 1973; Martin, 1995). *Touga* is the most commonly used life form, and carries utilitarian and categorical meaning. Sometimes *touga* is locally translated as *rbɛ* (weed in Moroccan Arabic), but not all weeds are *touga* nor all *touga* are weeds. The term is used to refer to fodder plants, and almost all plants can be used as fodder in Imegdale either because they are harvested and brought to domestic livestock or because they grazed by herds.

Table 2.2 Folk plant categories.

Tashelhit term	Description	Example
Touga	Plants collected as fodder for livestock, but also used to refer to weeds. It corresponds to the equivalent cross-cutting categories of grasses and forbs in English, since it refers to non-woody plants which do not survive the dry season.	*Piptatherum coerulescens*
Ifski	Plants with lignified stems branching from the base or with several stems growing from the base, usually small bushes or cushion-like. Aerial parts are present during the dry season.	*Cladantus scariosus*
Ankash	Plants with a basal leaf rosette.	*Bellis caerulescens*
Teskra, krzez	Spiny plants with a basal leaf rosette or leaves all along the stem.	*Eryngium variifolium*
Ashdir	Spiny plants with lignified stems.	*Rubus ulmifolius*
Tsjrt (from *sjra*, Moroccan Arabic term)*, ashgar*	Trees or bushes of considerable size.	*Quercus ilex*
Akneri	Succulent plants.	*Sedum acre*
Tamshfalt (lit. "to go up")	Vines and climbers.	*Bryonia dioica*
Ajrid	Palm (unaffiliated taxa *sensu* Hunn, 1976)	*Phoenix dactylifera*
Aγalim	Cane (unaffiliated taxa *sensu* Hunn, 1976)	*Arundo donax*

Plants were often described by their underground organs' morphology: plants with taproots are called *khizo* (lit., "carrot") or *tirkamt* (lit. "turnip") and bulbs are called *azalim* (lit. "onion"). Plants with conspicuous flowers are sometimes called *ajdik*, literally "flower".

Two utilitarian categories were recorded. The term *izoran* (sing. *azour*), translated as "roots", is used to describe plants whose roots are used medicinally, usually collected from alpine areas and traded by shepherds down to the valley villages; it carries only utilitarian meaning. Useful roots collected from other environments may also be called *izoran* but would not be considered part of the complex of "roots" when the term is used to label the category. The category *zrb* is used to describe thorny or prickly plants used to build enclosures, either to keep animals in or out.

Life form terms are not always mutually exclusive in Tashelhit, since terms can carry complementary meanings. For instance, *khizo n igdad* (*Torilis arvensis*; "carrot of the birds") can be considered *touga* or *ifski*. Here *touga* refers to its use as fodder and *ifski* points out the overall appearance. Moreover, much variation in the use of life form terms was documented amongst informants: whereas *ifski* is always used to refer to small bushes, *tsjrt* is used to name trees by some informants, but was used to refer to herbs, bushes, shrubs and palms by others (including for example, *Foeniculum vulgare, Lavandula dentata, Globularia alypum, Chamaerops humilis*). *Tsjrt*, an originally Arabic term for "tree", was the common word mentioned during interviews instead of the Amazigh term *ashgar*; this could explain its loose meaning. People do not follow a single set of classification criteria (Randall, 1976); classification systems as used in ordinary daily situations are inherently flexible with classifying priorities being context dependent (Alcántara-Salinas et al., 2016; Hunn, 1982). The use of classificatory terms in specific contexts also depends on individual's knowledge and relationship to plants (*e.g.*, shepherds and shopkeepers would not use classificatory terms in the same way).

2.4 Conclusion

Analysis of plant names in Tashelhit supports the view, also reported by studies of other communities, that Tashelhit speakers have plant knowledge resulting from a locally placed experience and specific livelihoods. Names reveal culture-specific views on similarities between plants or between plants and animals, values about biodiversity (some plants considered "wild" or "fake" versions of more important ones), folk uses, and the classification of local environments.

Plant classification into folk life forms reflects the central role of pastoralism for local livelihoods in the High Atlas; the most commonly used plant life form term can also indicate the use of that plant as fodder.

Local and indigenous cultures are not only embedded in natural environments, but also in specific social environments. Through the identification of loanwords, aspects of history and socioeconomic relationships between the Tashelhit-speaking minority and the Arabic-speaking majority that dominates trade and business are revealed.

Chapter 3 *Isafrn*: The medicinal flora of a Tashelhit speaking community in the High Atlas

3.1 Introduction

Herbal medicine is an important healthcare resource in Morocco (Bellakhdar, 1978, 1997; Bellakhdar et al., 1982; Benchâabane & Abbad, 1997) and plays central role in the daily lives of many rural and urban Moroccans (Eddouks et al., 2002; El-Hilaly et al., 2003; Fakchich & Elachouri, 2014; Hmammouchi, 1999; Jouad et al., 2001; Merzouki et al., 2003; Sijelmassi, 1993; Tahraoui et al., 2007; Ziyyat et al., 1997). Medicinal plants are often collected from the wild, both for home use and as an additional source of income for rural families across the country (El-Hilaly et al., 2003; Ouarghidi et al., 2013). As reviewed by Ouaghidi et al (2013), efforts have been made for the last 30 years to document traditional knowledge from poorly studied areas of Morocco focusing on the northern, north-eastern and south-eastern provinces (Eddouks et al., 2017; El-Hilaly et al., 2003; El Rhaffari & Zaid, 2002; Fakchich & Elachouri, 2014; Hmammouchi, 1999; Merzouki et al., 2003), herbalists and healers (Bellakhdar et al., 1991; Claisse, 1990), and specific ailments including hypertension, diabetes and cardiac diseases (Eddouks et al., 2002; Jouad et al., 2001; Tahraoui et al., 2007; Ziyyat et al., 1997). Elements of the Moroccan medicinal flora are also documented in the grey literature (Bellakhdar, 1978, 1997; Bellakhdar et al., 1982; Benchâabane & Abbad, 1997; Boulos, 1983; Sijelmassi, 1993). However, ethnobotanical local knowledge from many areas of Morocco, especially in the south, remains poorly known (Ouarghidi et al., 2013). This is the case for medicinal plant knowledge in the High Atlas amongst Tashelhit speaking communities.

In Morocco, medicinal plants are used in the context of a pluralistic medical system that incorporates Prophetic and Galenic humoral medicine (Greenwood, 1981), as well as biomedicine (Mateo Dieste, 2010); illness and treatment are understood through a combination of local beliefs. However, in ethnopharmacological research diseases are often described in biomedical terms and, while standard classifications can be useful, they do not reflect the local perception of disease (Staub et al., 2015). Different cultures define illness in specific ways that do not always correspond to biomedical diseases, including folk ailments that are unique to a particular group of people, cultural or geographical area, namely cultural bound syndromes (Helman, 2007). Moreover, plant use depends on cultural constructs of efficacy (Etkin, 1988a; Moerman & Jonas, 2002; Ortiz de

Montellano, 1975), local knowledge on how to prepare and administer plants (Etkin, 1988b; Hsu, 2010) as well as plant selection according to local classification systems (Berlin, 1973; Berlin et al., 1973). Hence, it is crucial that ethnomedical and ethnobotanical field studies take these local views into account to properly contextualise medicinal plant use (Heinrich et al., 2009).

Although there are detailed accounts from medical anthropology about Moroccan illness explanatory models and healing systems (Bakker, 1992, 1993; Greenwood, 1981; Mateo Dieste, 2010), these studies do not link healing practices with the use of medicinal plants. Furthermore, in the context of Moroccan ethnobotany there have been few attempts to report the vernacular names for diseases, or to explain the relationships between local illness concepts and medicinal plant use. An exception is the work of El Rhaffari and Zaid (2002), who mention the notions of "hot" and "cold" and the belief in supernatural causes of disease as basis for diagnosis in southern Morocco, common in the Arabo-Muslim traditional medicine (Ghazanfar, 1994; Greenwood, 1981). However, these concepts do not inform the interpretation of their results (El Rhaffari & Zaid, 2002). Therefore, the main aims of this study are (1) to contribute to original documentation of medicinal plant use by Ishelhin people in the High Atlas, and (2) to provide novel insights into the relationship between local and biomedical disease concepts in Morocco, elucidating their influence on medicinal plant use.

3.2 Methods

3.2.1 Field data collection

This study was carried out between February and June 2015; 106 adult informants were interviewed in nine villages of the rural commune of Imegdale, which were representative of the diversity of environments in the commune. Four villages are at the top of the different watersheds that flow into the N'Fiss valley, where the other five villages are located. Eighty-five percent of the informants were women since men often referred to their wives when we attempted to interview them. Since many women do not know their exact age, informants were classified in age groups: young (<30 years old; 18%), middle aged (30–60; 55%) and older (>60; 27%). Interviews were conducted in Tashelhit with the aid of a French-speaking local translator and recorded with pen and paper. Random and snowball sampling techniques were used for selecting informants (Bernard, 2011). Interviews with herbalists were conducted about plant mixtures that locals usually acquire from them, in the souks of Asni, Tlat N'Yakoub and Amizmiz (n= 4).

3.2.2.1 Interviews

Individual free-listing and semi-structured interviews were conducted, along with focus group discussions concerning local use of medicinal plant resources (Martin, 1995). Plant names were mostly given in Tashelhit, but vernacular names in Moroccan Arabic were recorded when mentioned. During discussions, focus was put on understanding local healing strategies, including illness aetiologies and their perceived symptoms, as well as plants' preparation and administration modes (*i.e.* in mixtures). Much understanding was also gained through participant observation (Martin, 1995), especially when herbal remedies where being prepared and used, and by joining villagers in plant collection activities.

Additional medicinal plants were identified by conducting nineteen structured interviews at the end of the field study using herbarium specimens as visual clues to identify local plants (Appendix 2.3). Specimens used are part of the herbarium of Imegdale, established as part of ongoing ethnofloristic documentation work by the Global Diversity Foundation. One hundred nineteen herbarium specimens were selected to represent all available medicinal plants previously reported, as well as a range of common species in the area. For each specimen, informants were asked about the plant's name, uses and parts used, plant life-form and location where it is found.

3.2.3.2 Botanical collection and plant identification

Voucher specimens were collected in the field with the collaboration of informants. Specimens from the local herbarium of Imegdale were used to identify species referred by vernacular names when collection was not possible. Vouchers have been deposited at the Marrakech Regional Herbarium (MARK, Morocco) and the University of Reading Herbarium (RNG, United Kingdom; Appendix 3.1). Vouchers of the local herbarium of Imegdale are deposited at the Marrakech Regional Herbarium and the *Institut Scientifique de Rabat* Herbarium (Morocco; RAB). Market samples were purchased in the souks of Asni and Tlat N'Yakoub and deposited in the University of Reading Herbarium. Taxonomic identification follows the *Flore Pratique du Maroc* (Fennane et al., 1999, 2007, 2015) and nomenclature and family assignments follow The Plant List (2013) and APG IV (2016).

3.2.4 Data analysis

Data were structured in use reports, which refer to each mention of one plant for one therapeutic application given by one informant. Data collected for each use report includes its local name(s), part(s) used, modes(s) of administration, intended therapeutic application and origin (wild, cultivated or acquired in the souk). Part(s) used and mode(s) of administration were classified and codified according to the "Economic botany data standard" (Cook, 1995). Three ethnobotanical indices were calculated to describe the data: Use Value (UV), Fidelity Level (FL) and Informant Consensus Factor (F_{ic}; indices described in Table 3.1). Agreement among informants (F_{ic}) was calculated for the most cited folk ailments as well for biomedical therapeutic categories of plant use. For each use report, the liaison between folk and biomedical terms was made depending of the context in which the folk term was used and the symptomatology explained. Fourteen biomedical use categories were considered. Following suggestions made by Staub et al (2015), most biomedical categories were based on the treated body systems: cardiovascular, dermatological, endocrinological, gastrointestinal, gynaecological, musculoskeletal, ophthalmological, otolaryngological & respiratory and urological & nephrological. To this list five locally relevant categories were added in order to better represent the ailments mentioned during interviews: cancer, general health, paediatric, injuries and ritual & spiritual. All calculations are based on plant vernacular names, not on botanical species (Berlin, 1973). The software *anthropac* (Borgatti, 1996) was used to find a consensus model of known medicinal plants listed by informants (Romney et al., 1986). It was also used to elucidate patterns of medicinal plant use through Johnson's Hierarchical Clustering (Johnson, 1967), which allows for the identification of sets of plants commonly used together based on plants' co-occurrence and clustering within in free-lists.

Table 3.1 Indices used to describe medicinal plant knowledge.

Use Value (UV)	**Informant Consensus Factor (F_{ic})**	**Fidelity Level (FL)**
UV evaluates of the relative cultural importance of each plant according to the number of use reports. Based on Phillips and Gentry (1993), simplified by Rossato et al (1999).	F_{ic} assesses the agreement among informants on the plants used for each use category. Based on Trotter and Logan (1986) and Heinrich et al (1998).	FL identifies the main use of each plant, and calculates the use reports' relative importance for each category of use. Based on Friedman et al (1986).
$UV = \frac{\Sigma Uis}{N}$	$Fic = \frac{Nuc - Nt}{Nuc - 1}$	$FL = \left(\frac{Np}{N}\right) x\ 100$
∑Uis is the sum of the total number of use reports concerning a given ethnospecies and *N* is the total number of informants. The most reported plants have the highest UV values.	*Nuc* is the total number of use reports in each use category and *Nt* is the number of ethnospecies used in that category. High *Fic* values indicate agreement among informants on which plants to use for a particular use category.	*Np* is the number of use reports for a use category and *N* the total number of informants citing an ethnospecies for any use. High FL values indicate that a plant is mainly used only for one use category. FL is artificially high for plants with few use reports, thus plants with less than five use reports were excluded from the discussion.

3.3 Results and discussion

3.3.1 Medicinal plant users

Women are the main medicinal plant knowledge stakeholders in the rural commune of Imegdale, as found in other regions of Morocco (Abouri et al., 2012; El-Hilaly et al., 2003; El Rhaffari & Zaid, 2002; Fakchich & Elachouri, 2014; Merzouki et al., 2000). Fakchich and Elachouri (2014) argue that this is because women are more attached to traditional practices than men (Jouad et al., 2001), and knowledge is more readily transmitted among them because it may increase their social status (Tahraoui et al., 2007). Methodological reasons are also mentioned in the literature to explain the perceived gender differences; women are more often at home when surveys are being carried out (Jouad et al., 2001). However, findings in this study support the view that women are the main holders of medicinal plant knowledge because they manage the household health (Voeks, 2007; Wayland, 2001) and are in charge of the household diet. Besides evidence from participant observation and informal conversations, paediatric ailments were amongst the most cited therapeutic plant uses during interviews (see section 3.3.4). Children's health is women's responsibility. Agriculture-related labour, as other household responsibilities, is also gendered in rural Morocco: women and men do not carry out the same agricultural activities. Women in the High Atlas create their own medicinal flora by selecting plants from the environments where they spend most time in, as observed elsewhere in the world (Howard, 2003; Kainer & Duryea, 1992; Pfeiffer & Butz, 2005; Sunderland et al., 2014; Voeks, 2007). Differences in medicinal plants cited by men and women are discussed in Chapter 4. As the main managers of household health, women are familiar with treatments for common ailments, which are dealt with at home, but they seek to be treated by local or biomedical specialists in case of complex ailments (Monteiro et al., 2006; Shrestha & Dhillion, 2003) or when their own knowledge fails (Geniuz, 2009).

3.3.2 Medicinal plant diversity

In total, 151 vernacular names of medicinal plants (*isafrn* in Tashelhit) were mentioned during the interviews, corresponding to 159 botanical species. Most of them were identified through free-listing and semi-structured interviews (n= 144), but structured interviews based on herbarium specimens allowed further identification of plants used medicinally (n= 7). The medicinal plants' inventory is summarized in Table 3.2, including vernacular and scientific names, local use (folk ailments) and use categories, as well as the number of use reports (UR), use values (UV) and the highest fidelity level value (FL; the corresponding category of use is highlighted in bold). Two vernacular names could not be identified, whereas five were identified at genus level and four at family level. Medicinal plant diversity is concentrated in five plant families: Lamiaceae (25 species), Asteraceae (11 species), Apiaceae (10 species), Fabaceae (6 species) and Rosaceae (6 species). These results are similar to those from other parts of the country (Fakchich & Elachouri, 2014) and other Mediterranean regions (Bonet & Vallès, 2003; Rigat et al., 2007). A high number of use reports correspond to the Lamiaceae, as well as Asteraceae, Cupressaceae, Apiaceae, Fabaceae, Rutaceae and Amaranthaceae. The consensus model or typical medicinal plant list in Imegdale includes: *azukni* (*Thymus saturejoides*; UV 1.43), *shih* (*Artemisia herba-alba*; 1.23), *timja* (*Mentha suaveolens*; 1.23), *azuka* (*Tetraclinis articulata*; 0.88) and *timzurri* (*Lavandula dentata*; 0.74). According to UV values, *ifzi* (*Marrubium vulgare*; 0.88), *aurmi* (*Ruta chalepensis*; 0.55), and *mkhinza* (*Dysphania ambroisoides*; 0.52) are also culturally important plants. Although none of these are used also as foods, many medicinal plants used in Imegdale are also edible. This highlights that the food and medicine plant use categories are often indistinct (Touwaide & Appetiti, 2015).

Table 3.2 Medicinal flora of Imegdale. Vernaculars: [MA] indicates names in Moroccan Arabic. Vouchers: Herbarium voucher details are in Appendix 3.1. Source: wild (W), wild naturalised (W(Nat)), cultivated (Cu), imported (Imp). Part used: aerial parts (AP), bark (B), bulbs (Bu), epicarp (Epi), exudates & resin (ExR), flowers (Fl), flower buds (Flb), fruits (Fr), galls (G), inflorescences (infl), infructescences (infr), leaves (L), oil (O), rhizomes (Rh), roots (R), root bark (rB), seeds (S), stems (St), tubers (Tu), wood (W). Numbers in brakets indicate the number of use reports. Administration: baths (B), charms (C), ear drops (AD), external applications (unspecified, EA), incense (IN), inhalers (I), liniment (L), masking (MA), oral ingestion (OI), poultices (P), qwi (Q), teas (T), washes (W). Excipient: indicates when medicinal plants taken in food (F), or prepared with honey (H), olive oil (O) or milk (M). Folk ailments: Folk ailment vocabulary is detailed in the glossary (Appendix 1.1). Categories of use: cancer (CA), cardiovascular (CV), dermatological (D), endocrinological (E), gastrointestinal (GI), general health (GH), gynaecological (GY), injuries (I), musculoskeletal (MS), ophthalmological (OP), otolaryngological & respiratory (OR), paediatric (P), ritual & spiritual (RS), urological & nephrological (UN). The use category with highest fidelity value for each plant has been highlighted in bold.

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Adiantaceae	touga n lɛin (H), touga n uzbar	*Adiantum capillus-veneris* L. (FD136)	W	Fr (4)	-	-	azbar (4)	-	-	-	-
Amaranthaceae	mkhinza	*Dysphania ambrosioides* (L.) Mosyakin & Clemants (IME02)	W(Nat)	L (43)	OI (24), P (9), T (5), B (5)	-	skhana (36), kolshi (5), meda, skar	E, **GH**, GI, P	43	0.88	0.52
Amaryllidaceae	azalim	*Allium cepa* L. (NA)	Cu	Bu (4)	OI (3), B	-	skhana (4)	**GH**	4	1	0.05
	touma	*Allium sativum* L. (NA)	Cu	Bu (8)	OI (7), P	O (3), F	tuhut (4), ruah (3), asumid	GH, GY, **OR**	8	0.75	0.10
Anacardiaceae	igg	*Pistacia atlantica* Desf. (IME82)	W	G (5), L	IN (2), EA (2), I, B	-	alen (2), ɛin, shqeqa, kolshi, iqdi	**GH, OP**, P, RS	6	0.33	0.07
	imitgg	*Pistacia lentiscus* L. (HAM153)	W	L (2)	T, B	-	skhana (2)	**GH**	2	1	0.02
	louz n wulli, ouingg	*Searsia tripartita* (Ucria) Moffett (FD53)	W	L	B	-	kolshi	**P**	1	1	0.01
Apiaceae	bqbouka	*Bunium bulbocastanum* L. (MAR60_08, MAR63_12)	Imp	-	-	-	-	-	-	-	-
	fassough	*Ferula communis* L. (NA)	Imp	ExR (9)	IN (9)	-	bkhorr (5), ɛin (4)	**RS**	9	1	0.11
	habt halawa	*Pimpinella anisum* L. (MAR40)	Imp	Fr (2)	OI (2)	-	asumid (2)	**GH**	2	1	0.02
	kamoun beldi	*Cuminum cyminum* L. (MAR65)	Imp	Fr (6)	OI (6)	O (2)	meda (3), asumid, frigg, tuhut	GH, **GI**, OR, P	6	0.5	0.07
	kamoun sofi	*Ammodaucus leuchotricus* Coss. (MAR41)	Imp	Fr	OI	O	frigg	**P**	1	1	0.01
	karwiya	*Carum carvi* L. (MAR7)	Imp	Fr	OI	O	frigg	**P**	1	1	0.01

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Apiaceae	mɛdnus	*Petroselinum crispum* (Mill.) Fuss (IME99)	Cu	L (4), AP (2), S	T (4), OI (3)	H, F	klaui (3), asumid (2), azbar, meda	GI, GY, MS, **UN**	7	0.43	0.09
	qzbor	*Coriandrum sativum* L. (IME42)	Imp	Fr (6), O, L (2)	OI (4), T (2), EA (2), IN	F, O	kolshi (2), frigg (2), adis, klaui, iqdi, bkhorr, asumid	GH, GI, GY, **P**, RS, UN	9	0.33	0.11
	teskra tumlilt	*Eryngium tricuspidatum* L. (IME89)	W	R (2)	OI, T	H	asumid, meda	**GI, GY**	2	0.5	0.02
	wamsa, nɛfɛ [MA]	*Foeniculum vulgare* Mill. (IME27)	W	Fr (21), L (4), R	OI (20), T (5), EA	F (4), H	meda (9), asumid (5), msran (5), klaui (2), alen, adis, azbar, kolshi, skar	E, GH, **GI**, OP, UN	26	0.62	0.32
Apocynaceae	alili, tfla [MA]	*Nerium oleander* L. (IME70)	W	L (11), W (4)	EA (7), IN (3), P, B, I, T, OI	O	alen (7), frigg (2), cancer, asumid, kolshi, shqeqa, skar, ɛin	CA, E, GH, MS, **OP**, P, RS	15	0.47	0.18
Arecaceae	tini, abhus [MA]	*Phoenix dactylifera* L. (HAS142)	Imp	S (8)	EA (8)	-	alen (8)	**OP**	8	1	0.10
	tiznirt	*Chamaerops humilis* L. (HAS31)	W	L (3)	OI, T, Q	O (2)	frigg, bousfer (2)	**E**, P	3	0.66	0.04
Aristolochiaceae	brrsdm, tibersnt	*Aristolochia paucinervis* Pomel (IME108)	W	L, R	EA, OI	H	boumzui, zagaz	**CV, GI**	2	0.5	0.02
Asparagaceae	azalim n wuccn	*Drimia maritima* (L.) Stearn (HAS153)	W	Bu (2)	P (2)	-	asumid (2)	**GY**	2	1	0.02
Asphodelaceae	blalouz	*Asphodelus microcarpus* Salzm. & Viv. (MAR63_07)	Imp	-	-	-	-	-	-	-	-
	taiziut, aghozir, aziot (H)	*Asphodelus tenuifolius* Cav. (HAM31)	W	Bu (3)	-	-	asumid (3)	-	-	-	-
Asteraceae	arshmush	*Onopordum acaulon* L. (IME91, IME95)	W	R (9)	OI (9)	F (7), H (2)	asumid (4), saht (3), kolshi, adis	**GH**, GI, MS	9	0.56	0.11
	babunj	NA (NA)	Imp	Fl	OI	O	frigg	**P**	1	1	0.01
	ijjaumgar	*Inula montana* L. (IME08)	W	L (25)	T (20), OI (5)	F (6)	kolshi (11), ruah (5), skhana (2), azbar (2), asumid (2), mrrara, klaui, meda	**GH**, GI, OR, RS	25	0.64	0.30

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Asteraceae	itzγi, ifzki n warras, touga n ifski	*Cladanthus scariosus* (Ball) Oberpr. & Vogt (IME34)	W	L&infl (15), L (3)	T (8), OI (6), B (4)	F (2), O (2), F	kolshi (9), skhana (2), meda (2), frigg (2), asumid (2), iurigh	**GH**, GI, GY, P	18	0.56	0.22
	lgnbes	*Tagetes minuta* L. (HAS133)	Cu	Fl	T	-	asumid	**MS**	1	1	0.01
	shiba	*Artemisia absinthium* L. (NA)	Imp	L (9)	T (9)	-	kolshi (4), meda (2), iurigh, frigg, msran	**GH, GI**, P	9	0.44	0.11
	shih	*Artemisia herba-alba* Asso (IME17)	W	AP (101)	T (63), EA (16), OI (10), W (6), MA (2), IN (2), B, I	F (3), F	kolshi (32), azbar (20), jerh (14), meda (7), asumid (4), okhass (4), skar (4), iurigh (3), frigg (3), atsirid (2), msran (2), klaui (2), shqeqa (2), ruah, alen	E, **GH**, GI, GY, I, OP, OR, P, UN	101	0.32	1.23
	taddad, addad	NA (IME98)	W	R (13)	OI (11), EA, P	F (5), H (2)	asumid (10), saht, shεar, skar	D, E, **GH**, GI, GY	13	0.69	0.16
	tefgha	*Carlina gummifera* (L.) Less. (IME96, IME103)	W	-	-	-	-	-	-	-	-
	teskra	*Echinops spinosissimus* Turra / *Cirsium chrysacanthum* (Ball) Jahand. / *Carlina hispanica* Lam. (IME81, IME97 / HAM126 / HAS145)	W	R (8)	OI (6), T (2)	F (4), H (2)	asumid (5), klaui, ado, meda	GH, GI, **GY**, UN	8	0.38	0.10
	teskra krzes, qrziz	*Carlina* sp. (IME113)	W	R (2)	OI (2)	F	ado, asumid	**GH, MS**	2	0.5	0.02
	tlir, tlirin	*Dittrichia viscosa* (L.) Greuter (IME31)	W	L (32)	T (15), B (11), OI (4), P, EA	O	kolshi (13), skhana (7), skar (3), meda (3), frigg (2), ruah (2), azbar, asumid	E, **GH**, GI, GY, OR, P	32	0.56	0.39
Boraginaceae	taililut	*Cerinthe major* L. (IME87, IME75)	Cu	L (7)	OI (4), T (3)	F (3), F (2)	saht (3), azbar (2), asumid (2)	**GH**, GY, OR	7	0.57	0.09
Brassicaceae	grnunsh	*Nasturtium officinale* R. Br. (IME18, IME107)	W	L (7)	OI (6), T	-	asumid (60), frigg	**GH**, P	7	0.86	0.09
	hab rshad	*Lepidium sativum* L. (MAR69_14)	Imp	S (29)	OI (23), T (6)	F (18), F (3), H	asumid (8), kolshi (7), saht (6), ruah (3), azbar (3), meda, skar	E, **GH**, GI, GY, OR	29	0.52	0.35

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Burseraceae	salaban	*Boswellia* sp. (MAR26)	Imp	ExR (5)	IN (3), OI, I	O	ɛin (2), frigg, ruah, asumid	GH, OR, P, **RS**	5	0.4	0.06
Cactaceae	ajdik akneri	*Opuntia ficus-indica* (L.) Mill. (IME100)	W(Nat)	Fl (7)	T (4), OI, B, AD	O	alen (2), frigg, imezguane, kolshi, meda, msran	GH, **GI**, OR, P	7	0.57	0.09
Capparaceae	taililut	*Capparis spinosa* L. (IME79)	W	Flb (2), L, Fr	OI (4)	F (2)	asumid (3), kolshi	**GH**, GY	4	0.75	0.05
Caprifoliaceae	irifi	*Lonicera biflora* Desf. (HAS90)	W	L (2)	B (2)	-	skhana, kolshi	**GH, P**	2	0.5	0.02
	izoran melul, izoran umlil, igudi	*Pterocephalus depressus cf.* Coss. & Balansa (IME83)	W	R (21)	OI (18), T (3)	F (8), H (2)	asumid (13), saht (3), asumid (3), meda (2), kolshi, adis	**GH**, GI, GY, MS	21	0.62	0.26
Caryophyllaceae	hrras lhajar	*Herniaria hirsuta* L. (IME64)	W	AP (4)	T (4)	-	klaui (3), mrrara	GI, **UN**	4	0.75	0.05
	talwurst	*Polycarpon polycarpoides* (Biv.) Zodda (HAM84)	W	Fr (6), R (3), S	OI (10)	F (4), H	asumid (7), azbar (2), kolshi	**GH**, GI, GY, MS, UN	10	0.4	0.12
	taγiγasht (H)	*Silene vulgaris* (Moench) Garke (FD29)	W	R (3)	-	-	shɛar (2), asumid				
Cistaceae	hmiku	*Cistus laurifolius* L. (IME36)	W	S (15)	OI (15)	H (8), F (4)	asumid (14), kolshi	**GH**, GI	15	0.93	0.18
	irgl	*Cistus salviifolius* L. / *Cistus creticus* L. (IME56 / IME86)	W	L (9), S (9)	OI (9), T (8), EA	H (6), F	meda (10), asumid (6), skar, kolshi	E, GH, **GI**	18	0.56	0.22
Cucurbitaceae	aslaui	*Lagenaria siceraria* (Molina) Standl. (NA)	Cu	Epi	IN	-	shqeqa	**GH**	1	1	0.01
Cupressaceae	aifs	*Juniperus phoenicia* L. (IME32)	W	L (2), Fr (1)	OI, P, IN	-	asumid (2), bkhorr	**GY, MS, P**	3	0.33	0.04
	azuka, ɛarɛar [MA]	*Tetraclinis articulata* (Vahl) Mast. IME07	W	L (70), Fr (2)	OI (36), P (11), IN (10), I (8), T (4), B (2), EA	H (13), F (8), O (2)	iurigh (22), skhana (11), shqeqa (8), kolshi (5), skar (5), ɛin (5), ruah (4), frigg (3), asumid (3), bkhorr (2), meda (2), klaui, adis, mrrara	E, **GH**, GI, OR, P, RS, UN	72	0.37	0.88
	qtran, qtran rqeq	*Tetraclinis articulata* (Vahl) Mast. / *Juniperus* sp. (IME07 / NA)	W	ExR (8)	EA (3), OI (3), IN, MA	O (3)	frigg (4), tuhut (2), ɛin, iqdi	OR, **P**, RS	8	0.63	0.10

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Dioscoreaceae	agulz	*Dioscorea communis* (L.) Caddick & Wilkin (IME88)	W	Tu (12)	OI (11), T(1)	F (7), H (2)	asumid (7), saht (3), meda (2), frigg	**GH**, GI, MS, P	12	0.5	0.15
Equisetaceae	bilkam	*Equisetum ramosissimum* Desf. (HAS105)	W	L	B	-	skhana	**GH**	1	1	0.01
Euphorbiaceae	lhbaq n ughyul, harriga melsa [MA]	*Mercurialis annua* L. (IME20)	W	L	OI	-	frigg	**P**	1	1	0.01
Fabaceae	afzdad	*Ononis natrix* L. (IME09)	W	AP (10)	OI (5), T (4), B(1)	F (5), F	bousfer (5), iurigh, boumzui, kolshi, skhana, frigg	CV, **E**, GH, GI, P	10	0.5	0.12
	algu	*Retama dasycarpa* Coss. (IME102)	W	S	OI	H	klaui	**UN**	1	1	0.01
	cawcaw	*Arachis hypogaea* L. (NA)	Imp	S	OI	F	asumid	**GH**	1	1	0.01
	soja	*Glycine max* (L.) Merr. (MAR69_10)	Imp	S (2)	OI (2)	F	meda, saht	**GH, GI**	2	0.5	0.02
	tefedas, helba [MA]	*Trigonella foenum-graecum* L. (IME60)	Imp	S (38)	OI (28), IN (7), T, I, B	F (16), H (2), F (2)	asumid (9), saht (8), kolshi (6), ruah (4), bkhorr (3), meda (3), εin (2), iurigh, mrrara, skar	CV, E, **GH**, GI, GY, OR, P, RS	38	0.5	0.46
	tekeda, grrob [MA]	*Ceratonia siliqua* L. (IME23)	Cu	Epi (9), L (6)	OI (8), B (4), T (3)	F (2), F	meda (7), kolshi (3), skhana (2), iurigh, skar, asumid	E, GH, **GI**, P	15	0.6	0.18
Fagaceae	tasaft, dbargh [MA]	*Quercus ilex* L. (IME35)	W	rB (8), L	T (8), B	-	meda (8), kolshi	CV, GH, **GI**	8	0.75	0.10
Geraniaceae	latarsha	*Pelargonium odoratissimum* (L.) L'Hér. (IME43)	Imp	L (4)	T (3), OI	-	kolshi (2), meda, frigg	**GH**, GI, P	4	0.5	0.05
Iridaceae	susban	*Iris germanica* L. (IME72)	Cu	Bu (4)	OI (4)	H (3)	asumid (2), saht, klaui	**GY**, UN	4	0.75	0.05
	zεfran	*Crocus sativus* L. (NA)	Imp	Fl (8)	OI (8)	O (4), H	frigg (7), boumzui	E, **P**	8	0.88	0.10
Juglandaceae	grgε, tswig [MA]	*Juglans regia* L. (IME74)	Cu	L (12), B, infl	B (5), T (4), MA (3), P (2)	-	kolshi (4), okhass (3), shεar (2), asumid (2), frigg, meda, tuhut	D, GH, GI, MS, **OR**, P	14	0.29	0.17

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Juncaceae	azmay	*Juncus acutus* L. (IME71)	W	S (4), L	EA (2), T, Q, B	-	alen, meda, bousfer, skhana, kolshi	**D, E, GH, GI, OP**	5	0.2	0.06
Lamiaceae	azir	*Rosmarinus officinalis* L. (MAR48)	Imp	L&infl (19)	T (17), OI (2)	F	kolshi (4), msran (4), azbar (4), meda (2), boumzui (2), skar, frigg, adis	CV, E, GH, **GI**, GY, P, UN	19	0.42	0.23
	azukni, zεtra [MA]	*Thymus saturejoides* Coss. (IME37, IME49)	W	L (117)	T (82), OI (28), I (5), B (3), EA	F (14), F, H, O	azbar (35), kolshi (28), asumid (13), meda (10), ruah (10), iurigh (4), boumzui (3), skar (3), frigg (2), mrrara, shqeqa, εin, klaui, fqrdem, tuhut, msran, saht, skhana	CV, D, E, **GH**, GY, MS, OR, P, RS, UN	117	0.34	1.43
	fleyou	*Mentha pulegium* L. (IME39)	W	L (27)	T (19), OI (6), EA, I	F (13), F (2), H	ruah (16), kolshi (5), tuhut (4), iurigh, asumid	GH, GI, **OR**	27	0.7	0.33
	grz ɣyiel, grzgiai	*Lavandula maroccana* Murb. / *Lavandula multifidia* L. (IME06, IME109 / IME63)	W	L&infl (23)	T (19), OI (3), EA	F, O	kolshi (11), meda (4), azbar (3), frigg (2), asumid, iurigh, jerh	**GH**, GI, GY, I, P	23	0.52	0.28
	ifzi, frqezot	*Marrubium vulgare* L. (IME24)	W	L (65), St (7)	T (17), B (15), OI (12), Q (10), P (8), EA (4), AD, IN, MA, W	F (7), O (5)	kolshi (18), skhana (7), skar (5), asumid (5), frigg (5), shqeqa (4), cancer (4), msran (4), saht (4), bousfer (3), jerh (3), boumzui (2), imezguane, okhass, toqal, taqait, iqdi, adis, fqrdem, tuhut	C, CV, E, **GH**, GI, GY, I, MS, OR, P	72	0.32	0.88
	imzurria, timzurri	*Lavandula dentata* L. (IME03, IME53)	W	L&infl (61)	T (46), OI (7), B (3), W (2), P (3)	F (4), O	kolshi (27), azbar (13), asumid (6), meda (4), tuhut (2), skar (2), shεar (2), atsirid (2), iurigh, frigg, skhana	D, E, **GH**, GY, MS, OR, P, UN	61	0.52	0.74
	khzema	*Lavandula angustifolia* Mill. (MAR5)	Imp	L&infl (28)	T (19), OI (5), W (2), B, P	F, O	azbar (9), asumid (5), kolshi (4), meda (2), frigg (2), skhana (2), atsirid, klaui, shεar, ruah	D, **GH**, GI, GY, MS, OR, P, UN	28	0.36	0.34

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Lamiaceae	khzemt	*Lavandula pedunculata* (Mill.) Cav. / *Lavandula stoechas* L. (IME85 / IME52, IME62)	W	L&infl (18)	T (11), P (3), OI (2), W	F	kolshi (7), azbar (5), atsirid (3), shεar (2), meda	D, **GH**, GI, GY, OP, OR, P	18	0.39	0.22
	lahbak	NA (NA)	Cu	L (2)	OI, B	-	frigg, iqdi	**P**	2	1	0.02
	lqma	*Mentha spicata* L. (NA)	Imp	L (13), St	T (9), OI (3), B (2), Q	F	kolshi (7), frigg, meda, msran, skhana, boumzui, asumid, iurigh	CV, **GH**, GI, P	14	0.57	0.17
	mrdedush	*Origanum majorana* L. (HAS122)	Cu	L (5)	T (4), OI	-	kolshi (3), frigg, meda	**GH**, GI, P	5	0.6	0.06
	salmia	*Salvia officinalis* L. (IME44)	Cu	L (9)	T (8), OI	-	kolshi (3), meda (2), ruah, frigg, azbar, skar	E, **GH**, GI, GY, OR, P	9	0.33	0.11
	salmia n udrar	*Salvia aucheri* Benth. (MAR53)	W	L (3)	T (2), OI	F	kolshi, meda, klaui	**GH, GI, UN**	3	0.33	0.04
	tfleyout	*Mentha gattefossei* Maire (IME84)	W	L (2)	T (2)	-	kolshi (2)	**GH**	2	1	0.02
	tatait, tiqi n uzru	*Micromeria graeca* (L.) Benth. ex Rchb. / *Micromeria hochreutineri* (Briq.) Maire (IME112 / FD14)	W	L (2)	T (2)	-	klaui, kolshi	**GH, UN**	2	0.5	0.02
	tazgzaut	*Clinopodium atlanticum* (Ball) N.Galland (IME110)	W	L	OI	O	frigg	**P**	1	1	0.01
	tazuknit	*Thymus maroccanus* Ball / *Thymus willdenowii* Boiss. (IME51 / IME93)	W	L&infl (13)	T (9), OI (4)	F (4), O, F	asumid (8), azbar (3), meda, frigg	**GH**, GI	13	0.77	0.16
	tlba	*Ajuga iva* (L.) Schreb. (IME68, MAR42)	W	Fl	T	-	asumid	**GI**	1	1	0.01
	timja, timja tumlilt, tiguiyin	*Mentha suaveolens* Ehrh. (IME05, IME40, IME50)	W	L (101)	T (60), OI (22), B (12), I (2), EA (2), P, IN, W	F (13), O (4), F (2), H	kolshi (35), azbar (24), meda (7), adis (6), asumid (6), frigg (5), ruah (5), skhana (3), jerh (3), iurigh (2), skar, mrrara, shqeqa, okhass, saht	E, **GH**, GI, GY, I, MS, OR, P	101	0.46	1.23

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Lamiaceae	tzdit	*Salvia taraxicifolia* Coss. ex Hook.f. (FD28)	W	R	OI	F	asumid	**GH**	1	1	0.01
	warimsa, touga n ifzi, tifziguiyin	*Ballota hirsuta* Benth. (IME26)	W	L (23)	T (10), OI (7), B (6)	F (2), O	kolshi (7), skhana (6), frigg (3), meda (2), asumid (2), azbar, mrrara, msran	**GH**, GI, GY, P	23	0.52	0.28
Lauraceae	qrfa	*Cinnamomum* sp. (MAR49_10, MAR63_01, MAR69_11)	Imp	B (13)	H (8), OI (5)	M (2), M (2), Z	azbar (5), asumid (4), meda, frigg, kolshi, ruah	**GH**, GI, GY, P	13	0.46	0.16
Linaceae	zreet lktan	*Linum* sp. (NA)	Imp	S (3)	OI (3)	F	asumid (2), kolshi	**GH**	3	1	0.04
Lythraceae	henna	*Lawsonia inermis* L. (NA)	Imp	L (13)	P (10), EA, IN, T	-	shɛar (8), skhana (2), ɛin, meda, skar	**D**, E, GH, GI, RS	13	0.62	0.16
	rman	*Punica granatum* L. (IME61)	Cu	Epi (6), Fl (5)	OI (5), T (5), P	O	meda (7), frigg (2), adis, shɛar	D, **GI**, P	11	0.73	0.13
Malvaceae	tibi	*Malva sylvestris* L. / *Malva neglecta* Wallr. (IME106 / HAS148)	W	tibi	L (3)	OI (3)	asumid (2), saht	**GH**	3	1	0.04
Molluginaceae	taussergint	*Corrigiola litoralis* L. (MAR15)	Imp	R (4)	IN (2), MA, EA	-	kolshi (3), okhass	**GY, OR, P, RS**	4	0.25	0.05
Moraceae	iukzern, azar	*Ficus carica* L. (IME73)	Cu	Infr (4), L	OI (3), T, B	O (3)	ruah (3), asumid, tuhut	GH, MS, **OR**	5	0.6	0.06
Myristicaceae	gusa, bsibissa	*Myristica fragrans* Houtt. (MAR49_15, MAR63_08)	Imp	S (2)	T, OI	-	asumid (2)	**GH**	2	1	0.02
Myrtaceae	kalitus	*Eucalyptus* sp. (NA)	Imp	L	B	-	asumid	**MS**	1	1	0.01
	knorfel, qronfel	*Syzygium aromaticum* (L.) Merr. & L.M. Perry (MAR49_06)	Imp	Fr (13)	EA (5), OI (3), T (3), MA (2)	O (2)	alen (4), okhass (3), frigg (2), azbar, asumid, adis, kolshi	GH, GI, GY, **OP**, OR, P	13	0.31	0.16
Nitrariaceae	harmel	*Peganum harmala* L. (IME101)	Cu	S (36)	IN (23), EA (3), I (3), P (2), C (2), T, OI, B	O, F	ɛin (13), bkhorr (8), jerh (3), shqeqa (2), kolshi (2), shɛar (2), ruah (2), skhana, frigg, tuhut, asumid	D, GH, I, MS, OR, P, **RS**	36	0.64	0.44
Oleaceae	asln	*Fraxinus dimorpha* Coss. & Durieu (IME69)	W	Fr (4), L (4)	OI (4), B (3), T	F (2), H	asumid (3), kolshi (3), klaui, skhana	**GH**, UN	8	0.88	0.10

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Oleaceae	azmour	*Olea europaea* L.	W	L	B	-	kolshi	**P**	1	1	0.01
	zeet l3ud	*Olea europaea* L. (IME22)	Cu	L (10), O (8), S (4), W (2)	B (6), EA (6), OI (5), IN (2), T (2), P (2), I	-	kolshi (7), ruah (5), alen (3), tuhut (3), imezguane (2), frigg, εin, skar, shεar	D, E, GH, OP, **OR**, P, RS	24	0.29	0.29
Papaveraceae	kaush	*Papaver hybridum* L. / *Papaver rhoeas* L. / *Papaver dubium* L. (IME58 / IME59 / IME76)	W	R	OI	H	klaui	**UN**	1	1	0.01
Pedaliaceae	jnjlan	*Sesamum indicum* L. (NA)	Imp	S (2)	OI (2)	-	asumid	**GH**	2	1	0.02
Pinaceae	teida	*Pinus halepensis* Mill. (HAS7)	W	S, B	OI, EA	H	boumzui, jerh	**E, I**	2	0.5	0.02
Piperaceae	εmer, bzar [MA]	*Piper nigrum* L. (MAR49_05)	Imp	Fr (9)	EA (9)	-	alen (9)	**OP**	9	1	0.11
	dar flfl	*Piper longum* L. (MAR49_08, MAR63_02)	Imp	Fr	OI	F	saht	**GH**	1	1	0.01
	nuwiwira	*Piper cubeba* Vahl (MAR49_04)	Imp	-	-	-	-	-	-	-	-
Plantaginaceae	tirqa, taqrailut	*Globularia alypum* L. (IME90)	W	L (2)	T (2)		azbar, kolshi	**GH, GY**	2	0.5	0.02
Plumbaginaceae	awgdmi, izoran azugah, izoran zugagnin	*Armeria alliacea* (Cav.) Hoffmanns. & Link (IME92)	W	R (29)	OI (23), T (6)	F (8), H (7)	asumid (15), saht (3), meda (3), kolshi (3), azbar (2), fqrdem (2), adis	E, **GH**, GY, MS, P	29	0.52	0.35
Poaceae	amezgour	*Zea mays* L. (NA)	Cu	Fr	OI	-	klaui	**UN**	1	1	0.01
	illan	*Pennisetum glaucum* (L.) R.Br. (MAR60_13)	Imp	S (2)	OI (2)	F	jerh, kolshi	**GH, I**	2	0.5	0.02
	njm	*Cynodon dactylon* (L.) Pers. (HAM81)	W	Rh	OI	H	klaui	**UN**	1	1	0.01
Ranunculaceae	azenzou	*Clematis flammula* L. (HAM107)	W	L, S	B, MA	-	kolshi, okhass	**P, OR**	2	0.5	0.02
	sanouj	*Nigella sativa* L. (MAR8)	Imp	S (31)	OI (30), I	F (22), H (3)	asumid (10), saht (9), kolshi (6), klaui (2), azbar, meda, iurigh, ruah	**GH**, GI, GY, OR, UN	31	0.71	0.38

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Rhamnaceae	azugar, nbg [MA]	*Ziziphus lotus* (L.) Lam. (IME57)	W	Fr (3)	OI (3)	-	klaui (2), meda	GI, **UN**	3	0.67	0.04
Rosaceae	ashdir, agfraig	*Rubus ulmifolius* Schott (IME21)	W	L (9)	B (6), T (3)	-	kolshi (5), asumid (2), skhana (2)	**GH**, MS, P	9	0.56	0.11
	louz	*Prunus dulcis* (Mill.) D.A.Webb (IME30)	Cu	L (7)	B (4), OI (2), T	F	kolshi (3), frigg (3), skar	E, **GH, P**	7	0.43	0.09
	mzah	*Eriobotrya japonica* (Thunb.) Lindl. (HAS100)	Cu	L	T	-	meda	**GI**	1	1	0.01
	khal n tfah	*Malus domestica* Borkh. (NA)	Cu	Fr	OI	-	skhana	**GH**	1	1	0.01
	touga n lmeda	*Agrimonia eupatoria* L. (IME114)	W	L (2)	T (2)	-	meda (2)	**GI**	2	1	0.02
	wrd	*Rosa centrifolia* L. (IME105)	Cu	Fl (9)	T (6), OI (2), P, B	O (2)	msran (5), frigg (2), shεar, kolshi	D, GH, **GI**, P	9	0.56	0.11
Rubiaceae	tarubi, lfoua [MA]	*Rubia peregrina* L. (IME01)	W	R (34)	OI (19), T (15)	F (16)	fqrdem (28), bousfer, jerh, boumzui, adis, kolshi, saht	CV, **E**, GH, GI, I	34	0.82	0.41
Rutaceae	aurmi, fijil [MA]	*Ruta chalepensis* L. (IME33, MAR56)	W	AP (26), R (7), L (7), EP (5)	T (19), IN (14), I (6), OI (3), Q, B, EA	O (3)	adis (10), εin (8), shqeqa (4), kolshi (4), asumid (3), meda (3), bhor (3), frigg (2), msran (2), bousfer, boumzui, azbar, skhana, skar, ruah	CV, E, GH, **GI**, MS, OR, RS	45	0.33	0.55
	limun	*Citrus sinensis* (L.) Osbeck (HAS101)	Cu	Fr (13)	OI (13)	H	skhana (11), ruah, tuhut	**GH**, OR	13	0.85	0.16
Salicaceae	safsaf	*Populus alba* L. (IME28)	W	L	B	-	kolshi	**P**	1	1	0.01
	tishki	*Salix purpurea* L. (HAM97)	W	L, Bu	B, OI	F	skhana, asumid	**GH**	1	1	0.01
Schisandraceae	badiana	*Illicium verum* Hook.f. (MAR49_17, MAR63_06)	Imp	-	-	-	-	-	-	-	-
Scrophulariaceae	almansir, ifr tarrausht	*Verbascum* sp. (HAM51)	W	L (3)	-	-	asumid, bouzlou, kolshi	**-**	-	-	-
	ifski n ughyul, touga n ifski	*Scrophularia laevigata* Vahl (IME66, IME111)	W	L (2), Fl	B, OI, T	-	skhana (2), kolshi	**GH**, GI	3	0.67	0.04
Solanaceae	matisha	*Solanum lycopersicum* L. (NA)	Cu	Fr	OI	-	skhana	**GH**	1	1	0.01

FAMILY	VERNACULARS	SPECIES (vouchers)	SOURCE	PART USED	ADMINISTRATION	EXCIPIENT	FOLK AILMENTS	CATEGORIES OF USE	UR	highest FL	UV
Solanaceae	tedalen	*Solanum americanum* Mill. / *Solanum nigrum* L. (IME16 / HAM14)	W	L	OI	-	frigg	**P**	1	1	0.01
	tinart (H)	*Withania frutescens* (L.) Pauquy (HAS21)	W	St (2)	-	-	tafalda (2)	-	-	-	-
	waililu	*Hyoscyamus niger* L. (HAM58)	W	L (2)	OI, IN	F	alen, asumid	**MS, OP**	2	0.5	0.02
Styracaceae	jawi	*Styrax benzoin* Dryand. (MAR28)	Imp	ExR (16)	IN (13), I, B, OI	O	ɛin (6), bkhorr (4), ruah (2), kolshi (2), iqdi, frigg	GH, OR, P, **RS**	16	0.75	0.20
Theaceae	attay	*Camellia sinensis* (L.) Kuntze (NA)	Imp	L	OI	-	adis	**GI**	1	1	0.01
Urticaceae	khalis n zunti, zunti n udrar (H)	*Forsskaolea tenacissima* L. (HAM11)	W	L (2)	-	-	meda (2)	-	-	-	-
	zunti, harriga harsha [MA]	*Urtica pilulifera* L. / *Urtica dioica* L. (IME77 / IME78)	W	L (4)	OI (2), T (2)	-	asumid (2), klaui, marrara	GI, **MS**, UN	4	0.5	0.05
Verbenaceae	angarf	*Vitex agnus-castus* L. (HAM78)	W	Fr	OI	-	asumid	**GI**	1	1	0.01
	louisa	*Aloysia citriodora* Palau (NA)	Imp	L (7)	T (6), OI	F	kolshi (5), iqdi, meda	**GH**, GI, P	7	0.71	0.09
Vitaceae	adel	*Vitis vinifera* L. (HAS97)	Cu	L	-	-	Kolshi	-	-	-	-
Zingiberaceae	khoudenjal	*Alpinia officinarum* Hance (MAR3)	Imp	Rh (6)	OI (3), T (3)	F, F	asumid (3), tuhut, kolshi, ruah	**GH**, OR	6	0.83	0.07
	khrkom	*Curcuma longa* L. (MAR63_03)	Imp	-	-	-	-	-	-	-	-
	skinjbir	*Zingiber officinale* Roscoe (MAR49_12, MAR63_05)	Imp	Rh (13)	OI (6), T (5), B, EA	F (4), F (2)	ruah (4), asumid (4), tuhut (3), kolshi, alen	GH, MS, OP, **OR**	13	0.46	0.16
UNIDENTIFIED	tauijant	NA	W	L	B	-	kolshi	**P**	1	1	0.01
	tlanin, tinirin	NA	W	R	OI	F	asumid	**GI**	1	1	0.01

Medicinal plant diversity in the High Atlas derives from the Ashelhi agro-pastoralist lifestyle and the influence of Arabo-Muslim pharmacology, which includes many non-native plants including naturalised, cultivated and imported species, these traded mostly from Asia (Bellakhdar, 1997). The agro-pastoralist character of the Ishelhin peoples is reflected in the environments where most plants are sourced (Chapter 2). Plants are harvested from the wild (59%; both native and naturalised plants), mostly in mountain areas (*adrar*) and semi-arid slopes with little soil and sparse vegetation (*lbour*), or are locally cultivated (14%) around the fields (*yigran*) and in home gardens (*jrda*). All the culturally important plants cited above are locally ubiquitous and easy to access and harvest. Importantly, a third (27%) of the medicinal plants used in Imegdale are acquired in the souks, often frequented by men who trade local produce for foreign goods including imported plant species.

Plants acquired in the markets are mostly spices, but also resins used as incense. Some of these plant products, were historically traded from the Arabian Peninsula through incense trade routes across the Mediterranean since Roman times (Groom, 1981). Tropical Asian spices shipped from India were supplied through Arabian trade routes, as well as Arabian plants such as frankincense (Groom, 1981). These plant products probably first arrived to the Maghreb with the Romans (200 BC - 400 AC aprox.; Chafik, 2005), but its use was probably not widespread until centuries later (Groom, 1981; Van der Veen & Morales, 2015). Spices were only available to the upper strata of society at first, but their chemical properties and elite status made them desirable to the wider society (Van der Veen & Morales, 2015) and they have come to be central healing elements in Ashelhi households. Spices used in Imegdale include *skinjbir* (*Zingiber officinale*)*, khoudenjal* (*Alpinia officinarum*)*, khrkom* (*Curcuma longa*), *qrfa* (*Cinnamomum* sp.), *gusa* and *bsibissa* (*Myristica fragrans*) and *lɛmer* (*Piper nigrum*), and incense plants are *salaban* (*Boswellia* sp.), and *jawi* (*Styrax benzoin*).

Arabo-Muslim medicine could have influenced plant use in the High Atlas through written texts (Leonti, 2011), especially the Quran, the Hadith (reports on the life of the prophet Muhammad) and the *Tibb-ul-Nabbi* ("Medicine of the Prophet", which integrates both previous texts; Elgood, 1962). Many plants cited in these books are often eaten and used medicinally in Imegdale, including at least *henna* (*Lawsonia inermis*)*, tefedas* (*Trigonella foenum-graecum*)*, tekeda* (*Ceratonia siliqua*), *rman* (*Punica granatum*)*, tazart* (*Ficus carica*)*, adel* (*Vitis vinifera*)*, zeet* (*Olea europaea*)*, skinjbir* (*Zingiber officinale*)*, tswig* (*Juglans regia*)*, sanouj* (*Nigella sativa*)*, hbt halawa* (*Pimpinella anisum*), *limun* (*Citrus sinensis*)*, tini* (*Phoenix dactylifera*), *zɛfran* (*Crocus sativus*), *touma* (*Allium sativum*), and *azalim* (*Allium cepa*). For some of these plants (*rman, zeet* and *henna*), informants mentioned the plant's citation in the Quran or the Hadith to validate their medicinal use.

3.3.3 Modes of administration, plant parts used and diversity of uses

Medicinal plants are mostly ingested orally as infusions (36% of the use reports), as reported in other regions of Morocco (Merzouki et al., 2000), or mixed with milk (12%), olive oil (20%), honey (18%) or food (38%). They can be chewed (<1%), used as ear drops (<0.5%), incense (6%) or inhaled directly (2%), applied externally in poultices (3.5%), baths (7%) and washes (<1%) or in ways not specified (5%), or carried on the body in little bundles (charms, <1%). Four species are used in *qwi* (<1%), a technique that uses dry plant stems burned at one end to make them hot and then applied to the afflicted person's skin in specific places. Incense is the preferred mode of use to treat ritual & spiritual ailments. Although common ailments are mostly treated with herbal medicine, treatment can also encompass dietary changes and rest.

For 73% of the plants, more than one plant part is used medicinally (Table 3.2). Leaves are the part most used (55%), followed by underground parts (40%, including roots, tubers, bulbs and rhizomes), flowers and inflorescences (18%), seeds (16%) and fruits (15%). Barks, stems, wood, galls, oils and exudates are also used, though rarely. The widespread use of Lamiaceae could explain the prevalence of leaves and inflorescences, whereas the popularity of roots as remedies (common throughout Morocco; Ouarghidi et al., 2013) is possibly linked to illness aetiologies and local conceptualisations of disease, speficially the "hot/cold" model, as detailed below.

Fidelity Level (FL) is one of the quantitative tools used to select plants from ethnopharmacological field studies for further pharmacological screening, under the assumption that plants that are used only for one ailment are more likely to be effective (Andrade-Cetto & Heinrich, 2011; Heinrich et al., 1998). However, the index can also be used to interpret plant use in local contexts. High FL values indicate that the plant tends to be used to treat a single therapeutic category and low FL values show that plants are used for a wide range of ailments. Only 13 plants (<10%) show high fidelity values to specific biomedical categories of use (≥0.75; Table 3.2). *Mkhinza* (*Dysphania ambrosioides*; 0.88) and *limun* (*Citrus sinensis*; 0.85) constitute the main remedy against fever. *Hmiku* (*Cistus laurifolius*; 0.93), *tazuknit n uzagar* (*Thymus marrocanus* and *Thymus willdenowii*; 0.77), *asln* (*Fraxinus dimorpha*; 0.88), *grnunsh* (*Nasturtium officinale*; 0.86) and *khoudenjal* (*Alpinia officinarum*; 0.83) are all "hot" plants used for "cold" ailments. The root bark of *tasaft* (*Quercus ilex*; 0.75) is used almost exclusively for stomach problems and the roots of *tarubi* (*Rubia peregrina*; 0.82) are used against *fqrdem* (anaemia) due to the red coloration of its infusion, an association that could be attributed to the "doctrine of signatures" (Bennett, 2007). *Jawi* (*Styrax benzoin*; 0.75) is used as incense for all ailments since it is believed to relieve negative influences from jinni and sorcery. *Zɛfran* (*Crocus sativus*; 0.88) was mentioned by lay people as a key plant used by local healers, *ferraggat*, to heal children's ailments which are sorcery-related. Finally, *touma* (*Allium sativum*; 0.75) is mostly used against cough and chest problems.

Almost all the plants with high UV are used for a wide range of ailments (FL <0.50; Table 3.2); only one of them has a specific therapeutic application (*mkhinza*, *Dysphania ambrosioides*, to treat fever). Moreover, many plants were used for all ailments (*kolshi*, which literally means "everything" in Tashelhit). Low fidelity levels of the most used plants are indicative of the popular character of Ishelhin medicine, where home remedies rather than plants prescribed by specialists are used. Similar results have also been found among Tibetan villagers, whose medicinal plant knowledge focused on general health remedies and unspecified therapeutic applications (Byg et al., 2010). Moreover, when comparing medicinal floras cross-culturally, Saslis-Lagoudakis et al (2011) observed that families overrepresented in medicinal floras tend to encompass uses for a wide range of therapeutic applications.

3.3.4 Mixtures

Mixtures are frequently used as remedies in Morocco (Bellakhdar, 1997; Merzouki et al., 2000; Ouarghidi et al., 2013) and this is also true for the High Atlas region. Species-rich mixtures can be effective in treating ailments with multifactorial or complex causes (Brendbekken, 1998; Leonti & Casu, 2013) and may also be an effective strategy in a context of few illness-specific treatments. Mixtures used in the High Atlas are dried plants, ground and added to food, fresh leaves used in showers or baths or dried plants burned as incense. Infused dried herbs are also normally used in combinations. Mixtures can be bought already made from the herbalists in the souk, which is the case for *msahan* (mixture added to food to treat "cold" ailments) and *ishgaf* (mixture used as incense to clean the ambience and heal ailments believed to be caused by sorcery deeds), or prepared at home. Whilst medicinal mixtures made at home bring together plants that grow locally (*e.g. tadouart nyigran*), those prepared by herbalists may include native Moroccan as well as imported species (*e.g. msahan*). Locally recognized mixtures are listed in Table 3.3, whereas plants normally used in combination, but not formally recognized as named mixtures are explained below.

Table 3.3 Mixtures. Vernacular names that could not be botanically identified are indicated by NA (identification Not Available).

Mixture	**Medicinal plants possibly included**	**Plant acquisition and mode of preparation**	**Ailments treated (use category)**
Tadouart n yigran (also called *ifskan*; various herbarium specimens)	*Mkhinza (Dysphania ambrosioides), igg (Pistacia atlantica), imitgg (Pistacia lentiscus), louz n wulli (Searsia tripartita), itzɣi (Cladanthus scariosus), lgnbes (Tagetes* sp.*), shih (Artemisia herba-alba), tlir (Dittrichia viscosa), irifi (Lonicera biflora), irgl (Cistus salviifolius, Cistus creticus), bilkam (Equisetum ramosissimum), algu (Retama dasycarpa), tekeda (Ceratonia siliqua), tswig (Juglans regia), azukni (Thymus saturejoides), fleyou (Mentha pulegium), grz ɣyiel (Lavandula maroccana, Lavandula multifidia), ifzi (Marrubium vulgare), timzurri (Lavandula dentata), khzemt (Lavandula pedunculata, Lavandula stoechas), tatait (Micromeria graeca, Micromeria hochreutineri), tlba (Ajuga iva), timja (Mentha suaveolens), warimsa (Ballota hirsuta), rman (Punica granatum), asln (Fraxinus dimorpha), zeet l3ud (Olea europaea), tirqa (Globularia alypum), azenzou (Clematis flammula), ashdir (Rubus ulmifolius), louz (Prunus dulcis), tarubi (Rubia peregrina), safsaf (Populus alba), ifski n ughyul (Scrophularia laevigata), ifr tarrausht (Verbascum* sp.*), angarf (Vitex agnus-castus), adel (Vitis vinifera), taujant (*NA*), tlanin (*NA*)*	Plants collected from the wild or the fields close to villages. Fresh leaves infused and used as a bath or wash.	General health, paediatric
Msahan (MAR49, MAR60, MAR63, MAR69)	*Bqbouka (Bunium bulbocastanum), taililut (Capparis spinose), gusa* and *bsibissa (Myristica fragrans), knorfel (Syzygium aromaticum), ɛmer (Piper nigrum), dar flfl (Piper longum), nuwiwira (Piper cubeba), wrd (Rosa centrifolia), badiana (Illicium verum), blalouz (Asphodelus microcarpus), khoudenjal (Alpinia officinarum), khrkom (Curcuma longa), skinjbir (Zingiber officinale)*	Mixture bought from herbalists. Dried plants ground and mixed with food.	General health, gyneacologycal, musculoskeletal
Ishgaf (MAR61)	*Qzbor (Coriandrum sativum), harmel (Peganum harmala), sanouj (Nigella sativa), aurmi (Ruta chalepensis)*	Mixture bought from herbalists. Plants burned as incense.	Ritual & spiritual
Izoran (various herbarium specimens)	*Teskra tumlilt (Eryngium tricuspidatum), arshmush (Onopordum acaulon), taddad (*NA*), tefgha (Carlina gummifera), teskra krzes (Carlina* sp.*), igudi (Pterocephalus depressus), awgdmi (Armeria alliacea)*	Plants collected from the wild. Dried plants ground and mixed with food, infused or mixed with olive oil and applied externally.	General health, gyneacologycal, musculoskeletal
Kohl (various herbarium specimens)	*Bzar* (*Piper nigrum*), *tini* (*Phoenix dactylifera*), *wamsa* (*Foeniculum vulgare*), *alili* (*Nerium oleander*)	Plants collectef from the wild and brought from herbalists. Dried plants applied topically around the eyes.	Ophtalmological

A well-known remedy for all ailments is called *tadouart n yigran* or *ifskan* (lit. “mixture of the fields” or “bushes”; Table 3.3) and includes up to 15 plants with individual recipes varying from informant to informant. As many as 38 plants were documented in total from 15 informants, of which only *ashdir (Rubus ulmifolius), ifzi (Marrubium vulgare), louz (Prunus dulcis), mkhinza (Dysphania ambrosioides), zeet l3ud (Olea europaea)* and *timja (Mentha suaveolens)* were listed in more than half of the mixtures. *Tadouart n yigran* was described as a mixture of “all you can find on your way to the fields”; it consists of a collection of fresh leaves from plants that grow in the village environs (*douar, lbour*) and in agricultural fields (*yigran*), infused and either drunk or used as a shower. It is used especially in cases of fever or as a preventive medicinal bath for babies. Preventive baths are a globally widespread healthcare strategy to help babies grow healthy and strong (Hilgert & Gil, 2007; Li et al., 2006; Ruysschaert et al., 2009; Zumsteg & Weckerle 2007).

Plant mixtures can also be used as incense in a practise called *bkhorr* in which plants are sprinkled on hot coals. *Harmel* (*Peganum harmala*; FL 0.64), *jawi* (*Styrax benzoin*; 0.75) and *fassough* (*Ferula communis*; 1.00) show high FL values for the ritual & spiritual use category and tend to co-occur in plant lists, but can be used together or separately. *Salaban* (*Boswellia* sp.) and *igg* (*Pistacia atlantica*) are also regularly used in *bkhorr*. Unlike the *bkhorr* mixture, *ishgaf* is prepared and sold by herbalists. This mixture includes *harmel* (*Peganum harmala*), *sanouj* (*Nigella sativa*), *aurmi* (*Ruta chalepensis*) and *qzbor* (*Coriandrum sativum*) as well as animal parts such as sea urchin shells, crab exoskeleton and cuttlebone, not recorded in the present study (Table 3.3).

Sets of plants can be used together often in food, but not be locally identified as a mixture. *Sanouj* (*Nigella sativa*), *tefedas* (*Trigonella foenum-grecum*) and *hab rshad* (*Lepidium sativum*) are regularly used together in food to build strength, gain weight and “warm up” the body. Plants used in recipes for traditional desserts (*slilou* and *tummit*) were believed to treat gastrointestinal problems: *cawcaw* (*Arachyis hypogaea*), *habt halawa* (*Pimpinella anisum*), *jnjlan* (*Sesamum indicum*) and *gusa* (*Myristica fragrans*). The *msahan* mixture, composed mostly of imported spices (Tables 3.3), is also administered with food, added to specific dishes prepared to improve women’s health. The boundary between medicinal plants and condiments is often indistinct (Etkin, 1996; Rigat et al., 2009; Touwaide & Appetiti, 2015) and spices have a long history of use in food to maintain health in the Islamic world (García Sánchez, 2002). As with condiments, combinations of aromatic plants to flavour tea blur the distinction between edible and medicinal categories (Leonti, 2014). Tea itself was not viewed as a medicinal plant in Imegdale, only one person used it medicinally.

A last important mixture is used to treat eye problems; *kohl* (galena, PbS) is combined with medicinal plants. It has been argued that *kohl* remedies constitute a health risk for the population, especially children, due to their high concentration of lead, but this is lowered by mixing *kohl* with herbal products (Lekouch et al., 2001). Besides treating eye complaints, *kohl* is believed to be protective against supernatural forces and can be applied to healthy babies.

3.3.5 Folk ailments, biomedical categories of use and agreement among informants

During semi-structured interviews, 144 plants were mentioned to treat 36 folk ailments (including *kolshi*, a common answer meaning “everything” and corresponding to a “cure-all” in English; Table 3.4). Ailments identified locally have little resemblance with biomedical classifications of disease (Berlin & Berlin, 1996; Heinrich, 1994; Heinrich et al., 2009; Helman, 2007; Staub et al., 2015; Table 3.4) and include many culturally bound syndromes (*iqdi, taumist, taqait,* and *boumzoui*; Helman, 2007), ailments with supernatural causes (*ɛin, lariah*; Foster, 1976) and folk ailments cross-cutting biomedical disease classification (*azbar*, lit. “pain” and *asumid*, lit. “cold”; Table 3.4). The boundry between ailments and aetiologies is blurred (*i.e., ado* was cited as an ailment and the cause of *ruah* and *tuhut*, and *ɛin* expresses both an ailment and a cause), evidencing that local healing systems often address causes rather than symptoms (Kleinman, 1978; Waldstein & Adams, 2006).

Table 3.4 Number of use reports (UR), plant vernaculars (N) and informant consensus values (F_{ic}) per category of use (A) and most cited folk ailments (B). Folk ailment terms are detailed in the glossary (Appendix 1.1).

A) Biomedical use categories	**UR**	**N**	**F_{ic}**
General health	678	95	0,86
azbar, skhana, kolshi, asumid, shqeqa, saht			
Gastrointestinal	317	70	0,78
iurigh, msran, meda, azbar, mrrara, adis, touqal, zagaz			
Paediatric	139	60	0,57
kolshi, iqdi, taumist, taqait, frigg			
Gyneacological (female)	126	37	0,71
azbar, asumid			
Otolaryngological & respiratory	109	33	0,70
ado, ruah, imezguane, okhass, tuhut			
Endocrinological	85	29	0,67
bousfer, skar, fqrdem			
Ritual & spiritual	82	16	0,81
ɛin, lariah			
Ophthalmological	40	11	0,74
alen			
Musculoskeletal	38	26	0,32
asumid, azbar			
Urological & nephrological	36	25	0,31
klaui, asumid, atsirid			
Injuries	31	9	0,73
jerh			
Dermatological	22	11	0,52
chɛar, tafalda			
Cardiovascular	15	10	0,36
boumzui			
Cancer	4	2	0,67

B) Folk ailments	**UR**	**N**	**F_{ic}**
Kolshi ("everything")	340	68	0,80
Asumid ("cold")	272	70	0,75
Azbar ("pain")	135	26	0,81
Meda ("stomach")	127	48	0,63
Skhana ("fever")	114	30	0,74
Ruah ("flu")	77	24	0,70
Saht ("health", it refers to put on weight)	64	20	0,70
ɛin ("evil eye")	45	13	0,73
Iurigh ("heartburn")	41	15	0,65
Skar ("diabetes")	37	21	0,44
Alen ("eyes")	36	11	0,71
Adis ("diarrhoea")	35	20	0,44
Fqrdem ("anaemia")	32	4	0,90
Bkhorr ("incense")	31	10	0,70
Klaui ("kidneys")	29	21	0,29
Shqeqa ("migrane")	25	10	0,63

As in many other rural and mountainous communities around the world (*e.g.*, Mexican Maya as described in Berlin and Berlin, 1996; Andean Quechua as in Thomas, 2013), medicinal plants are commonly used to treat infectious diseases in the High Atlas, especially gastrointestinal and respiratory disorders which are easily transmitted. These ailments are perhaps common due to poor hygienic conditions, proximity to livestock and high-altitude harsh weather conditions (Gracey & King, 2009). Common, non-deadly complaints may also heal without treatment, and this could explain preference for medicinal plant use to treat them. Medicinal plants are also popular remedies for female gynaecological and paediatric complaints, which are also mostly minor ailments, supporting the view that plant efficacy is not always essential to healing.

Rural Moroccans integrate symptomatology and aetiology in illness diagnosis, which determine the therapeutic application of plants. Concepts of health and illness in Morocco blend Prophetic and humoral principles, and increasingly biomedical concepts (Greenwood, 1981; Mateo Dieste, 2010; Obermeyer, 2000), and ailments can be classified as having natural or supernatural causes (Foster, 1976). Personalistic aetiologies, based on the idea of supernatural causes of illness, are common in many ethnomedicinal systems (Cosminsky, 1977). In the rural communes of the High Atlas, illness is associated with "bad luck" and often when someone in a household is sick, a cleansing of the house is performed with incense (*bkhorr*). Potentially, any disease can have a supernatural cause, but this is especially true for ailments of children, since they are considered to be more vulnerable to sorcery (Teixidor-Toneu et al., 2017). Incense is also burned in *bkhorr* when there is a new-born in the house as a protective measure against sorcery and illness. Besides the use of *bkhorr*, evil eye (*ɛin*), "winds" (*lariah*) and, *iqdi* and *taumist* (children's ailments treated by *frigg*) were considered to be caused by supernatural forces. *ɛin* is related to the practice of magic (*suhur*) and *lariah* refers to supernatural beings with whom humans are believe to coexist (Greenwood, 1981). They believed to result in peoples' dysfunction (anxiety, aggressivity). *Iqdi, taumist* and *taqait* are cultural bound syndromes jointly classified as *frigg* (FR) since they are ailments treated with the same set of plants by local healers (discussed elsewhere; Chapter 5, Teixidor-Toneu et al., 2017).

Natural illness causes include weather conditions, coupled or not with excessive physical activity and eating routine changes (*i.e.*, Ramadan). Cold weather is the ultimate cause of *asumid*, literally meaning "cold", a culture bound syndrome that can manifest in a range of ailments, from infertility (gyneacological), muscular and joint pains (musculoskeletal), urine infections and kidney problems (urologic & nephrologic) to general lack of energy and poor health (general health). People with "weak constitution" are more prone to suffer from it. Plants considered "hot" are used to treat *asumid* although not all "hot" plants are used to treat the whole range of symptoms of *asumid*, nor all “cold” diseases (Alcorn, 1984). Roots and other plants’ underground parts of plants are always considered to be “hot”, and many of the plants used to treat *asumid* are medicinal roots included in the mixture *izoran* (Table 3.3). Also, plants that grow in cold areas such as the alpine zone, are considered “hot”. These include *awgdmi* (*Armeria alliacea*), *arshmush* (*Onopordum acaulon*), *izoran umlil* (*Pteocephalus depressus*) and *hmiku* (*Cistus laurifolius*). The *msahan* mixture is also used for “cold” ailments, especially by women to gain weight and treat fertility problems.

The distinction between “hot” and “cold” plants is not associated with specific chemical compounds (Ankli et al., 1999), but has important symbolic meaning and is a common concept in areas as diverse as Latin America (Weller, 1983), China (Anderson, 1987), and the Arabian Peninsula (Ghazanfar, 1994). Unlike in Latin American cultures, where the “hot” and “cold” dichotomy is perceived as a balance that can destabilize to either pole (Foster, 1976), it has a marked asymmetry in Ishelhin medicine and in Morocco in general (Greenwood, 1981): most ailments are “cold” and most medicines are “hot”. An informant quoted the prophet Muhammad: *fight against cold as if it were an enemy*, although no such claim is made in the *Tibb-ul-Nabbi* (“Medicine of the Prophet”; Elgood, 1962). Nonetheless, some medicinal plants are considered “cold”. These are mostly used during summer (*e.g.*, *timja*, *Mentha suaveolens*), whereas “hot” remedies are better for winter times (*e.g.*, *timzurri*, *Lavandula dentata*).

The “hot/cold” dichotomy seems to be the only relevant dimension of the more complex Galenic humoral system in rural Morocco. According to Greenwood (1981), this can be interpreted as a deterioration of the Galenic humoral system, which originally included four humours modified by four qualities. However, the “hot/cold” dichotomy could also be a pre-Galenic binary opposition principle, which is widespread among indigenous medical systems (López Austin, 1980; Messer, 1987; Ortiz de Montellano, 1980; Tedlock, 1987). A similar observation has been made to understand the origin of the “hot/cold” dichotomy in Mesoamerica (Geck et al., 2017), which was often interpreted as a result of the European humoral concepts that arrived to America through colonisation (Currier, 1966; Foster, 1994). Besides “cold” (*asumid*), other culture bound syndromes have natural causes: *ado* (literally “wind”) and *boumzui*. *Ado* is caused by exposure to sudden winds, which can produce cough (*tuhut*) or flu (*ruah*), ailments grouped under the otolaryngological & respiratory category, and fever (*skhana*). *Boumzui* was described by informants as palpitations in abdominal area after long periods of hard work and hunger or stress.

Consensus among informants is generally high, both when taking into account biomedical or local categories (Table 3.4). High consensus is defined as the use of relatively few taxa among many informants to treat a specific ailment, and according to Heinrich et al (1998), F_{ic} above 0,68 indicate high consensus. However, high F_{ic} values can result from both large numbers of use reports and plants used to treat a category, which does not necessarily represent agreement among informants. This is likely the case for the use categories (folk and biomedical) with over 50 plants cited. High F_{ic} values and low numbers of plants used are found for the biomedical categories of ritual & spiritual, ophthalmological, and injuries (Table 3.4a). High agreement about plants used in the ritual & spiritual (*ɛin, lariah, bkhorr*) and ophthalmological (*alen*) categories is due to the use of few well-known mixtures. Similarly, a narrow range of plants with antiseptic properties is used to treat injuries (*jerh*). In general, higer F_{ic} values are observed when folk ailment categories are used to calculate agreement among informants.

3.4 Conclusion

Ishelhin people of the High Atlas use a wide diversity of local native and non-native plants as medicine. Medicinal plants are used in ways that are culture-specific and reflect the Ashelhi agro-pastoralist lifestyle, Arabo-Muslim health beliefs, and trade networks. Most plant medicines are harvested or grown locally, both in man-made environments and in the wild, but some are imported. These are mostly spices and incense plant products that were historically traded through the Arabian Peninsula and associated with high social status. In this regard, medicinal plant use in the High Atlas is a syncretic medical treatment system.

Medicinal plant use is characterised by plants' low specificity to treat individual ailments. The most salient medicinal plants are used to treat a broad range of ailments, and only a few plants are used only for specific illnesses. *Kolshi* (lit. "everything") was often mentioned by non-specialist informants when enquired about a plant's use, and low plant specificity also stems from the use of mixtures, common throughout Morocco. Mixtures can be an adaptive strategy to treat ailments with complex causes and to dilute potentially toxic substances. However, most common ailments treated with medicinal plants are minor, and plant efficacy may not always be essential for healing.

Medicinal plants are used to treat both symptoms and aetiologies according to local illness concepts, in particular the "hot" and "cold" dichotomy and supernatural disease aetiologies. Hence, classification of medicinal plant uses into biomedical categories is problematic due to the lack of correspondence with local perceptions of disease. This is rarely discussed in ethnopharmacological studies and may hinder conclusions from medicinal plant studies.

Chapter 4 Variation and transmission of medicinal plant knowledge in a High Atlas community

4.1 Introduction

Medicinal plant knowledge is dynamic and adaptive to environmental and socioeconomic changes (Alexiades, 2009; Brodt, 2001; Carlson & Maffi, 2004; Ohmagari & Berkes, 1997; Ross, 2002; Toledo, 2002; Zarger, 2002; Zarger & Stepp, 2004; Zent, 1999, 2009), but the imposition of a globalised industrial economic model may result in acculturation and the loss of local knowledge (Benz et al., 2000; Godoy et al., 2005; Gray et al., 2008; Kingsbury, 2001; Turner & Turner, 2008) including knowledge of medicinal plants (Geck et al., 2016). Knowledge changes through time are mediated through processes of cultural transmission (Blanco & Carrière, 2016; Ohmagari & Berkes, 1997; Zent, 2009). Transmission of plant knowledge among rural communities worldwide is often informal, unconscious and unplanned, activity-situated and participatory (Katz, 1986, 1989; Lave & Wenger, 1991; Lozada et al., 2006; Zarger, 2002; Zent, 2009). As knowledge itself, processes of transmission are context-dependent and embedded in social systems (Berkes et al., 2000).

Processes of transmission are often inferred from variation in medicinal plant knowledge among the members of a community (Begossi et al., 2002; Coe & Anderson, 1996; McCarter & Gavin, 2015; Monteiro et al., 2006; Souto & Ticktin, 2012; Zent, 2009). Differences across generations are studied to assess changes through time (Lee et al., 2001; Zent, 2009), but other factors are also important to understand knowledge dynamism. Variables such as status and profession (Alencar et al., 2014; Godoy et al., 1998; Medin et al., 2002; Reyes-García et al., 2005), gender (Díaz-Reviriego et al., 2016; Howard, 2003; McCarter & Gavin, 2015; Torres-Avilez et al., 2016; Voeks, 2007), linguistic preference (Benz et al., 2000; McCarter & Gavin, 2015), level of formal education (Quinlan & Quinlan, 2007), and market integration or isolation (Brodt, 2001; Guest, 2002; McCarter & Gavin, 2015; Vandebroek et al., 2004) may be drivers of local knowledge change. As the socioeconomic and environmental context of a community changes, so does its plant knowledge and the processes of its acquisition and transmission (Gallois et al., 2015; Gómez-Baggethun & Reyes-García, 2013).

In Morocco, sharing local plant knowledge is a social risk-management strategy that tends to disappear as semi-nomadic populations become sedentary (Blanco & Carrière, 2016). Bellakhdar

(1992) notes that medicinal plant knowledge is being lost in urban environments, whilst it retains function in rural environments. Although many ethnobotanical studies highlight widespread use of herbal medicine among lay people in rural Morocco (Bellakhdar, 1992; El-Hilaly et al., 2003; Fakchih & Elachouri, 2014; Merzouki et al., 2003; Tahraoui et al., 2007), others observe a generational change (Abouri et al., 2012; Teixidor-Toneu et al., 2017), but none has directly identified patterns of medicinal plant knowedge so far. As observed by Bakker (1992, 1993), understanding prestige structures may be key to understanding changes in Moroccan healing systems. This chapter aims to describe the variation in medicinal plant knowledge among the inhabitants of a rural community in the High Atlas and present narratives on the role of medicinal plant use. The factors driving local change in medicinal plant knowledge transmission are inferred from direct enquiry and knowledge variation among community members.

4.2 Methods

4.2.1 Field data collection

This study includes two components: ethnographic fieldwork to investigate transmission of knowledge about medicinal plants and healthcare preferences, and a quantitative analysis of the variation in medicinal plant knowledge among Imegdale's community members.

Primary data on medicinal plants were collected using free-listing and semi-structured interviews, which are the backbone of the dataset used in quantitative analysis (Appendix 4.1). The fifty-three individual medicinal plant lists used were collected between February and June 2015 in nine of the 28 villages of the rural commune of Imegdale. Data on the informants' gender, place of residence, place of birth, age and occupation was also collected. Dominance of the vernacular language, in this case Tashelhit, was not considered since all the inhabitants of Imegdale communicate in Tashelhit. The only community members proficient in Moroccan Arabic are young men that engage in seasonal labour who could not be interviewed because they are mostly away from the commune. Villages were selected to be representative of the social and ecological conditions in the commune: four villages at the top of water sheds (Annamer, Aggrd, Semgourd, and Ighdiwen), two at the valley bottom but away from the road (Ighrm and Tiniskt) and three by the road that runs through the

N'Fiss valley (Emesguine, Imidl, and Imegdale; Figure 4.1). Random and snowball techniques were used to select informants (Bernard, 2011).

Open-ended interviews were conducted with the same community members focusing discussions on the nature of medicinal plant knowledge transmission and healthcare preferences of the community members. Healthcare preferences were addressed since these may influence the transmission of knowledge about medicinal plants to future generations. Morover, nurses and doctors (n= 5) in health centres attended by Imegdale inhabitants (Imegdale and Ouirgane) were interviewed. All interactions were conducted in Tashelhit with the aid of a local translator. Interviews were registered with pen and paper. Much insight was gained through observing daily life (Bernard, 2011; Martin, 1995), and through informal discussions with people going or coming back from the public healthcare centre in the community.

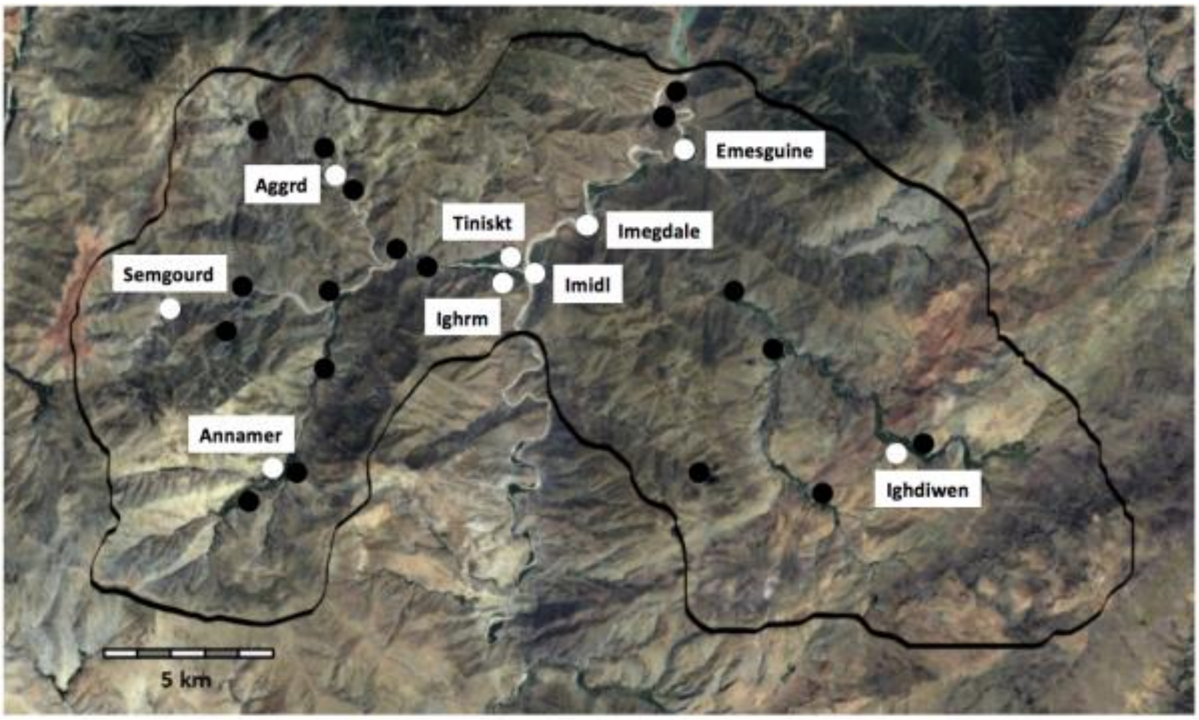

Figure 4.1 Map of the rural commune of Imegdale; surveyed villages are labelled shown white, non-surveyed villages are in black.

4.2.2 Data analysis

Data collected were analysed qualitatively and quantitatively. Ethnographic data were summarised and synthesised to build a narrative account on medicinal plant knowledge transmission and healthcare preferences, contrasting medicinal plant use with biomedical resources (Newing et al., 2011). In the quantitative analysis, medicinal plant lists were used as a proxy for informant's knowledge, although they do not necessarily correlate with medical knowledge. Medicinal plant lists may fail to be good proxies for medicinal plant knowledge if, for example, some informants know a few plants but successfully use them to treat a great number of ailments, whereas others cite more plants but have a shallow understanding of how to use them. The dataset incorporates data from free-lists as well as in-depth, semi-structured interviews, since free-lists are strongly biased towards plants recently used (Sousa et al., 2016).

Medicinal plant lists were compared among informants and the effects of various social and demographic variables shaping medicinal plant knowledge were analysed (n= 53). Interviews that included the contribution of several people were excluded from the analysis. A presence/absence matrix included a total of 80 plants (plants mentioned by only one interviewee were excluded) and four demographic and social attributes defining each interviewee (gender, place of residence, age and occupation; Appendix 4.1). Place of residence was coded in two ways: according to the specific village where people lived, and according to the distance to the road (by the road, valley bottom villages and valley top villages). Informants were classified in three age groups: young (<30 years old), middle aged (30-60 years old) and older (>60 years old). Most women in Imegdale engage in many agricultural activities, but some of them also are midwives (*qblat*) or practice a traditional healing practice called *frigg* (Teixidor-Toneu et al., 2017); coding for occupation allowed to distinguish local specialists from lay people. Place of birth was excluded from the analysis because of lack of replicates: only a few interviewees were from various different neighbouring communes.

Quantitative analyses follow Salali et al (2016). Generalised mixed-effects logistic regressions were used to predict the co-occurrence of plants in lists across interviewees (GLMMs). GLMMs are an extension of linear mixed models that allow for binary response variables (such as presence or absence of plants in a list) and include random effects as well as fixed effects (independent variables; Gelman & Hill, 2007). The independent variables considered here were gender, place of residence, age and occupation. The interviewee ID was used as a random effect. A first analysis was performed to look for differences in plant lists between men and women. Then, men's lists were excluded (n= 8, 15%) and the other predictors were used to predict similarities between women's plant lists. Analyses were carried out in R v. 3.2.3 (R Core Team, 2015) using the function *glmer()* from the "lme4" library (Bates et al., 2015).

4.3 Results

4.3.1 Knowledge variation among Imegdale's inhabitants

A total of 53 informants were included in the quantitative analysis, of which 85% were women (Table 4.1). Knowledge about medicinal plants in Imegdale is not evenly distributed among community members. Significant differences were observed between men and women's medicinal plants lists (n= 53, GLMM p-value 0.00597). Men (n= 8) listed 8 (±3) medicinal plants, whereas women (n= 45) cited 15 (±7) plants. Men often included species of the commune's medicinal plant consensus model (*azukni, shih, timja, azuka* and *timzurri*; Teixidor-Toneu et al., 2016a) and almost always mentioned medicinal roots (especially *igudi* and *awgdmi*) which they collect during seasonal shepherding in the alpine area. Only one man mentioned spices and traded plants, which are common in women's lists. Medicinal roots were sometimes, but not always, present in women's lists, who cited a wider range of species used medicinally. Perhaps due to the women's responsibility of the household diet, spices and food plants were more often mentioned as having medicinal uses by women (43% of the citations were cultivated or imported plants) than by men (27%). Place of residence did not explain variability in women's medicinal plant lists (n= 45, GLMM coefficient p-value > 0.05; Table 4.2), but differences were observed across age groups, with lists given by elders being significantly different to those given by younger women (Table 4.2). Lists given by elder women were significantly different to those from middle aged and young women (GLMM coefficient p-value 0.0205; Table 4.2). Occupation as a healer did not result in knowledge variation among women (GLMM coefficient p-value > 0.05; Table 4.2). Although *ferraggat* cited on average more plants (Table 4.1), these are not significantly different than those cited by lay women (discussed elsewhere; Chapter 5, Teixidor-Toneu et al., 2017).

Table 4.1 Socio-demographic characteristics of the women informants and average number of ethnospecies cited in their lists (singletons were omitted).

			Number of informants	**Average number of ethnospecies listed (± standard deviation)**
Age	Old		12	18.4 (± 8)
	Middle		26	14.2 (± 7.5)
	Young		7	12.6 (± 3.5)
Place of residence (village)	Road	Imidl + Imegdale	4	19.8 (± 10.1)
		Emesguine	3	7 (± 6.6)
	Valley bottom	Ighrm	13	12.5 (± 5.3)
		Tiniskt	3	13.7 (± 10.8)
	Valley top	Aggrd	7	14.4 (± 3.1)
		Annamer	2	23 (± 5.7)
		Semgourd	4	17.3 (± 8.1)
		Ighdiwen	9	17.3 (± 8.7)
Occupation	Non-healer		42	14.6 (± 7.5)
	Ferragga		3	20.7 (± 1.5)

*Table 4.2 Mixed-effects logistic regression, model summary and odd ratios. Model AIC 3396; N observations 3600; N informants 45. CI = Confidence Interval. * = statistical significance.*

Fixed effect	**Estimate (SE)**	**p value**	**Odds ratios (CI)**
(Intercept)	-1.5089 (0.3731)	5.26e-05 *	0.22114 (0.10642, 0.45952)
Valley-bottom villages	0.0373 (0.2748)	0.8920	1.03801 (0.60572, 1.77883)
Valley-top villages	0.4233 (0.2573)	0.1000	1.52704 (0.92207, 2.52894)
Old age	0.4692 (0.2025)	0.0205 *	1.59873 (1.07494, 2.37774)
Young age	0.0082 (0.2534)	0.9739	1.00832 (0.61361, 1.65692)
Occupation	-0.4237 (0.3386)	0.2109	0.65460 (0.33704, 1.27133)

4.3.2 Learning and sharing medicinal plant knowledge in Imegdale

Knowledge about medicinal plants in the High Atlas is not textual, but learnt through observation and experience, as in other societies or for other aspects of traditional ecological knowledge (Katz 1986, 1989; Lave & Wegner, 1991; Prince et al., 2001). Children observe and participate in the preparation of herbal remedies and are familiar with the medicinal plants that they take regularly, such as those used to treat common colds and stomach aches. Some informants recalled learning from their mothers and observing herbal remedies being used at home. Hence, common remedies are likely learnt vertically or by oblique transmission, from parents and other elders to children. However, according to the interviewees, knowledge about medicinal plants in Imegdale is mostly shared among women during adulthood. Although horizontal transmission events are often isolated and more difficult to remember than the repeated family learning (Lozada et al., 2006), most informants referred to neighbours (often including blood or in-law family members but not the parents) as sources of information about medicinal plant use.

Informants linked idiosyncratic knowledge to individual medical histories since several informants pointed out that people learn about plant use progressively with age if they are sick. Necessity would be reinforced by personal resourcefulness and interest in the subject (Quinaln & Quinlan, 2007). An interviewee said: *People who know about plants are those that are or have been sick. When someone is sick, they will ask about what they can do to heal, but if not, the person has no need to know about plants* (9th March 2015, Ighrm). Some informants recalled learning specific remedies from peers and elders in time of need, identified as local innovations (horizontal and oblique transmission). For example, a man in the village of Annamer explained how, when he was sick with kidney stones, a local friend who had moved to Casablanca and befriended herbalists there had taught him how to prepare a mixture to treat kidney problems. This results in some people knowing more than others.

Newly learned remedies can also replace old ones, when they are perceived as more efficient or convenient. A woman from the village of Imidl recalled starting to use cinnamon with yogurt to treat children's common colds recently, following advice from a neighbour. She observed that "*this mixture works and now a lot of women use it because we can buy yogurt in the shop and it is easy to give to children*" (3rd March 2015, Imidl). However, it is the use of pharmaceuticals that mostly replaces herbal remedies.

Although medicinal plants are believed to be good and all people interviewed had some knowledge of medicinal plant use, biomedical care was the preferred healthcare option to treat most adults' ailments as elsewhere in Morocco (Abouri et al., 2012; Mateo Dieste, 2010; Obermeyer, 2000). "*Now everything is bought in the market and in the pharmacy, people go to the doctor and don't need medicinal plants anymore*" (10th March 2015, Imidl) was a common comment among women. However, while discussing neurologic problems, a staff member from the public health centre in Ouirgane explained that "*when people believe that they are psychiatric problems they come* [to the health centre] *to get checked and take pills, but those who think it is* lariah [supernatural forces that can cause illness] *who are causing the illness, they don't come*". Herbal remedies were preferred to treat ailments associated with supernatural causes (especially those afflicting children; Chapter 5, Teixidor-Toneu et al., 2017), when biomedical treatment was not accessible or when it was perceived as unnecessary.

When asked about teaching and learning about medicinal plants, both young and elder women expressed little interest in transmitting or acquiring medicinal plant use skills. On the one side, this may result from the lack of conscious learning during childhood or unless people are sick and actively looking for remedies. On the other, it may stem from the locally widespread idea that nature is rich in medicinal resources, but people do not know much about them or how to use them properly. This contrasts with documented evidence; over 2000 use reports for 159 plants were collected during this research (Teixidor-Toneu et al., 2016a), but builds upon finding low specificity of the herbal remedies used. Elders recalled that there is not a deep tradition of medicinal plant use in the High Atlas. Baths using mixtures of plants called *tadouart n yigran* (Teixidor-Toneu et al., 2016a) or absence of treatment were mentioned as common among older generations. These ideas, together with socioeconomic changes including schooling and the arrival of electricity and television in the commune, were put forward by informants as factors contributing to the lack of interest in transmitting knowledge about herbal remedies.

4.4 Discussion

The study carried out here did not quantify the contribution of the different transmission components (vertical, oblique and horizontal, *sensu* Cavalli-Sforza and Feldman, 1981), but horizontal transmission seems to play an important role in medicinal plant knowledge sharing in Imegdale. Following the model developed by Cavalli-Sforza and Feldman (1981), other ethnobotanical studies have found that the transmission of ethnobotanical knowledge is mostly vertical (Lozada et al., 2006; Ohmagari & Berkes, 1997; Reyes-García et al., 2013; Soldati et al., 2015) or oblique (Reyes-García et al., 2009), but Mathez-Stiefel and Vandebroek (2012) found evidence of horizontal transmission of medicinal plant knowledge in rural Andean communities. Souto and Ticktin (2012) observed differences in the transmission of various types of ethnobotanical knowledge. Similarly, different transmission pathways may play a role for the acquisition of knowledge about different herbal remedies. Vertical transmission seems to guide learning of common herbal remedies such as those to treat minor pains or gastrointestinal ailments, which are all used regularly in most households. Oblique and horizontal transmission would play a role when people seek specific remedies to treat uncommon ailments. Overall, oblique and horizontal transmission arehaving an important impact on the spread of new health narratives in developing, rural Morocco.

Variation in medicinal plant knowledge across social and demographic variables, and local narratives of knowledge transmission reflect both characteristics of the Ishelhin culture as well as trends of cultural change. Local livelihoods and kinship systems underpin the structure of medicinal plant knowledge in the High Atlas, and the exchange of medicinal plant knowledge is inextricably linked to social organisation, specifically around kinship and same-gender relationships among members of the community (Díaz-Reviriego et al., 2016; Salali et al., 2016).

Gendered labour and household responsibilities results in medicinal plant knowledge differences between men and women (Howard, 2003; Kainer & Duryea, 1992; Pfeiffer & Butz, 2005; Sunderland et al., 2014; Voeks, 2007; Wayland, 2001), evidenced quantitatively here for Morocco for the first time. The lack of differences in women's knowledge across space probably results from the patrilineal and varilocal Ishelhin society. Through this kinship system, males are the house heads and when women marry they move to the husband's home, which is often his parents' home or a house nearby in the same village. Since women are the main users of medicinal plants, this results in the regional homogenisation of medicinal plant knowledge over time.

Market visits could also contribute to the homogenisation of medicinal plant knowledge in the commune; Powell et al (2014) identified market places as important hubs for the horizontal transmission of ethnobotanical knowledge in Morocco. Although in Imegdale there is a gradient of accessibility to markets, public health centres and urban areas between the villages by the road and those further up in the mountains, this does not result in differences in medicinal plant knowledge. Visits to weekly markets are indispensable to all local families in Imegdale both to acquire non-local products and to sell cattle and other local agricultural produce. Although the regularity of these visits may vary among people from more or less isolated villages, all inhabitants attend markets regularly. Hence, all inhabitants would be similarly exposed to globalization narratives on the one side (Crawford, 2008), and products sold by ambulant herbalists, on the other (Teixidor-Toneu et al., 2016a).

Integration into the globalised economy may have a lesser impact on the transmission of medicinal plant knowledge than access to biomedical care. Narratives on the supremacy of biomedicine impact the specific cultural contexts that allow customary knowledge transmission processes to reproduce itself over time (Zent, 2009). Differences in medicinal plant lists between older and younger women could indicate change or loss in medicinal plant knowledge among lay people in the High Atlas or reflect the natural increase in knowledge with age (Godoy et al., 2009). Medicinal plant knowledge in the High Altas is learned throughout a person's lifetime, often linked to illness events, thus generational differences are likely due to the fact that older people had more time to learn (Quinlan & Quinlan, 2007). This does not rule out the possibility that medicinal plant knowledge is being eroded and parts of it may be already or soon lost. Children raised in environments where biomedicine is available learn significantly fewer medicinal plants (Zent, 2009) and results from discussions and non-structured interviews reveal that younger women who have attended school are less likely to use plants and rely more on the public health system than their mothers and grandmothers do. Although lack of transmission between generations is often attributed to the decrease of time that children spend with their elders (van't Klosster et al., 2016; Ohmagari & Berkes, 1997), in the High Atlas changes in time allocation would have a lesser effect than the influence of narratives about biomedical care, which facilitate a shift of local health paradigms (Whyte et al., 2002). Village-based, oral knowledge, is perceived as backward and no longer carries prestige, whereas literate knowledge is a marker of social power (Agrawal, 1995; Campbell, 2004; Pigg, 1992), and prestige structures underpin Moroccan healing systems (Bakker, 1993). Hence, the preference for biomedicine could be, to some extent, attributed to institutional social status and prestige (Henrich et al., 2008). Biomedical treatments are associated with modernity, development and globalisation, and can be perceived as more efficacious (Mateo Dieste, 2010; Obermeyer, 2000; Wayland, 2004; Whyte et al., 2002). Moreover, women that have left the countryside and moved to urban areas, where workloads are radically decreased and access to modernised commodities enhanced are perceived as successful (Hoffman, 2007). The willingness to imitate them could result in preference for biomedical treatments when these are accessible, and this could hamper the transmission of medicinal plant knowledge. However, local medicine is maintained to treat culturally bound syndromes and ailments with personalistic aetiologies, as observed elsewhere (Foster, 1976; Teixidor-Toneu et al, 2017; van Andel and Westers, 2010; Volpato and Waldstein, 2014), as well as to treat common complaints for which biomedicine is perceived as unnecessary.

In situations of cultural change young generations are most likely to gather information from age-peers or from prestigious individuals and institution; these updates replace previous information acquired from parents and speed changes in local knowledge (Aunger, 2000; Cavalli-Sforza & Feldman, 1981; Henrich & Broesch, 2011; McElreath & Strimling, 2008). Knowledge adaptation to socioeconomic change also results in cognitive and behavioural changes, with younger generations imitating outsider's behaviour rather than that of their own elders (Ross, 2002). Hence, a replacement of local herbal knowledge for biomedical treatments may be expected in the near future as biomedicine is increasingly available.

4.5 Conclusion

Medicinal plant knowledge is gendered in Morocco; it is a women's domain. Thus processes of transmission are gender-specific and linked to social organisation and kinship relationships. Importantly, the Ishelhin varilocal kinship system, where wives tend to originate from outside the community, may have a homogenizing affect across space and time in the High Atlas. Horizontal transmission plays an important role in learning about medicinal plant knowledge, especially new remedies which people often seek when they are ill. Medicinal plant knowledge varies with idiosyncratic life experiences and increases with age, resulting in medicinal plant lists significantly different between older and younger generations. Vertical and oblique transmission components are also important for the learning of common herbal remedies during childhood.

Medicinal plant knowledge in the High Atlas is sensitive to socioeconomic changes, especially schooling and availability of biomedicine. Biomedicine often holds a higher status than local herbal treatments and this could result in the interruption of transmission of knowledge about medicinal plants. However, maintenance of herbal remedies is observed when ailments are believed to have supernatural causes.

Chapter 5 Treating infants with *frigg*: linking disease aetiologies, medicinal plant use and care-seeking behaviour

5.1 Introduction

Herbal remedies used in local medicine are the primary health care resource in many rural communities around the world (Alves & Rosa, 2007; Vandebroek et al., 2004; WHO, 2013). Local medicines are dynamic systems encompassing the "knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures that are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental illness" (WHO, 2000). The availability of biomedicine (defined here as the medical system based on western scientific principles), often perceived as a symbol of modernity, development and globalization in the non-Western world (Wayland, 2004; Whyte et al., 2002), alters care-seeking behaviour and often displaces local medicines (Quinlan & Quinlan, 2007; Saethre, 2007; Vandebroek et al., 2004). However, local medicine continues to be used because of its perceived effectiveness, high cost of biomedical services, long distances to public health facilities, cultural preferences or a combination of these factors (Perry & Gesler, 2000; Foster, 1976; Obermeyer, 2000; Thomas, 2013; Vandebroek et al., 2004). Moroccans often use local herbal medicine and biomedicine simultaneously, and consider them compatible (Mateo Dieste, 2010).

Moroccan ethnomedicine is itself a pluralistic system, blending Prophetic and Galenic humoral medicine (Greenwood, 1981). Since medieval times, indigenous Berber medicine has incorporated aspects of oriental Arabic medicine, as well as Al-Andalusian and Sub-Saharan knowledge (Bellakhdar, 1997). Classification and treatment of illnesses is based on the "hot/cold" dichotomy derived from humoral medicine, but also on personalistic aetiologies such as the evil eye, sorcery or intervention of spirits (Greenwood, 1981). Belief in evil and sorcery as a source of health problems for children and adults is widespread across Morocco (Mateo Dieste, 2010). Whereas naturalistic causes, those that are physical, chemical or pathological, can be treated with medicinal plants at home or by herbalists (*ashub*) and midwifes (*qblat*), personalistic or supernatural causes are treated ritualistically by holy men and women (*sherif, shorfa*) or Quran experts (*fqih*) (Bakker, 1992; Foster, 1976; Greenwood, 1981). Here I report on traditional healers that practice in southern

Morocco called *ferraggat* that whilst treating ailments caused by supernatural causes, use medicinal plants as their main treatment.

Ferraggat (*ferragga* in singular) are not midwifes (*qblat*) but specialize in treating children and women' illnesses. *Ferraggat* are consulted by lay people of all social backgrounds (Sajiai, 2007); they are invariably women, normally elderly, who often use a mix of medicinal plants called *frigg* in their treatments. The word *frigg* is also used to refer to the treatment itself. Despite their ubiquity as traditional healers in urban and rural southern Morocco, they have been overlooked by the most important references on Moroccan medical anthropology and ethnobotany (Bellakhdar, 1997; Mateo Dieste, 2010; Bakker, 1993). The context in which *ferraggat* work is one of partial or limited access to public health care. In 2015, there were approximately 19.8 deaths of under-fives per 1000 live births in Morocco (mortality rate of 27.6) with pneumonia, injuries and diarrhoea as the leading causes of death (UNICEF, 2015). Although much effort has been put in Morocco towards establishing a national health system to improve health standards and child mortality has decreased considerably in the last decades, the system still has insufficient human and material resources, an uneven geographic distribution of health coverage to the detriment of rural areas, and minimal insurance benefits (Semlali, 2010). There is only one public health centre in each rural commune, for between 5000 to 8000 people (Semlali, 2010), and they do not all have a doctor. Moreover, public health centres are usually staffed by non-locals who do not speak Tashelhit, which can pose serious communication issues between staff and their patients.

Local and indigenous medicines have been considered highly symbolic; most elements of medicine are meaningful, and meaning can have physiological effects, triggering biological responses in sick people (Moerman & Jonas, 2002). Moerman and Jonas (2002) argue that meaning plays a key role in understanding effectiveness of traditional medicines, which are used in culture-specific contexts. Cultural constructs of efficacy and concepts about health and illness underlie any physiological response to meaning (Etkin, 1988a; Moerman & Jonas, 2002; Ortiz de Montellano, 1975). However, phylogenetically related medicinal plants are selected across cultures, suggesting pharmacological efficacy of herbal remedies (Moerman, 1979; Saslis-Lagoudakis et al., 2012). Studies identifying medicinal plants are common in the ethnobotanical literature, but few consider the illness explanatory models in which they are used (Kleinman, 1978; Waldstein & Adams, 2006). Nevertheless, there are examples in the literature where medicinal plant use is presented in an ethnographic context and described alongside ceremonial, ritualistic treatments (Frazão-Moreira, 2016; Paulos et al., 2016; Ruysschaert et al., 2009; Thomas et al., 2009). These studies stress that both the experience of illness and its treatments need to be understood in their cultural and social contexts. In the case of Morocco, studies either emphasise botanical identifications of medicinally-used plant species (El-Hilaly et al., 2003; Fakchich & Elachouri, 2014) or the links between ailment aetiologies and healthcare seeking behaviour (Bakker, 1992; Greenwood, 1981; Mateo Dieste, 2010; Obermeyer, 2000).

Given the scarcity of literature describing the *ferraggat* and their practices, the initial aim of this study was to fill this knowledge gap, understanding how knowledge about *frigg* is learned and transmitted. The ailments treated by *ferraggat* are described from an emic perspective and build a basic explanatory model (Kleinman, 1978), focusing on the symptoms, known causes, therapies and prognosis. This chapter aims to understand the selection of medicinal plants used in *frigg*, linking the treatment with folk healing specialists, popular explanatory models and care-seeking behaviour, in a sociocultural context of recent modernisation and increasing availability of biomedical resources.

5.2 Methods

The present study was situated in the south of the Atlantic plains and neighbouring montane areas, both in the city of Marrakech and the mountainous areas of the El Haouz province, specifically in the N'Fiss valley in the High Atlas mountains from February to May 2015. Whilst different medical systems are available in Marrakech, the rural communes where interviews were conducted have limited access to biomedical resources.

The rural study sites were the commune of Imegdale and four other neighbouring rural communes where some of the *ferraggat* lived and practised. Mothers were selected haphazardly and interviewed in 11 villages in Imegdale (n= 33). Nine *ferraggat* from eight villages in five different rural communes were interviewed (n= 13). Healers in the High Atlas were identified by asking mothers which *ferraggat* they normally visit or if they knew of any other women who practised *frigg*. In Marrakech, *ferraggat* were contacted through the extended social networks of research assistants. Some of the *ferraggat* contacted did not wish to participate in the study either because of unwillingness to talk while practising (they seemed to be the busiest *ferraggat*) or distrust. Two of the *ferraggat* interviewed in Marrakech were originally from the High Atlas. In the N'Fiss valley, all available public health professionals (n= 5) were interviewed in the health centres of Imegdale and Ouirgane. Since *frigg* is based on a recipe of medicinal plants and herbalists are the main herb suppliers when *ferraggat* do not harvest the plants themselves, herbalists were also interviewed (n= 10). Herbalists were selected haphazardly and interviewed in rural market places in the N'Fiss valley (Asni and Talat N'Yakoub) and Marrakech.

Ferraggat (n= 13) and herbalists (n= 10) were asked to list the plants used in *frigg* (free-listing; Bernard, 2011; Martin, 1995). Informants were also asked about where plants are acquired, whether the mixture always has the same ingredients and about criteria for plant selection. A quantitative approach was used to analyse free-lists by calculating use values (UV) for plants in *frigg* to quantify their cultural importance, following the equation UV = ∑Uis / N, where *∑Uis* is the sum of the total number of use reports concerning a given species and *N* is the total number of informants (Tardío and Pardo-de-Santayana, 2008). R v. 3.2.3 (R Core Team, 2015) was used to carry out a non-metric Multidimensional Scaling (MDS) analysis to visualise differences among the plant lists given by informants (*isoMDS* function from the MASS library; Venables & Ripley, 2002), and a t-test to evaluate differences in the number of plants listed by *ferraggat* and herbalists. Pathways for the transmission of knowledge were evaluated by asking if there were any particular person or people from whom they had learned the practice of *frigg* or the preparation of *frigg* herbal mixtures (following Hewlett & Cavalli-Sforza, 1986).

Since very little was known of *frigg*, qualitative inductive methods where no hypothesis is pre-specified were used to elucidate the explanatory models (Kleinman, 1978). I observed twelve healing sessions with five different *ferraggat* and carried out in-depth interviews enquiring about the ailments treated, their symptoms, and disease aetiologies. Moreover, questions addressed where and from who *ferraggat* had acquired this knowledge and if they had taught it to someone else. The same questions were asked of herbalists (n= 10). Staff from public health centres were asked if they knew about *frigg* and, in the case that they did, they were asked to describe what *ferraggat* do and to give their opinion on the practice. Nurses and doctors (n= 5) were interviewed in the local health centre in the village of Imegdale where there is no doctor, and the health centre with a doctor and midwife in the neighbouring commune of Ouirgane. Mothers were asked if they brought their children to *ferraggat* when they were sick and why. Interviews were carried out with the assistance of a local Tashelhit-speaking translator in rural areas and a local Moroccan Arabic-speaking translator in urban areas. Qualitative data from in-depth interviews were analysed by cross-checking, summarising and synthesising data collected from interviews to construct a narrative account (Newing et al., 2011).

Plant specimens were collected in the field with the community's permission preferably with the collaboration of an informant or acquired in the nearest market place and vouchered. Specimens were identified using the *Flore Pratique du Maroc* (Fennane et al., 1999, 2007, 2015); nomenclature and family assignments follow The Plant List (2013) and APG IV (2016). Vouchers were deposited in the Marrakech Regional Herbarium (Morocco; MARK) and the University of Reading Herbarium (United Kingdom; RNG).

5.3 Results

5.3.1 *Frigg* narratives

Frigg is an important resource for infant healthcare in rural Morocco; 94% of the rural mothers interviewed seek help from *ferraggat* when their infants are sick. According to the informants, *ferraggat* deal with ailments that biomedicine is not effective in treating because of their supernatural cause, often associated with sorcery. Mothers from isolated villages also mentioned accessibility and availability as an important reason to prefer traditional medicine. Public health centres are often far away, understaffed or under-resourced, or economically inaccessible, whereas *ferraggat* live nearby or travel to the patient when necessary. They work "*fi sabilillah*", for the sake of Allah, without expecting compensation apart from donations. *Ferraggat* affirmed that they send infants to be treated in the hospital when the ailment is outside of their expertise. All workers of public health centres interviewed were opposed to *frigg* practise, characterising it as dangerous and backward.

Mothers were not interviewed in urban areas, but *ferraggat* do not lack patients in Marrakech. As they explained, mothers often bring their infants when biomedical treatments have proven ineffective. *Ferraggat* added that they also treat infants from "conservative" mothers who prefer Moroccan ethnomedicine because of their beliefs. *Ferraggat* in Marrakech are very much like those in the mountains in terms of the settings of the practice (generally their homes) and their availability (working "*fi sabilillah*"). However, it is worth mentioning the case of a young *ferragga* (in her thirties) who had an established practise in Marrakech with time schedules and set prices, showing a shift towards professionalization (Flint, 2001; Pordié & Simon, 2013).

5.3.2 Ailments treated: reported symptoms and perceived causes

Three main paediatric ailments are treated by *ferraggat*: *taqait*, *taumist* (*sarra* in Moroccan Arabic) and *iqdi* (*shem* in Moroccan Arabic), which can be considered cultural bound syndromes. *Ferraggat* can also treat children's physical development and musculoskeletal problems, as well as women's ailments (not explored here). *Taqait* literally means "little globule" and the word is normally used to refer to unripe fruits. This word is used because diagnosis is normally made by checking the palate of the infant with the thumb; *ferraggat* consider the infant has *taqait* if she feels a little globule on the palate, "like a grain of corn". Infants affected by *taqait* do not breastfeed, have difficulties in swallowing, can have ear pain (which *ferraggat* check by touching the area around the ears or softly pulling them) and may also be vomiting. The symptoms of *taqait* seem to correspond roughly to those of tonsillitis and ear infections. Workers from health centres showed no knowledge of this ailment and it was not mentioned by any *ferraggat* in Marrakech, so it could be endemic to the High Atlas.

Taumist and *iqdi* are related, and unlike *taqait*, both are associated with a sorcery-related cause. Infants are believed to be highly vulnerable to sorcery and passive victims of its harmful effects until the age of two or when they have all their teeth, as observed among other populations (Martínez, 2008; Ruysschaert et al., 2009; Thomas et al., 2009). *Taumist* means "bundle" and it refers to the talismans that people (normally women) carry. These talismans may heal or prevent disease, protect against the evil eye, or bring good luck. They are prepared by the *fqih*, the spiritual religious healer, part of the Moroccan therapeutic system (Bakker, 1993; Mateo Dieste, 2010). They are often made from a paper wrap on which Quranic verses are written and contain salt and seeds of *harmel* (*Peganum harmala*). They may contain other plants such as *qzbor* (*Coriandrum sativum*), *sanouj* (*Nigella sativa*), *fijl* (*Ruta montana*) and *azuka* (*Tetraclinis articulata*). Babies can fall sick of *taumist* when around a person carrying a talisman. They are diagnosed with *taumist* when they have a sunken fontanel, extending to the forehead, the eyes may be rolling up, lethargy may be experienced and the skin has a greenish colour. They may also suffer from diarrhoea, abdominal pain, fever, or a combination of these symptoms. *Iqdi* literally means "to smell" and it refers to infants "smelling" sorcery or physical bad smells and consequently getting sick. The symptoms of *iqdi* are a bad skin smell, vomiting, diarrhoea and difficulty with breastfeeding. From a biomedical perspective, these two ailments seem to roughly refer to gastroenteritis, a very common condition in rural areas mostly due to poor diets and inadequate sanitation (De Wet et al., 2010).

5.3.3 Treatment and prognosis

Healing sessions start with the creedal statement “*bismillah*”, “in the name of God”, and some *ferraggat* will sprinkle salt on the infant. The *Tibb-ul-Nabbi* (“Medicine of the Prophet”) of Mahmud bin Mohamed al-Chaghhayni states “begin with salt, for verily it is remedy for seventy diseases” (Elgood, 1962; p.187). Fumigants can also be used at the beginning of the session, especially burning dry stems of *henna* (*Lawsonia inermis*) or *marrut* (*Marrubium vulgare*) close to the infant so they inhale the smoke. *Taumist, taqait* and *iqdi* are identified and diagnosed as different ailments but they are generally treated in the same way. *Frigg*, a blend of dried plants, ground and mixed with olive oil, is used to massage the baby’s body. It can also be administrated orally and sometimes as ear and nose drops. Mothers may bring the infant to the *ferraggat* just once or up to three days in a row, depending on the *ferraggat*’s recommendation or on the perceived effectiveness of the treatment. Finally, most *ferraggat* use *qtran rqeq* (lit. “thin cade oil”), oils extracted from the roots and branches of various *Juniperus* species, such as *J. oxycedrus*, and *Tetraclinis articulata*. A bit of the smoky, strong-smelling oil is put under the baby’s nose as well as on top of the head helping “clean out” the “bad smells” and protect the infant from further “smelling”. Although sessions usually proceed in this way (for a detailed description see Appendix 5.1), one *ferraggat* only used onion, salt and her inherited Baraka. I was present in one of her healing sessions that started with the indispensable “*bismillah*” and sprinkling salt on the infant. Placing the infant on her lap, she took a piece of onion and rubbed it on the infant’s head, specifically the top and the sides of the forehead. She finally placed it on the top of the forehead and tied it with a piece of cloth. Ultimately, regardless of the treatment used, all *ferraggat* attribute healing to God’s will.

Perhaps surprisingly, herbalists reported an alternative mode of administration of plants by *ferraggat* and only two seemed familiar with *frigg* as reported by *ferraggat* themselves (Table 5.1). According to herbalists, plants used by *ferraggat* are put in a bundle of cotton cloth and infused in hot water. A bit of this water is given to the baby, usually by squeezing some drops from the bundle into the baby’s mouth. They call this mixture *taktira*, literally “drops” in Moroccan Arabic. *Taktira* as described by herbalists includes some plants not cited by *ferraggat* as part of *frigg* (Table 5.2).

Table 5.1 Frigg *practise and its transmission per informant. Informants marked with * were not included in the quantitative analysis (MDS).*

Practitioner code, location (U= urban, R= rural)	Age	Source of knowledge	Knowledge transmitted to younger generations	Years of practise	Number of plants used	Source of plants used	Mode of preparation; mode of administration
Ferragga1, U	>70	Another *ferragga* in Marrakech	No	>40	12	Urban herbalists and harvested from the wild in the high Atlas	Dried ground plants, mixed with olive oil; oral ingestion and massage
Ferragga2, U	>80	Mother (family women's lineage)	No	>40	6	Urban herbalists	Dried ground plants, mixed with olive oil; oral ingestion
Ferragga3, U	≈50	Mother	-	7	8	Urban herbalists	Dried ground plants, mixed in olive oil; oral ingestion and massage
Ferragga4, R	≈50	Mother	No	≈10	19	Harvested from the wild and cultivated in home garden	Dried ground plants, mixed with olive oil; oral ingestion
Ferragga5, R	>70	Another *ferragga* in Talat N'Yakoub	No	>40	7	Rural herbalists and harvested from the wild	Decoction in olive oil, filtered; nose drops and oral ingestion
Ferragga6, R	>70	Another *ferragga* in Tamslouht	-	>20	9	Rural herbalists and harvested from the wild	Dried ground plants, mixed with olive oil; oral ingestion
Ferragga7, R	≈50	Mother-in-law	No	≈30	10	Rural herbalists and harvested from the wild	Dried ground plants, mixed with olive oil; oral ingestion and massage
Ferragga8*, U	≈50	Father	No	>20	1	-	-
Ferragga9, R	>80	Mother	No	>60	9	Rural herbalists and harvested from the wild	Dried ground plants, mixed with olive oil; oral ingestion, ear and nose drops, massage
Ferragga10, R	≈50	Another *ferragga* in Maregha	No	3	16	Rural herbalists and harvested from the wild	Dried ground plants, mixed with olive oil; oral ingestion and massage
Ferragga11, R	>80	Mother-in-law	No	≈20	16	Rural herbalists and harvested from the wild	Dried ground plants, mixed with olive oil; massage
Ferragga12, R	>70	Sister-in-law	No	>20	12	Urban herbalists	Decoction of plants in olive oil, filtered; oral ingestion and massage
Ferragga13*, R	≈60	Mother-in-law	Yes	10	-	Urban herbalists	Dried ground plants, mixed with olive oil; massage

Practitioner code, location (U= urban, R= rural)	Age	Source of knowledge	Knowledge transmitted to younger generations	Years of practise	Number of plants used	Source of plants used	Mode of preparation; mode of administration
Herbalist1, U	≈40	Father	-	18	15	Wholesalers	Dried plants infusion; oral ingestion
Herbalist2, U	28	Father	-	5	7	Wholesalers	-
Herbalist3, U	85	Another herbalist in Marrakech	-	48	13	Wholesalers	Dried plants infusion; oral ingestion
Herbalist4, U	≈40	Father and other herbalists in Marrakech	-	>20	19	Wholesalers	Dried plants infusion; oral ingestion
Herbalist5, U	42	Father	-	32	22	Wholesalers	Dried plants infusion; oral ingestion
Herbalist6, U	≈50	Father	-	>30	11	Wholesalers	Dried plants infusion; oral ingestion
Herbalist7, U	≈50	Father and elder brother	-	>30	16	Wholesalers	Dried plants infusion or mixed with olive oil; oral ingestion, ointment for massage
Herbalist8, R	≈60	Other herbalist in Marrakech	-	≈40	9	Wholesalers and collectors (harvested from the wild)	Dried plants infusion; oral ingestion
Herbalist9, R	≈30	Grandfather	-	11	9	Wholesalers	Dried plants infusion; oral ingestion
Herbalist10, U	≈50	Father	-	>20	12	Wholesalers	Dried plants infusion; oral ingestion

Table 5.2 Botanical identification of the plants used in frigg*, voucher specimen, number of use reports mentioned by ferraggat (URf) and herbalists (URh), and Use Value (UV).*

Family	Vernacular names	Species (Vouchers)	Plant parts used	URf	URh	UV
Amaranthaceae	mkhinza	*Dysphania ambrosoides* (L.) Mosyakin & Clemants (IME02)	Leaves	2	0	0.09
Apiaceae	habt halawa	*Pimpinella anisum* L. (MAR40)	Fruits	1	6	0.32
	kamun beldi	*Cuminum cyminum* L. (MAR66)	Fruits	3	0	0.14
	kamun sofi	*Ammodaucus leuchotricus* Coss. (MAR41)	Fruits	4	8	0.55
	karwiya	*Carum carvi* L. (MAR38)	Fruits	5	9	0.64
	nɛfɛ, wamsa	*Foeniculum vulgare* Mill. (IME27)	Fruits	2	8	0.45

Family	Vernacular names	Species (Vouchers)	Plant parts used	URf	URh	UV
Apiaceae	qzbor	*Coriandrum sativum* L. (IME42)	Fruits	4	0	0.18
Asteraceae	babunj	NA (NA)	Flowers	2	3	0.23
	itzɣi, ifski n warras	*Cladanthus scariosus* (Ball) Oberpr. & Vogt (IME34)	Aerial parts	3	0	0.14
Asteraceae	jaidia, lɛggaye	NA (MAR36)	Flowers	0	2	0.09
	shih	*Artemisia herba-alba* Asso (IME17)	Aerial parts	4	3	0.32
Brassicaceae	habrrchad	*Lepidium sativum* L. (MAR69_14)	Seeds	1	3	0.18
Cactaceae	ajdig n'ouknari, nuwrat lkarmus	*Opuntia ficus-indica* (L.) Mill. (IME100)	Flowers	2	4	0.27
Cistaceae	irgl	*Cistus salviifolius* L. / *Cistus creticus* L. (IME56 / IME86)	Leaves	1	1	0.09
Cupressaceae	azuka, lɛrɛr	*Tetraclinis articulata* (Vahl) Mast. (IME07)	Leaves	3	0	0.14
Fabaceae	tefedas, helba	*Trigonella foenum-graecum* L. (IME60)	Seeds	1	1	0.09
Iridaceae	zɛfran	*Crocus sativus* L. (NA)	Stigmas	4	0	0.18
Lamiaceae	fleyou	*Mentha pulegium* L. (IME39)	Leaves	5	5	0.45
	azir, liazir	*Rosmarinus officinalis* L. (MAR48)	Leaves	2	5	0.32
	grz ɣyiel	*Lavandula maroccana* Murb. (IME06)	Leaves	2	0	0.09
	ifzi, mrrut	*Marrubium vulgare* L. (IME24)	Leaves	4	0	0.18
	khzema	*Lavandula angustifolia* Mill. (MAR5)	Leaves, inflores.	6	5	0.50
	menta	*Clinopodium nepeta* (L.) Kuntze (MAR1)	Leaves	1	5	0.27
	shndgora	*Ajuga iva* (L.) Schreb. (IME68)	Leaves, flowers	1	2	0.14
	timja	*Mentha suaveolens* Ehrh. (IME05)	Leaves	7	6	0.59
	timzurri, imzurria	*Lavandula dentata* L. (IME03)	Leaves, inflroes.	4	0	0.18
	zɛter	*Origanum compactum* Benth. (MAR14)	Leaves	2	8	0.45
	zɛtra, azukni	*Thymus saturejoides* Coss. (IME37)	Leaves, inflores.	5	8	0.59
Linaceae	zareɛt lktan	*Linum* sp. (NA)	Seeds	1	2	0.14

Family	Vernacular names	Species (Vouchers)	Plant parts used	URf	URh	UV
Lythraceae	rman amrouj	*Punica granatum* L. (IME61)	Flowers	4	8	0.55
Myrtaceae	knorfel	*Syzygium aromaticum* (L.) Merr. & L.M.Perry (MAR49_06)	Fruits	2	1	0.14
	riham	*Myrtus communis* L. (MAR22)	Leaves	1	2	0.14
Nitrariaceae	harmel	*Peganum harmala* L. (IME101)	Seeds	3	1	0.18
Pedaliaceae	jnjlan	*Sesamum indicum* L. (NA)	Seeds	2	1	0.14
Piperaceae	lɛsfor, bzar	*Piper nigrum* L. (MAR49_05)	Fruits	0	2	0.09
Ranunculaceae	sanouj	*Nigella sativa* L. (MAR8)	Seeds	3	6	0.41
Rosaceae	wrd	*Rosa* sp. (IME105)	Flowers	4	6	0.45
Rutaceae	fijil, aurmi	*Ruta chalepensis* L. / *Ruta montana* (L.) L. (IME73 / MAR6)	Leaves	3	0	0.14
Schisandraceae	badiana	*Illicium verum* Hook.f. (MAR49_17)	Fruits	1	1	0.09
Verbenaceae	louisa	*Aloysia citridora* Palau (NA)	Leaves	0	3	0.14

Musculoskeletal and development problems are treated by various stretching exercises and thorough massage with either *frigg* or a cream acquired in the pharmacy (in urban areas), followed by specific bundling sometimes with the use of wooden boards as supports. *Qwi*, a traditional cauterisation method, is sometimes also used to treat musculoskeletal problems. A burning, dried stem of *mrrut* (*Marrubium vulgare*) is used to lightly touch specific points of the baby's body, especially around joints, the abdominal area and the back. Unlike this practise in other countries (Ghazanfar, 1995), the stick touches the infant's skin very lightly and it was reported that the treatment never leaves a scar.

5.3.4 Ingredients of *frigg*

A high diversity of plants is used in *frigg*. In total, 67 vernacular plant names were inventoried corresponding to 70 botanical species. Five vernacular names were generic complexes (referring to more than one botanical species) and two others could not be identified. Informants listed 12 (±4) plants on average, and the number of plants listed by *ferraggat* or herbalists was not significantly different (t-test, p-value > 0.05). Fifteen vernacular names were only mentioned by one informant; plants mentioned by two or more informants are listed in Table 5.2. Almost half of the plants belong to three families: Lamiaceae (26%, 17 species), Apiaceae (9%, 6 species) and Asteraceae (8%, 5 species). Plants with the higher use values are *karwiya* (*Carum carvi*; 0.64)*, timja* (*Mentha suaveolens*; 0.59), *azukni* (*Thymus saturejoides*; 0.59), *kamun sofi* (*Ammodaucus leucotrichus*; 0.55)*, rman amrouj* (*Punica granatum*; 0.55), *khzema* (*Lavandula angustifolia*; 0.50), *zɛter* (*Origanum compactum*; 0.45), *fleyou* (*Mentha pulegium*; 0.45), *wamsa* (*Foeniculum vulgare*; 0.45), *wrd* (*Rosa* sp.; 0.45) and *sanouj* (*Nigella sativa*; 0.41). Except for *kamun sofi*, these are all commonly used plants in the High Atlas (Teixidor-Toneu et al., 2016a). Informants describe medicinal plants used in *frigg* as "mild", "not bitter" or "not spicy" (*maharrsh* in Moroccan Arabic); "bitter" plants (*harr*) such as *shndgora* (*Ajuga iva*) and *shih* (*Artemisia herba-alba*) are always used in small doses*.*

Various opinions about the importance of using plants were found among *ferraggat*. Some informants thought that correct dosages and the good quality of ingredients were the sole key to a treatment's success. Other *ferraggat* believed plants are good but the *ferragga*'s touch is more important for the treatment to work. This explanation is in line with what mothers believed about the treatment. Interestingly, eight informants (including three *ferraggat*) recalled that as recently as one generation ago, fewer plants were used or plants were not used at all. Seven colours of wool yarn and blood from a sheep slaughtered during *Eid Al-Adha*, one of the two main Islamic festivities, had been used to treat these same infant ailments. This practice is not carried out in the present.

As mentioned above, *ferraggat* and herbalists often give the medicinal plant mixture different names (*frigg* versus *taktira*) and the composition of the mixtures used or sold is also different (Figure 5.1; MDS stress factor = 0.19). Mixtures used by urban *ferraggat* are more similar to those known and sold by herbalists because these two groups have the same medicinal plants available, *i.e.* those that are traded. Lists from rural *ferraggat* include many plants that grow in the High Atlas and are not usually traded, such as *mkhinza* (*Dysphania ambrosoides*), *ifski n warras* (*Cladanthus scariosus*) and *grz ɣyiel* (*Lavandula maroccana*). However, *ferraggat*'s lists include *qzbor* (*Coriandrum sativum*), *azuka* (*Tetraclinis articulata*) and *zɛfran* (*Crocus sativus*), all traded species not present in herbalists' lists. Although herbalists do not act as healers in this case, their knowledge is not negligible, since all *ferraggat* rely on at least some traded plants and some acquire ready-made mixtures (Table 5.1). Differences in herbalists' mixtures compared to those used by *ferraggat* could also be biased by the herbalists' wish to sell specific plants and lack of knowledge about untraded plants that are common in the High Atlas.

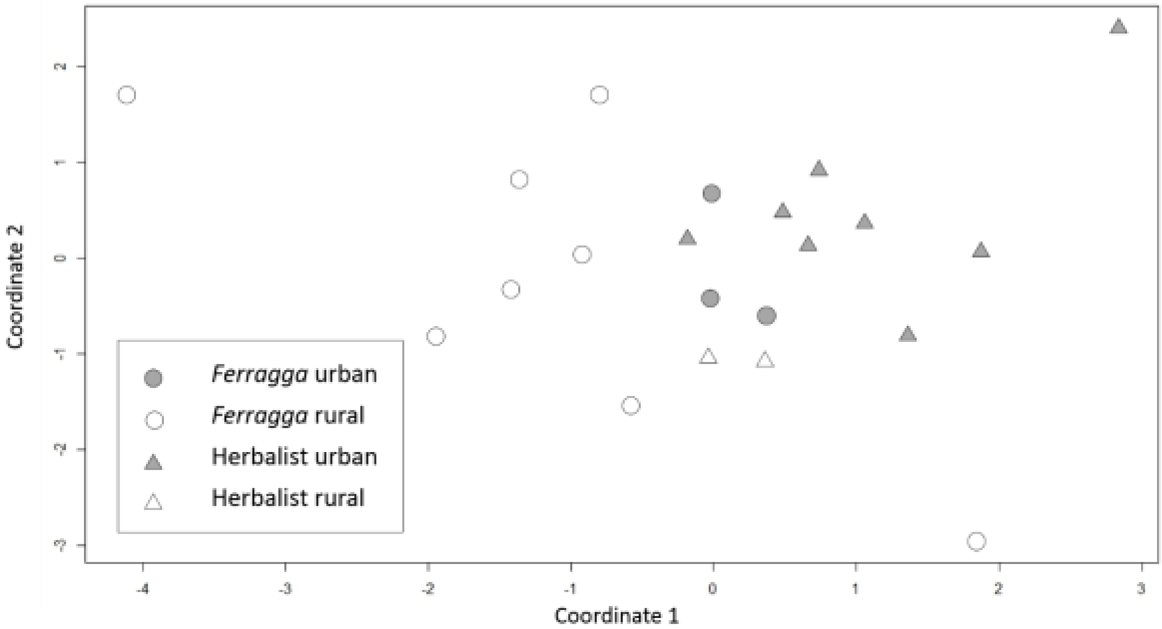

Figure 5.1 Non-metric Multidimensional Scaling analysis (stress = 0.19) of plant lists given by ferraggat and herbalists.

5.3.5 Transmission of knowledge about *frigg*

Knowledge entails being aware of facts as well as knowing how to put them into use (Puri, 2013). In the case of *frigg*, facts include which plants to use, where to acquire them, which ailments to treat, their symptoms and how to diagnose them, and skills encompass knowing how to prepare the herbal remedies, handle the infant and deliver the treatment. Knowledge about the medicinal plants used in *frigg* is transmitted orally and most *ferraggat* had learnt from their mothers, grandmothers or mothers-in-law (vertical and oblique transmission, *sensu* Cavalli-Sforza & Feldman, 1981; Table 5.1). Others had learnt from another *ferragga* (horizontal transmission). Herbalists learnt mainly from their fathers (80%, vertical transmission) and occasionally also from elder herbalists to whom they were apprenticed (oblique transmission; Table 5.1).

Unlike other folk knowledge about medicinal plants that people learn continuously from childhood to adulthood or need to come in direct contact with natural environments (Reyes-García et al., 2009), learning about *frigg* often occurs when women are middle aged and already have children. *Ferraggat* had learnt either from a relative or from a peer. When learning occurs from a relative, women observe and help elder *ferraggat* practise at home for long periods of time. On the other hand, *ferraggat* that had learnt from a peer explained that there is actually no teaching on how to become a *ferraggat* besides a few indications, such as the list of medicinal plants used and how to diagnose. Other *ferraggat*, herbalists, knowledgeable older women and even pharmacists were mentioned as sources of knowledge about medicinal plants. Only one of them reported she had gone through a period of apprenticeship. Importantly though, in all cases permission and the gift of Baraka has to be given from another *ferragga* for a woman to become a *ferragga* herself. This gift and transfer of authority is sometimes materialized by a pinch of salt that is physically given, and will be kept and passed on. Only two *ferraggat* considered this unimportant and placed much more value on the plants themselves. Four *ferraggat* explained that they became healers unintentionally: when learning how to treat their own infants, they were passed the gift of Baraka from another *ferragga* and thus they accepted the moral obligation to treat other infants if mothers in need approached them.

At the time of this study, only one *ferragga* had already taught someone else, but this apparent lack of transmission to younger generations is partially misleading. Most *ferraggat* only started learning and practising when there was the perceived need for it, for example when the village *ferragga* was dying or moving out, so the *ferraggat* interviewed during the course of this study may still pass on their knowledge. Also, mothers that learn how to treat their children without the intention of becoming a *ferragga* may become healers in the future. However, many of *ferraggat* explained that young people are not interested in learning about *frigg*, a view that was shared by mothers. When discussing the possible lack of *frigg* specialists in the future, several informants were of the opinion that ailment-related beliefs will also change so people may just go to the hospital. Moreover, sanitation and hygiene conditions in rural Morocco could improve in the future, further reducing ailments treated by *frigg*.

5.4 Discussion

Cultural and socioeconomic background are well known factors driving health care seeking behaviour (File & McLaws, 2015; Granich et al., 1999; Nnko et al., 2015; Paulos et al., 2016). In Morocco, biomedical treatment of illness predominates: a high proportion of patients use only biomedical resources or combine traditional and biomedicine (Mateo Dieste, 2010; Obermeyer, 2000). According to Obermeyer (2000), Moroccan women's beliefs and healthcare practices during pregnancy and birth allow a coherent integration of traditional and biomedical practice. As for other folk ailments with personalistic aetiologies (Berlin & Berlin, 1996), including illnesses resulting from the evil eye (Weller et al., 2015), popular explanatory models for *taumist* and *iqdi* have personalistic aetiologies and demand the use of traditional specialists (Foster, 1976).

According to Foster (1976), personalistic aetiologies describe ailments caused by "the *active, purposeful intervention* of an *agent* who may be human (a witch or sorcerer), nonhuman (a ghost, an ancestor, an evil spirit), or supernatural (a deity or other very powerful being)" (p. 775, italics in the original), whereas naturalistic aetiologies "explain illness in impersonal, systematic terms". *Taumist* and *iqdi* are not often the result of purposeful supernatural interventions, being caused by exposure to the harmful "properties" of magical items such as talismans, to which infants are vulnerable. The binary distinction between natural and supernatural causes is etic; emic perceptions and classifications may rather be a gradient between the two extremes defined by Foster (1976), which has also been observed by Thomas et al (2009) regarding *susto* aetiology.

Ferraggat address illnesses in a context of shared beliefs about health and ailment causality, *i.e.* the contact of the child with sorcery. They are associated with Baraka, or divine blessing as the gift for healing, so perceived efficacy of *frigg* may be influenced by cultural constructs of efficacy (Bakker, 1993; Etkin, 1988a) and responses to meaning (Moerman & Jonas, 2002). Equally important, *ferraggat* in rural areas have personal relationships with their patients and can be readily available in case of need, so psychological aspects of healing can be enhanced, contributing to the perceived efficacy of their therapy (Kleinman & van der Geest, 2009; Kleinman et al., 1978; Waldstein & Adams, 2006).

Frigg includes a mixture of ritualistic and ethnopharmacological treatments, as is common for other folk ailments with personalistic aetiologies (Berlin & Berlin, 1996; Thomas et al., 2009). In the case of *susto*, phytochemical activity of oral plant remedies has been demonstrated (Bourbonnais-Spear et al., 2007) and yet these are not the most common form of treatment and are often used externally (Thomas et al., 2009). Species-rich mixtures such as *frigg* may be effective means to treat ailments with multifactorial causes, including gastroenteritis (Brendbekken, 1998; Leonti & Casu, 2013), and there is evidence for pharmacological activity for over half of the high use value plants used in *frigg* (Teixidor-Toneu et al., 2016a). However, narratives about the *frigg* practice suggest that specific plant species are not as important to achieve healing as the healing hand itself. Perceived efficacy could be independent of the possible pharmacological effects of the plants *ferraggat* currently use, and this may not be necessary to achieve healing when ailments are minor.

Medicinal plants seem to be a recent incorporation into this healing practise, replacing more ritualistic treatments. This shift to plant based remedies used in *frigg* is probably due to currently popular narratives on plant efficacy and the influence of Islamic reforms. Symbolic remedies such as coloured wools and blood are linked to pre-Islamic beliefs, nowadays considered *haram* practises forbidden by Islam. Herbal remedies are a currently accepted means of treatment, representing the fusion of nature with science (Schultes & Raffauf, 1990), and are acknowledged by religion (Elgood, 1962). The rise of a more orthodox Islam, enhanced religious education in rural areas and globalisation, are weakening the legitimising power of Baraka (Bakker, 1993), altering other local beliefs and practises in the High Atlas such as saint worship (Dominguez & Benessiah, 2015) or women's tattooing. Islam has also been observed to affect the symbolic framework of healing practices in other Muslim countries (Frazão-Moreira, 2016) and rhetorics about religious and scientific legitimacy are key for the continuous use of exorcism practices in Morocco (Mateo Dieste, 2015).

Local healing systems are dynamic, historically contingent, and embedded within social institutions and socioecological processes. Thus, practices and treatments can be influenced by contact with modernity, science and technology, as well as by religious reforms. Although, medicinal plant use as a means of healing is often viewed as the result of long indigenous experimentation with the environment, there is evidence for rapid change of herbal practises when communities come in contact with new cultures and plants (Albuquerque, 2006; Medeiros, 2013; Molares & Ladio, 2009b). For example, the Ese Eja elders testify that in recent memory healers cured without using or ingesting any plants; in this context the adoption of plants represents the acquisition of knowledge, power and agency from "outsiders" (Alexiades & Peluso, 2009). Similarly, Polynesians are thought to have had a limited herbal medicine tradition prior to European contact (Cox & Banack, 1991; Etkin & Meilleur, 1993; Palmer, 2004). The use of mixtures is ubiquitous in the High Atlas and Morocco in general (Bellakhdar, 1997; Teixidor-Toneu et al., 2016a). Mixtures of widely-available plants are easy to adopt and may function to legitimise the *ferraggat*'s practice in the context of modernisation and biomedical treatment, by a transference of cultural meaning from currently illicit symbols. Indeed, ritualistic elements from the *frigg* practice that are accepted by religion, namely the use of salt, are maintained.

Sociocultural changes can result in changing experiences of illness and their explanatory models, and acculturation can lead to their dismissal altogether (Geck et al., 2016; Volpato & Waldstein, 2014). Although no changes were observed in the conceptualisation of *frigg* because of strong beliefs in supernatural ailment aetiologies, schooling and exposure to biomedicine could have an effect of this kind in the near future. School attendance is negatively associated with medicinal plant use (Giovannini et al., 2011), presenting a discourse where village-based knowledge is perceived as backward (Pigg, 1992). This goes hand in hand with the narratives on the supremacy of biomedicine from healthcare professionals (Wayland, 2004; Whyte et al., 2002) effectively shifting local medical knowledge paradigms. Leonti and Casu (2013) predict that changes in explanatory models could reduce the effectiveness of traditional therapies, because their meaning is weakened. *Frigg* practice altogether could also experience a loss of meaning in future generations, as observed for *eghindi*, a culture bound syndrome among the Sahrawi (Volpato & Waldstein, 2014). This loss of meaning could go hand in hand with health amelioration among children due to better sanitation and hygiene. Ideas on health and illness seem more resilient than the use of specific plants in herbal remedies (Vossen et al., 2014). Whether there is a differential change in different aspects of *frigg* medicinal practice, with disease conceptualisation persisting whilst the object of meaning for treatment adapts, and should be the focus of future research. This could provide insights into the processes by which traditional medical systems adapt to sociocultural, economic and environmental changes.

5.5 Conclusion

An overview of *frigg*, a Moroccan healing practice not previously reported in the ethnomedical literature, has been detailed in the context of modernisation and contact with biomedicine. *Frigg* is used to treat mostly ailments with personalistic causes, and this drives mothers' to seek treatment from traditional healers who practise in a context of shared beliefs on health and illness. As common elsewhere, personalistic ailments need the intervention of a specialist healer, who not only uses medicinal plants but is also attributed particular skills that the biomedical systems lacks. Despite that biomedicine is currently available, preference of mothers to visit *ferraggat* for certain infant ailments persists, as observed for other illnesses in various cultures.

Contrary to the widespread view among ethnobotanists that medicinal plant knowledge is inherited for many generations and largely based on prolonged experimentation in one's environment, medicinal plants might have been recently adopted as the core for the *frigg* treatment. Southern Moroccan women and healers maintain folk conceptualisations of illness, but adapt treatments to match modern ideas, especially those stemming from new religious viewpoints. Use of medicinal plants is historically contingent and rather being used because of their medicinal properties, plants may serve to legitimise a treatment which a generation ago relied on apparently more symbolic remedies. This case study provides new insights on the dynamic aspects of traditional medicine and how sociocultural changes impact medicinal plant use, challenging widespread views about medicinal plant use being mostly based on cultures' cumulative knowledge from experimentation with the natural environment over multiple generations.

Chapter 6 Biogeographical patterns and the assemblage of medicinal floras

6.1 Introduction

Indigenous medicinal floras are largely shaped by people's floristic environment (Coe & Anderson, 1999; Inta et al., 2008; Ladio et al., 2007; Saslis-Lagoudakis et al., 2014). However, changes in local healing treatments may draw plants from the native medicinal flora or incorporate exotic species, which can be cultivated, imported, or be new invasive plants (Albuquerque, 2006; Harris, 2010; Medeiros, 2013; Pfeiffer & Voeks, 2008; Teixidor-Toneu et al., 2017; Touwaide & Appetiti, 2013; Van der Veen & Morales, 2015). Native plants remain the most significant component in medicinal floras of rural communities (Albuquerque, 2006; Molares & Ladio, 2009b), but cultivated plants, less frequent in number, can be the most important remedies (Ellen & Puri, 2016). The local floristic environment could be studied through plant biogeographical patterns and yet these have rarely been used to understand how local medicinal floras are assembled. Plant distributions could help explain the composition of local medicinal floras in at least two ways. Firstly, overrepresentation of taxa from specific biogeographical regions can be interpreted as a footprint of deep historical migrations (Leonti et al., 2003; Moerman et al., 1999). Secondly, many studies have proposed that medicinal plants often have widespread distributions (Ellen & Puri, 2016; Marshall & Hawthorne, 2012; Voeks, 2004), but systematic testing of this hypothesis is still limited (Cámara-Leret et al., 2017).

6.1.1 When people move they bring ethnobotanical knowledge with them

People's migrations entail the spread of cultural traits and traditional knowledge. The diffusion of major technological innovations in prehistory, such as the spread of farming through Europe, was probably linked to the movement of farmer populations (Ammerman & Cavalli-Sforza, 1971). Non-advantageous cultural, genetic and linguistic traits can be spread with demic flows (Ackland et al., 2007); migrant populations also carry botanical knowledge to the new environments where they settle (Campos & Ehringhaus, 2003; Medeiros et al., 2012; Pieroni & Vandebroek, 2007). Knowledge about medicinal plants can be maintained over long periods of time after migration, and over multiple migration waves (Pieroni & Gray, 2008; van Andel et al., 2012). Van Andel et al (2012) describe how the practice of drinking bitter tonics to enhance male sexual power and prevent disease by populations of African origin is still practiced by Caribbean migrants in Europe after two migratory events. According to Moerman et al (1999), similarities across Holarctic medicinal floras can be explained by the selection of similar plants by humans that first populated Eurasia and North America. Leonti et al (2003) found evidence to support this hypothesis; they observed that the Popoluca in Mexico inhabit a predominantly Neotropical environment, but their medicinal flora comprises more Holarctic elements. Migrants' knowledge can also transform medicinal floras in environments that are already populated. Contact with colonisers and their imported plants changed the medicinal floras of Hawaiians (Palmer, 2004) and the Ese Eja ethnic group in the Amazonia (Alexiades & Peluso, 2009). Similarly, Jernigan (2012) observed that medicinal plants used by Iquito speakers in the Peruvian Amazon changed after contact with mestizo settlers, with higher prestige given to non-native species. In a new environment, migrants continue to use of the original flora (if plants can be cultivated or imported, or are already present in the new environment), and they substitute medicinal plants from the original environment by plants in the new flora (Medeiros et al., 2012; van Andel et al., 2012; Volpato et al., 2009; Vossen et al., 2014), often using congeneric species (Voeks, 1990). Although there is a growing body of knowledge about medicinal plant selection by migrant populations, it mostly considers how medicinal plant use changes among the migrant populations themselves (Medeiros et al., 2012; Pieroni & Vandebroek, 2007). The effect of historically 'imported knowledge' relative to indigenous knowledge in local medicinal floras is still poorly understood, especially at deep time scales and when migrant and indigenous populations have coexisted and intermarried over centuries.

6.1.2 Medicinal plants have big geographic range sizes

Several studies observed that widespread species are often used medicinally. Cosmopolitan species are often more accessible or ubiquitous than plants with narrow geographical ranges, and plants with such characteristics are likely to be used medicinally (Lawrence et al., 2005; Lucena et al., 2007; Phillips & Gentry, 1993). These include many invasive and alien species (Pfeiffer & Voeks, 2008). Voeks (2004) observed that small-scale farming societies exploit disturbance vegetation, which provides familiar, accessible plants, rich in bioactive compounds. Disturbance vegetation is rich in pioneer and herbaceous species, found to be overrepresented in tropical African medicinal floras (Marshall & Hawthorne, 2012) and these tend to have widespread global distributions. Ellen and Puri (2016) noted that some of the most important medicinal plants across Southeast Asia are either cultivated, cosmopolitan or widely distributed. They call these remedies the 'core' medicinal flora (Ellen & Puri, 2016). Humans are dispersal agents of culturally important plants, cultivated or not (Cámara-Leret et al., 2017; Clement & Freitas, 2013; Meyer et al., 2012; Rangan et al., 2015; Zerega et al., 2004). Moreover, species with a wide distribution also characterise the pharmacopoeias of migrant people, since migrants can continue to use those plants found both in their homeland and new settlements (Medeiros et al., 2012; Voeks, 1990).

The effect of plant distribution size on medicinal plant selection has been tested recently for the first time in American palms (Cámara-Leret et al., 2017). The study finds that medicinal palms have significantly wider geographical ranges than non-medicinal ones, and this is attributed to the fact that widely distributed palms are more conspicuous. The authors also note that wider distributions imply that more people and cultures are exposed to a particular species, so the human-plant interaction is higher and cross-cultural knowledge transmission enhanced. However, high correlations between geographic range size and overrepresentation in medicinal floras could result from regional analysis bias; there is a higher chance to find medicinal uses for widespread species. If plants with wide distributions are also overrepresented locally is yet to be formally tested.

6.1.3 Aims

Morocco is an ecologically and culturally diverse country, with a medicinal flora resulting from a long history of cultural transmission through migration events and trade networks (Bellakhdar, 1997). Deep migration histories, such as the arrival of European Muslims, Arabs and sub-Saharan slaves in Morocco, have influenced the country's medicinal flora. After evaluating but not testing for the role of cultivated plants in the Moroccan medicinal flora, this chapter addresses the research questions: Are plants from any neighbouring biogeographical region overrepresented in the native Moroccan medicinal flora? And, are native Moroccan plants with wider areas of distribution more likely to be used medicinally? These questions are intertwined: biogeographical overrepresentation is hypothesised to be, at least in part, the result of migrating people continuing to use species (or their close relative or congenerics) if they encounter them along migration routes. I hypothesise that plants with distributions in the Saharo-Arabian floristic region will be overrepresented in the

Moroccan medicinal flora, and that Moroccan medicinal plants will be likely to have widespread distributions.

6.2 Methods

6.2.1 Data collection: floristic checklists and plant geographical distribution

A floristic checklist of all native and naturalised plants in Morocco was compiled from the *Flore Pratique du Maroc* (Fennane et al., 1999, 2007, 2015) at a species level (infra-specific taxa were considered at species level; Appendix 6.1). Species listed in the flora as doubtfully present in Morocco were not included in this study. Scientific literature on medicinal plant use in Morocco was compiled from peer-reviewed journals; a literature review was carried out in scientific databases (DOAJ, Google Scholar, PubMed, Science direct, and Scopus) using combinations of the keywords “medicinal”, ethnobotan*”, “Morocco” and “Maroc”. Studies were selected according to the following criteria: (1) they should have been carried out in Morocco, (2) the species list should be the result of ethnobotanical fieldwork, *i.e.*, not from bibliographical reivews, (3) studies should present complete checklists of the studied area, *i.e.* not only descriptions of plants used only for one or few ailments, and (4) studies should explicitly state that voucher specimens were collected and deposited in recognized herbaria. Unfortunately, poor taxonomic practices are common in ethnopharmacology and botanical names linked to a vouchered specimen are indispensable (Bennett & Balick, 2014; Rivera et al., 2014). Seven ethnobotanical studies were identified; botanical identifications and vernacular names for all medicinal plants listed were compiled and species were coded as native (or naturalised) in Morocco, and locally cultivated or imported (only spermatophytes; Table 6.1; Appendix 6.2). Botanical names were verified according to The Plant List (2013), and accepted species names and family assignments were used (APG, 2016). In the case of taxon names reported as unresolved by The Plant List, the names mentioned by the bibliographical sources were accepted. Plants with names not found in The Plant List (n= 6) were excluded from the analysis.

Table 6.1 Ethnobotanical studies from which data on the medicinal flora of Morocco were sourced.

Location	**Code**	**Language group**	**Phytogeographic region (as in the *Flore Pratique du Maroc*)**	**Reference**
Oriental Morocco: Provinces of Nador, Berkane, Taourirt, Jerada, Figuig and prefecture of Oujda-Angad	ORI	Moroccan Arabic and Tarifit	Mediterranean and Saharan (R, MA, Op, Om, Mc, SA, S)	Fakchich & Elachouri, 2014
Tanounate province	TAN	Moroccan Arabic and Tarifit	Mediterranean (NAt)	El-Hilaly et al., 2003
Ksar Lakbir district	KSA	(not recorded)	Mediterranean (NAt)	Merzouki et al., 2000
El Haouz province, rural commune of Imegdale	IME	Tashelhit	Mediterranean (HA)	Teixidor-Toneu et al., 2016b
Tata province	TAT	Moroccan Arabic and Tashelhit	Mediterranean and Saharan (AA, S)	Abouri et al., 2012
Errachidia province, rural commune of Tafilalet	TAF	Moroccan Arabic and Tamazight	Saharan (S)	El Rhaffari & Zaid, 2002
Errachidia province, Draa-Tafilalet region	DRA	Moroccan Arabic and Tamazight	Mediterranean and Saharan (HA, S)	Eddouks et al., 2017

Plant distribution within Morocco was coded at species level as presence or absence in the Moroccan phytogeographic regions following the *Flore Pratique du Maroc* (Figure 6.1; Fennane et al., 1999, 2007, 2015; Appendix 6.1). Regional plant distribution at genus level was coded as presence or absence in seven non-overlapping major phytogeographic regions based in Takhtajan (1986) and Valdés et al (2006). The Macaronesian, Western Mediterranean, Eastern Mediterranean, Euro-Siberian, Irano-Turanian, Saharo-Arabian, and Sub-Saharan (including Tropical) floristic regions were considered (Figure 6.2). Although some species in the Acacia-Argania dry woodland and succulent thicket in the Atlantic Moroccan coast are related to the Macaronesian flora on the Canary Islands (WWF, 2017), they are not considered part of the Macaronesian phytogeographic region here. Generic distributions were drawn from Mabberley (2008; Appendix 6.3).

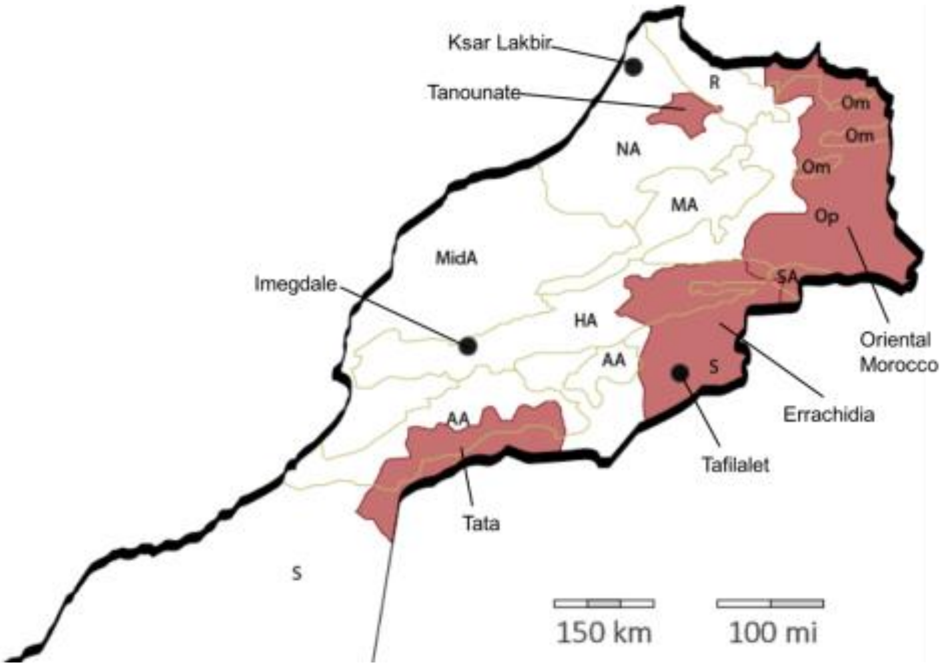

Figure 6.1 Delimitation of the phytogeograpic regions used to score species' areas of distribution within Morocco, based on the Flore Pratique du Maroc (Fennane et al., 1999, 2007, 2015). Phytogeographic regions are coded as: Rif (R), Mediterranean coast (Mc), Oriental mountains (Om), Oriental plains (Op), North Atlantic (NAt), Middle Atlantic (MidAt), Middle Atlas (MA), High Atlas (HA), Anti-Atlas (AA), and Sahara (S). The localities and regions where ethnobotanical studies have been retrieved from the literature are highlighted by a black dot or a dark area, respectively (see Table 6.1).

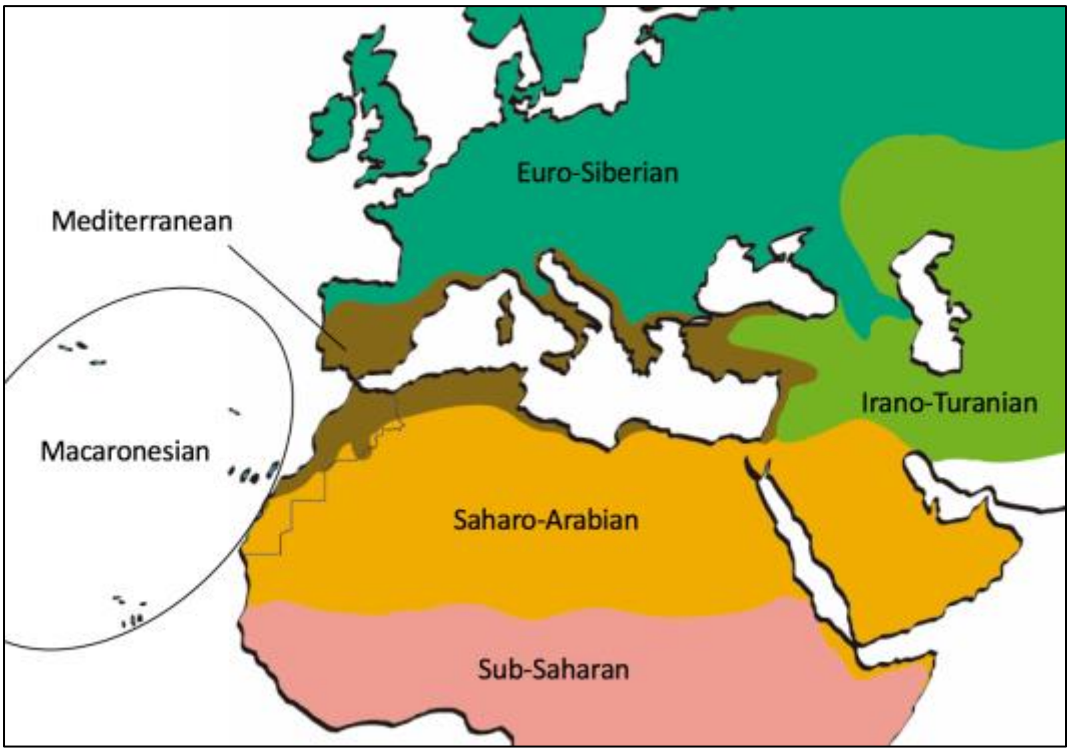

Figure 6.2 Delimitation of the phytogeograpical regions used to score regional genus distribution, based on Takhtajan (1986). The national border of Morocco is indicated (as acknowledged by its government, see Ethics).

6.2.2 Data analysis

6.2.2.1 Descriptive analyses

Ethnobotanical studies were compared to each other, quantifying the number of shared species including those that are locally cultivated in Morocco. The degree of similarity between sites was visualised through a non-metric Multi-Dimensional Scale analysis in R v. 3.2.3 (R Core Team, 2015) using the *isoMDS* function from the MASS library (Venables & Ripley, 2002), based on a Jaccard's positive match similarity matrix (Höft et al., 1999). Imported species were not considered, since they were not recorded in all studies and this could skew similarity.

6.2.2.2 Hypothesis testing

In this analyses, the list of medicinal plants compiled from the seven ethnobotanical studies was used (Appendix 6.2), imported and commonly cultivated species were not included. These plants have distributions resulting from human dispersal and management, hence would hamper results on selection of the native Moroccan flora by migrants. Naturalised invasive and alien species were not excluded. Correlations between (1) native Moroccan plant distribution and medicinal use, and (2) geographic range size and medicinal use were analysed using Logistic-Binomial Generalised Linear Models (GLMs). Logistic-Binomial GLMs are an extension of linear regression models that allow the dependent variable to be non-normal and binary, as it is the case here, with the dependent variable being medicinal use or not for each taxa (Gelman & Hill, 2007). Analyses were carried out in R v. 3.2.3 (R Core Team, 2015) using the function *glm()*. In order to validate the significance of the correlations, each GLM analysis is contrasted with a model that does not include the dependent variable (*i.e.*, random variability) by a likelihood ratio test (LRT) which evaluates the goodness-of-fit between two models using the method "LRT" in function *anova()* (*stats* package, R Core Team, 2015; Gelman & Hill, 2007).

The relationship between regional plant distribution and medicinal use was tested at generic level. The relationship between distribution within Morocco and medicinal use was investigated at species level. The Western Mediterranean biogeographical region was excluded from the regional analysis since most Moroccan plants are present in this region, and in order to avoid bias when testing for correlation between presence in the Saharo-Arabian floristic region and medicinal use, species only present and used in Saharan Morocco were excluded from the analysis. Hence, the ethnobotanical study carried out in Tafilalet (El-Rhaffari & Zaid, 2002) was not considered. Since multiple comparisons of medicinal use across regions were made, a Bonferroni correction was applied. The correction provides a conservative estimate of significance, minimizing the type I errors but can inflate type II errors (5% of significant uncorrected results may be type I errors). The relationship between distribution size and medicinal use was calculated using the frequency of occurrence of a genus or species in regional and national phytogeographic regions, respectively (Figure 6.1, 6.2).

All tests were repeated individually for each ethnobotanical study, considering the list of plants cited in that study and the local flora of the site where the ethnobotanical study was carried out. The local flora for each site was estimated using the plant distribution across phytogeographic regions in Morocco (Table 6.1, Phytogeographic region). Again, multiple comparisons were made and a Bonferroni correction was applied.

6.3 Results

6.3.1 The Moroccan pharmacopoeia: an overview

The seven ethnobotanical surveys cited a total of 493 medicinal plant species belonging to 305 genera and 78 families. The study carried out in Tafilalet (TAF) emerges as an outlier when compared to the other sites (Figure 6.3); the dataset analysed comprised 493 species of which seven species were cited in all studies, 28 in six, 30 in five, 29 in four, 34 in three and 91 in two and 274 were singletons. This study has more singletons and fewer medicinal plants shared with other studies (Appendix 6.2). Tafilalet is the only study located entirely in the Saharan floristic region. Although the Tata (TATA), Tafilalet-Draa (DRA) and Oriental Morocco (ORI) areas are also partially lying on the Saharan floristic province, their medicinal flora cluster with the ethnobotanical studies carried out in the Mediterranean. The Tafilalet study does not include cultivated medicinal plants, so shared use of cultivated species might account for the placement of Tata (TATA), Tafilalet-Draa

(DRA) and Oriental Morocco (ORI) with the Mediterranean studies. Although only two of the species shared among the seven studies (*Olea europaea* and *Rosmarinus officinalis*) are commonly cultivated in Morocco, 68% and 60% of the species shared by six and five studies are commonly cultivated, supporting the view that shared use of cultivated plants groups medicinal floras of all Moroccan sites other than Tafilalet (TAF).

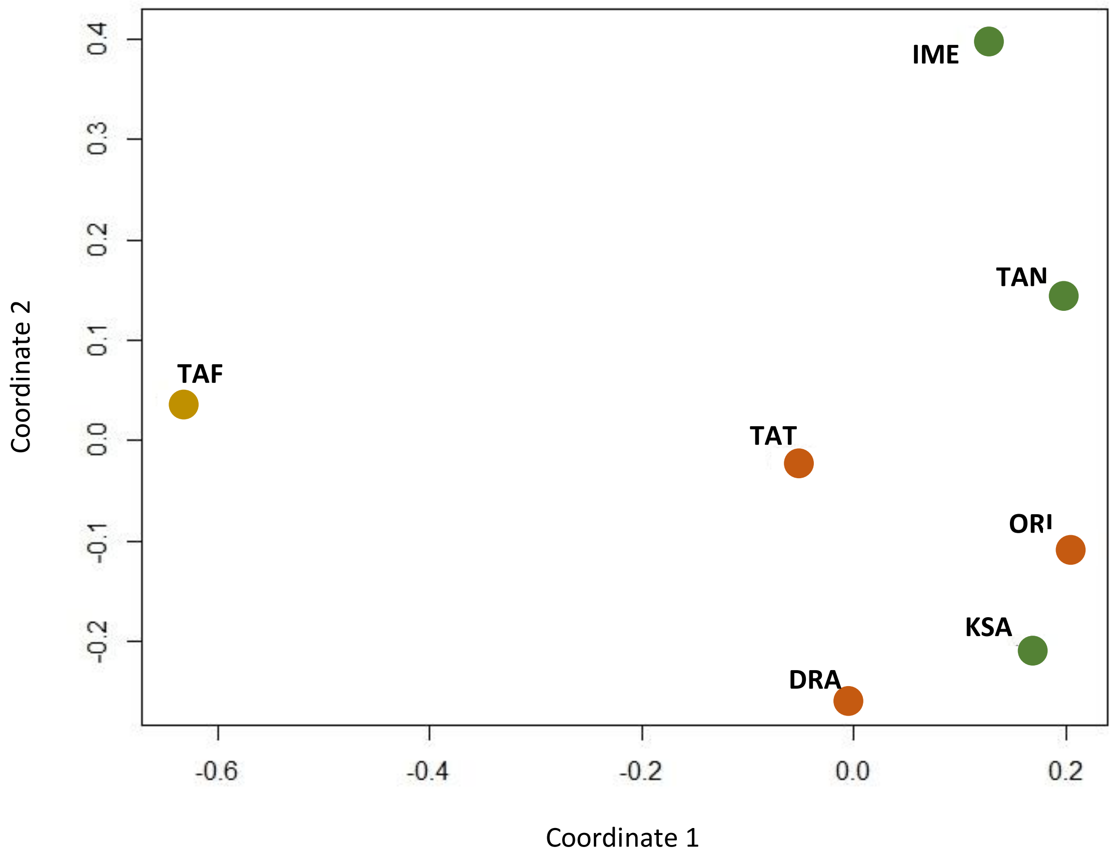

Figure 6.3 Non-metric Multidimensional Scaling analysis (stress = 0.0077); comparison of ethnobotanical studies. Sites have been colour-coded according to biogeographic regions. Studies in the Mediterranean are highlighted in green (Imegdale, IME; Taounate, TAN; Ksar Lakbir, KSA), studies both in the Mediterranean and the Saharo-Arabian regions in orange (Tata, TAT; Oriental Morocco, ORI; Tafilalet-Draa, DRA) and in the Saharo-Arabian region in yellow (Tafilalet, TAF).

6.3.2 Area of distribution does not predict medicinal plant use in Morocco

There is little variation in the percentage of non-cultivated native and naturalised Moroccan medicinal genera present in each global biogeographic region (Figure 6.4), and overall medicinal use in Morocco does not correlate with plant presence in any floristic region after Bonferroni correction (Table 6.2). However, Saharo-Arabian plants are significantly overrepresented in the medicinal flora of one ethnobotanical study in the Mediterranean region (Tanouate, El-Hilaly et al., 2003; Appendix 6.4).

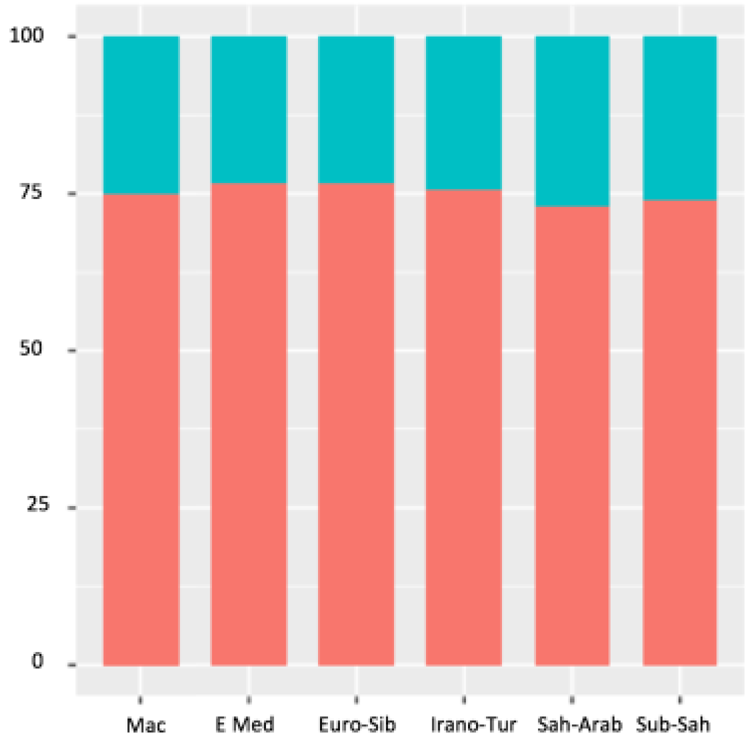

Figure 6.4 Percentage of Moroccan medicinal (in blue) and non-medicinal (in red) genera with distributions in the Macaronesian (Mac), East Mediterranean (E Med), Euro-Siberian (Euro-Sib), Irano-Turanian (Irano-Tur), Saharo-Arabian (Sah-Arab) and Sub-Saharan (Sub-Sah) floristic regions.

Table 6.2 GLMs summaries, including AIC and p-values; medicinal use is modelled by genera presence in regional biogeographic regions.

Floristic region	**Intercept (SE, p-value)**	**Coefficient (SE)**	**AIC**	**p-value**	**Bonferroni-corrected p-value**
Macaronesian	-1.3218 (0.0980, <2e-16)	0.2003 (0.1674)	976.13	0.2310	1.0000
E Mediterranean	-1.5606 (0.1697, <2e-16)	0.4021 (0.1921)	972.95	0.0364*	0.2184
Euro-Siberian	-1.3529 (0.1127, <2e-16)	0.1987 (0.1589)	975.98	0.2110	1.0000
Irano-Turanian	-1.3834 (0.1199, <2e-16)	0.2348 (0.1601)	975.38	0.1430	0.8580
Saharo-Arabian	-1.4037 (0.1045, <2e-16)	0.3741 (0.1613)	972.21	0.0204*	0.1224
Sub-Saharan	-1.3127 (0.0905, <2e-16)	0.2629 (0.1891)	975.66	0.1640	0.9840

6.3.3 Size of plant distributions and medicinal plant use

Plants with greater geographical range sizes are more likely to be used medicinally when taking into account all native and naturalised Moroccan plants and all medicinal plants recorded from multiple sites. Commonly cultivated species were excluded from this analysis to avoid bias, since their wider distributions can be due to human activity. There is a significant correlation between the size of the area of distribution, accounted for the number of floristic regions in which a genus is present, and the probability of a genus for being medicinal in Morocco (GLM, Fisher interactions = 4, p-value < 0.05, Figure 6.5(A); LRT p-value < 0.05). Such a correlation is stronger when considering medicinal plant use at species level and taking into account the breath of distribution within Morocco (GLM, Fisher interactions = 5, p-value < 0.001, Figure 6.5(B); LRT p-value < 0.05).

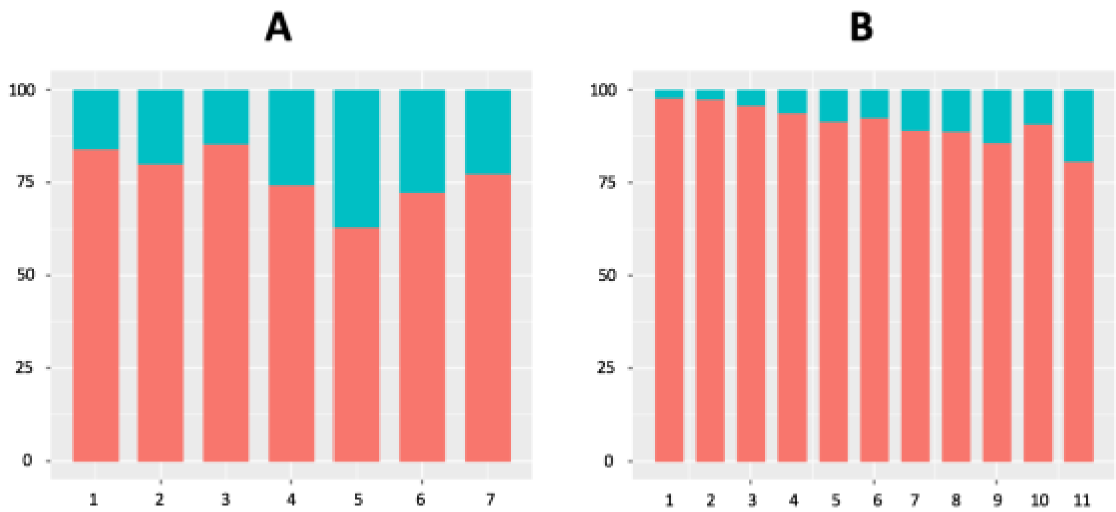

Figure 6.5 Percentage of Moroccan medicinal (in blue) and non-medicinal (in red) plants with distributions of different sizes. Distribution size has been calculated as presence in (A) one to seven global floristic regions considered at genus level (West Mediterranean, East Mediterranean, Macaronesian, Saharo-Arabian, Irano-Turanian, Euro-Siberian and, Sub-Saharan), and (B) in one to eleven floristic regions within Morocco at species level (Rif, Mediterranean coast, Oriental mountains, Oriental plains, North Atlantic, Middle Atlantic, Middle Atlas, High Atlas, Anti-Atlas, and Sahara).

However, this may an artefact of the higher chance of including plants with wider distributions when looking at regional medicinal floras. When tests were carried out for individual ethnobotanical studies, correlation between big distribution size and medicinal use was only significant in one out of seven cases at genus level globally, and in five out of seven cases at species level within Morocco (after Bonferroni correction; Appendix 6.4).

6.4 Discussion

6.4.1 Cultivated species confer homogeneity of regional medicinal floras

Cultivated species homogenise regional medicinal floras in Morocco as elsewhere (Ellen & Puri, 2016) and possibly allow for the transmission of botanical knowledge across communities (van Andel et al., 2015). Moreover, cultivated species constitute an important element of herbal remedies used by migrants (Medeiros et al., 2012; Kujawska & Pieroni, 2015; Voeks, 1990; Volpato et al., 2009) and their prevalence in the Moroccan pharmacopoeia could be due to the area's history of migrations. The one ethnobotanical study included in this review that did not record the use of widely cultivated and traded plants was an outlier in non-metric MDS (Tafilalet; Figure 6.3). Instead, people in Tafilalet (El-Rhaffari & Zaid, 2002) use a high number of local plants medicinally. The higher reliance on medicinal plants from the local flora in this oasis may be a response to the lack of use of crops and other cultivated medicinal plants commonly used as medicine elsewhere in Morocco. These include tree crops (*e.g.*, *Juglans regia, Ceratonia siliqua* and *Punica granatum*, vegetables (*e.g.*, *Allium sativum, Allium cepa, Zea mays, Daucus carota* or *Apium graveolens*, plants cultivated for their aromatic properties and often used in tea (*e.g.*, *Origanum majorana, Salvia officinalis* and *Mentha spicata*), or spices grown in Morocco and found in every marketplace (*e.g.*, *Pimpinella anisum, Trigonella foenum-graecum* and *Nigella sativa*)*.* It is unlikely that all these are not available for sale and used in the oasis of Tafilalet, especially since the use of these plants is recorded in the region (Eddouks et al., 2017), but the authors explicitly mention that a comprehensive ethnobotanical survey was carried out (El-Rhaffari & Zaid, 2002). Methodological differences could be hampering ethnobotanical comparisons (Albuquerque & Medeiros, 2012; Ellen & Puri, 2016).

Approximately two thirds of the medicinal plants shared across sites are species commonly cultivated and available in marketplaces. However, the Moroccan medicinal flora is highly diverse, with many medicinal plants being used only in small geographical regions. The high number of singletons observed in this comparison could be due to the turnover of botanical species being used under the same name in different sites. For example, the name of "al-berraztam" is used to refer to *Aristolochia paucinervis* in Merzouki et al (2000) and Teixidor-Toneu et al (2016b) and refers to *A. fontanesii* in El-Hilaly et al (2003) and Fakchich and Elachouri (2014). "Shih" is *Artemisia huguetii* in the Tata province (Abouri et al., 2012) and *A. herba-alba* in the High Atlas (Teixidor-Toneu et al., 2016b) and the north of Morocco (Fakchich & Elachouri, 2014; Merzouki et al., 2000). The maintenance of plant names with spatial species turnover could be enhanced by horizontal transmission of knowledge, especially through plant trade routes and in marketplaces. Powell et al (2014) observed that in Morocco plant knowledge and names are readily shared by villages accessing one common market place. In Tanzania, Otieno et al (2015) reported the homogenizing effect of trade, with traders, sellers and consumers using medicinal plant names in the dominant language. A similar scenario is likely in Morocco, where Moroccan Arabic is used for trade and business, connecting rural Amazigh speaking communities. Enhanced horizontal transmission of medicinal plant knowledge in market places and through trade routes could explain the significant overlap of the medicinal plants used across localities within the Mediterranean region, and to some extent, the similarity in the plant names used across the country.

6.4.2 Biogeographic footprint: Arab influence in the Moroccan medicinal flora

The processes contributing to the assemblage of local medicinal floras are complex and dynamic. Although important immigration events brought Arabian people and culture to the Maghreb, there is no overall overrepresentation of plants with Saharo-Arabian distributions in the Moroccan medicinal flora. This could result from an important horizontal knowledge transmission between the local populations and migrant communities, with the latter learning about local medicinal plants from indigenous inhabitants. Moerman et al (1999) explained medicinal plant similarities across Holarctic floras by the migration of peoples into unpopulated areas, yet Arab migrants settled into an already populated territory. Horizontal cross-cultural transmission from indigenous people has been observed to have an important role in the adaptation of migrant communities' medicinal floras (Camargo, 1994; Gispert & Gómez Campos, 1986; Lacuna-Richman, 2006). This could have been enhaced by intermarriage between Arab and Amazigh populations in Morocco (Bosch et al., 2000; El Ossmani et al., 2010; Mateo Dieste, 2012), which lead to cultural homogenization (Boyd & Richerson, 1991; Mace & Pagel, 1994). Moreover, it is likely that Arab migrations into the Maghreb were gendered biased. Some historical accounts record the movement of whole tribes from the Arabian Peninsula to the Maghreb, including women and children (recorded in the works of Ibn Khaldun; Pennell, 2003), but it is likely that most migrants were men due to the military nature of many of these migratory events (Chafik, 2005; Laroui, 1977). Medicinal plant knowledge in modern

Morocco and other Muslim countries is mostly held by women (Abouri et al., 2012; Al-Qethami, 2016; El-Hilaly et al., 2003; El Rhaffari & Zaid, 2002; Fakchich & Elachouri, 2014; Merzouki et al., 2000; Nawash et al., 2013; Teixidor-Toneu et al., 2016a). Hence, gendered biased immigration could have limited the maintenance of Arabian ethnobotanical knowledge in the new environment.

Although Arab migrants may not have maintained the use of plants similar to those in their native environments, there is a turnover of congeneric medicinal plant species between the Arabian Peninsula and the Maghreb. Examples include *sedr* or *assadra* which is used to refer to *Ziziphus lotus* in Morocco and *Z. spina-christi* in Saudi Arabia (Al-Qethami, 2016); *lkbar*, which refers to *Capparis spinosa* in Morocco and to *C. decidua* in Saudi Arabia; *Euphorbia resinifera* and *E. officinarum* are called “tikiut” in areas of Morocco and *E. balsamifera*, “tikedoha” in Saudi Arabia; and *Matricaria chamomilla* and *M. aurea* are called “babunj” or “babunaj” in Morocco and Saudi Arabia, respectively (Al-Qethami, 2016). Moreover, the Moroccan medicinal flora is highly influenced by beliefs and practices from the Arabo-Muslim medicine (Bellakhdar, 1997; Greenwood, 1981; Mateo Dieste, 2010; Merzouki et al., 2000). According to Merzouki et al (2000), “The diffusion of the Islamic religion [since the] 7th century AD completely upset the local traditional medicine of Moroccan autochthonous population”. The present herbal medical tradition in Morocco integrates classical Arabic medicine principles largely based on humoral theories, popular know-how, and magical-religious beliefs of supernatural causes of illness (Bellakhdar et al., 1991; Greenwood, 1981; Teixidor-Toneu et al., 2016a, 2017). For example, Groom (1981) describes the use of frankincense for forty days to protect a new-born from sorcery and the influence of jinn in the Arabian Peninsula, a practise still present nowadays in Morocco among Amazigh populations (pers. obs.). Moreover, many of the imported, cultivated and some non-cultivated medicinal plants used in Morocco are mentioned in Muslim texts including the Quran and the *Tibb-ul-Nabbi* (“Medicine of the Prophet”; Elgood, 1962), but also medieval Muslim treatises on botany and medicine (Greenwood, 1981; Merzouki et al., 2000), and their vernacular names are often loaned from Arabic. That some culturally important plants were cultivated or imported, and that there is no overrepresentation of Saharo-Arabian genera amongst the native and naturalised plants may reflect varying ethnopharmacological effects among different species and genera. Plants with effective or distinctive phytochemicals may be important enough to be traded and cultivated, whereas non-effective or easily replaceable ones are left behind when populations migrate to new environemnts. This idea is supported by the ‘diversification hypothesis’ proposed by Albuquerque (2006), which explains the use of exotic species as filling phytochemical gaps and having an enriching effect in local medicinal floras.

6.4.3 Geographic range size and medicinal plant selection

Many studies have highlighted the importance of widespread plants as medicines (Cámara-Leret et al., 2017; Ellen & Puri, 2016; Marshall & Hawthorne, 2012; Voeks, 2004). Many of these widespread species are cultivated or managed by people (Ellen & Puri, 2016; Voeks, 2004), and sometimes humans have been the dispersal agents of wild, culturally important plants (Rangan et al., 2015). There is little and inconclusive quantitative evidence for the overrepresentation of non-cultivated widespread plants in the Moroccan medicinal floras where globally widespread genera are overrepresented in the overall medicinal flora, but not necessarily locally in the medicinal floras of specific sites. This points towards a methodological bias in results from regional analyses. On the one hand, there is a higher chance of recording medicinal use of a widespread plant when including medicinal plant lists from various sites across a large area. On the other, analysis including plant distribution at genus level will necessarily inflate plant distributions, since generic distributions include many non-local species. Site-based, species level analyses do not have such methodological issues. Plant species with wide distributions within Morocco are often locally overrepresented in medicinal floras (Appendix 6.4), which could be due to preference for accessible or ubiquitous plants, but also to enhanced cultural transmission of knowledge, as suggested by Cámara-Leret et al (2017) and observed by Powell et al (2014).

6.5 Conclusions

As ethnobotanists consider meta-analysis to address broad questions, there is an increasing interest in identification and understanding of patterns of medicinal plant use at regional and global scales (Albuquerque & Medeiros, 2012; Ellen & Puri, 2016; Waldstein & Adams, 2006). Defining appropriate scales and units of analysis is crucial for meta-analysis of ethnobotanical data. Quantitative analyses carried out in this study evidence the importance of understanding the implications of working at different scales (*i.e.*, genus or species level), since they can provide disparate results.

As observed elsewhere (Ellen & Puri, 2016), cultivated species are important elements of the Moroccan medicinal flora. Cultivated and imported species were possibly a more important adaptation mechanism by Arab migrants in Morocco than the selection of different plants in the new environment similar to those used in their areas of origin. This could have enriched the local medicinal flora with new phytochemicals. Cultivated plants have widespread distributions and are shared cross-culturally in the Mediterranean through historical commercial relations.

Selection of Moroccan native or naturalised species similar to those used in the Arabian Peninsula, where Arab migrants originated from, would not have been necessary if interaction with indigenous populations facilitated the transmission of local medicinal plant knowledge. That a regional footprint reflecting plant distribution and peoples' migration was not revealed in this study contrasts with the observations of Moerman et al (1999) and Leonti et al (2003). These studies were concerned with migrations into unpopulated areas; presence of indigenous populations allow for the opportunity to adopt and adapt to local medicinal practices, and the impact of migrant plant preference may not be retained across generations. This might be especially the case in Morocco because populations are so homogenised.

This chapter brings new quantitative ethnobotanical methods to test the hypothesis that widespread plants are important elements of local medicinal floras. Under a migration scenario, selection of widespread plants or those with specific distributions and are strongly interlinked. Without finding evidence for preference for plants with particular distributions, preference for widespread species might not be expected. Even with no migration footprint, overuse of widespread species remains because there are explanations, beyond exposure to plants as knowledge and people migrate, that drive their adoption.

Chapter 7 General discussion and conclusions

7.1 The outset of this research project

The aim of this to study is to understand the effect of medicinal plant knowledge transmission in the evolution of medicinal floras. Such an ambitious endeavour could be addressed in several ways, but this project was devised to bridge between ethnographic and meta-analytical approaches and between medical anthropology and quantitative ethnobotany (Waldstein & Adams, 2006). Studying local knowledge is complex, since it entails information, skills and beliefs, is contextual, dynamic and intrinsically variable among individuals and communities (Ellen, 1996; Etkin, 1988b; Etkin & Elisabetsky, 2005; Heinrich et al., 2009), and knowledge about medicinal plants is further constrained by the floristic environment and plant availability (Ladio et al., 2007; Lucena et al., 2007; Saslis-Lagoudakis et al., 2014). Ethnographic and anthropological methods have been traditionally used to study plant use (Alcorn, 1981; Ellen, 1996; Etkin, 1988b), but addressing the evolution of medicinal floras is beyond the scope of field-based approaches and can benefit from comparative studies at regional and global scales (Albuquerque & Hanazaki, 2009; Etkin, 1988b; Waldstein & Adams, 2006). However, quantitative, comparative methods in ethnobotany are still being developed (Albuquerque & Hanazaki, 2009). Medicinal plant knowledge in ethnobotanical or ethnopharmacological studies is often databased as bare botanical lists, so that illness explanatory models (*sensu* Kleinman, 1978), which can be accurately defined only after in-depth fieldwork experience with a community, are ill defined if mentioned at all (Etkin, 1988b; Etkin & Elisabetsky, 2005). This study benefits from first-hand experience in the documentation of medicinal plant knowledge in the context of local explanatory models of illness, before attempting to carry out a regional comparative analysis of the medicinal plants used in Morocco. Field experience and results have proved to be key to the interpretation of the literature-based meta-analysis carried out in this thesis.

7.1.2 Choosing a fieldwork site, or being chosen by one: From Nepal to Morocco

Understanding the processes of transmission of knowledge between cultures as a key process in the evolution of local medicinal floras was the research aim at the outset of this study. Initially, Nepal was the targeted area, since it is a culturally diverse area (Gaenszle et al., 2015; Loh & Harmon, 2005; Maffi, 2005) with a relatively well-documented medicinal flora (Kunwar et al., 2011; Manandhar, 2002). However, setting up the fieldwork experience was challenged – a process from which I learnt about the importance of trustworthy collaborations and the need to adjust research ambitions with time limitations. In a fortunate turn of events, it was possible to conduct the research project in Morocco, an area that could not have had a more different cultural landscape. Whereas several societies, each speaking a different language, coexist in small geographical spaces in Nepal (Gaenszle et al., 2015), Morocco has been a melting pot for peoples and cultures for centuries (Mateo Dieste, 2012; Pennell, 2003). In Nepal it would have been possible to compare culturally distinct communities in the same floristic environment and asses the effect of ancestry and cross-cultural transmission of medicinal plant knowledge, which is not possible in Morocco. Although populations of Amazigh and Arabic descent are identified, centuries of intermarriage and cultural exchange have resulted in cultural homogenisation. Therefore, the research question was adjusted and emphasis was put in understanding medicinal plant knowledge transmission processes within a community and a syncretic culture.

7.1.3 Some considerations on documenting medicinal plant knowledge in Morocco

Insufficient and inadequate documentation of medicinal plants, including appropriate botanical identification of species (Bennett & Balick, 2014; Rivera et al., 2014), can hamper comparative studies in ethnobotany (Albuquerque & Hanazaki, 2009; Cámara-Leret et al., 2014; Ellen & Puri, 2016; Heinrich et al., 2009; Leonti & Weckerle, 2015; Medeiros et al., 2014). The literature review conducted during this research identified only seven peer-reviewed articles adequate for comparative analysis, including my own (Chapter 3; Teixidor-Toneu et al., 2016a, 2016b). Studies had disparate ways of classifying therapeutic applications of plants, which restricted further analysis to the similarity among plant lists (Heinrich et al., 2009; Staub et al., 2015).

The study of medicinal plant use demands the evaluation of the floristic environment; inadequacies or lack of floristic data can further difficult analysis (Weckerle et al., 2011, 2012). Although a comprehensive Flora of Morocco was completed in 2015 (Fennane et al., 2015), botanical collection bias has been observed in Morocco (Skipper, 2016), which could result in biased results from ethnobotanical meta-analysis carried out here.

7.2 Medicinal plant use and transmission of knowledge: insights from this thesis

7.2.1 Understudied peoples and aspects of the Moroccan medical system

This thesis has contributed to the documentation of aspects of traditional medicinal plant knowledge in Morocco that had been omitted by the literature so far. On the one side, a comprehensive study of the medicinal plants used by Tashelhit-speaking communities in Morocco was published for the first time as a result of this research (Chapter 3; Teixidor-Toneu et al., 2016b). Although it is often impossible to tease apart Arab and indigenous Moroccans genetically and culturally (Bosch et al., 2000; El Ossmani et al., 2010; Mateo Dieste, 2012), Amazigh identity is an important aspect of Moroccan diversity often associated with language (Hoffman, 2007) and overlooked by academic studies in Morocco (Crawford, 2002). On the other, the main health care resource to local and many urban mothers to treat their sick children, namely *ferraggat*, had escaped medical anthropology reports on Moroccan healing systems (Bellakhdar, 1997; Mateo Dieste, 2010; Bakker, 1993) and I have reported a full account of their practice in this thesis (Chapter 5; Teixidor-Toneu et al., 2017). This enhances the understanding of the pluralistic nature of healing and healthcare seeking behaviour in Morocco.

7.2.2 Medicinal plant use in context

Medicinal plant use reported in this thesis was analysed and described within the context of the local ethnobotanical knowledge and folk plant classification system (Chapter 2), local illness explanatory models (Chapter 3 and 4; *sensu* Kleinman, 1978), and healthcare seeking behaviour (Chapter 4 and 5). Variation among individuals was also reported and analysed (Chapter 4), providing the necessary background to understand processes of transmission of knowledge and trends of change.

Vernacular plant names are an emerging tool to understand plant use patterns and process of transmission of ethnobotanical knowledge (Bostoen et al., 2013; Rangan et al., 2015; Smith, 2011; van Andel et al., 2014) and, although they have not been used for this purpose during this research, I have explored their potential as a lens to look into the life of a rural community (Chapter 2). Such an insight into local livelihoods contextualises the focus of this thesis, namely medicinal plant use.

As observed by Etkin (1988b), medicinal plant use is dependent on cultural constructs of efficacy (Etkin, 1988a; Moerman & Jonas, 2002; Ortiz de Montellano, 1975), local plant selection and classification systems (Berlin, 1973; Berlin et al., 1973), as well as culture-specific preparation and administration modes (Hsu, 2010). This is also the case in Morocco (Chapter 3 and 5; Teixidor-Toneu et al., 2016a; 2017), where aspects of medicinal plant knowledge such as the prevalence of roots or the widespread use of mixtures can be explained through culture-specific beliefs or knowledge patterns of variability among community members. Moreover and importantly, in the context of globalisation and modernisation of rural Morocco, the practice of home herbal medicine is being to some extent replaced by biomedical treatments when these are available (Chapter 4).

7.2.3 Socioeconomic and religious change

Morocco proved to be an interesting study area due to the rapid cultural changes that are taking place, which are not only socioeconomic, but also religious. I had the opportunity to observe changes in medicinal plant use and its knowledge transmission, and access the local memory pool for information about changes undergone since the previous generation (Chapter 5). Medicinal plant knowledge is indeed context dependent, as evidenced by the adaptation of healing treatments following cultural change (Chapters 4 and 5). A key result from this thesis is the evidence that this change is constrained by the disease aetiologies that are treated by medicinal plants. Although, preference for biomedical treatment seems to be sweeping away medicinal plant use in rural Morocco, when available and affordable (Chapter 4), diseases believed to have supernatural causes still treated by local specialists able to heal in a context of shared ideas of health and disease (Chapter 5; Kleinman, 1978; Kleinman et al., 1978). Prince et al (2001) and Quinlan and Quinlan (2007) note that components of a medicinal system will be replaced when more effective equivalents are introduced, but results from this thesis illustrate the complexity of this replacement process: individual remedies, depending on the folk ailments they treat, will be abandoned or replaced according to the available options and knowledge at any particular time. When available, biomedicine could be preferred or be used alongside herbal remedies to treat some ailments (Calvet-Mir et al., 2008; Giovannini et al., 2011; Mateo Dieste, 2010; Prince et al., 2001), but culturally bound syndromes and ailments with personalistic aetiologies are preferably treated by local medicine (Foster, 1976; Teixidor-Toneu et al., 2017; Thomas et al., 2009; van Andel & Westers, 2010; Volpato & Waldstein, 2014; Vossen et al., 2014).

7.2.4 Decoupling of change between treatments and beliefs

The results from both the ethnographic enquiry and the meta-analysis point to maintencance of health beliefs but change in treatments (Chapter 5 and 6). Whilst in changing contexts treatments may quickly adapt to incorporate easily available, legitimate remedies, with preference for those that are associated with status and prestige (Alexiades & Peluso, 2009; Jernigan, 2012; Palmer, 2004; Teixidor-Toneu et al., 2017), beliefs around health and illness, such as the interference of supernatural beings (*lariah* and *jinni*) or the effects of evil eye, can be maintained (Teixidor-Toneu et al., 2017). This results in the loss of functionality of some but not all remedies or aspects of local knowledge, leading to an incomplete inter-generational transmission of knowledge and skills (Ohmagari & Berkes, 1997) and to the ready adoption of non-native plants at the expense of using the local flora after contact between indigenous and colonizing communities (Albuquerque, 2006; Harris, 2010; Jernigan, 2012; Medeiros, 2013; Palmer, 2004; Pfeiffer & Voeks, 2008). Although I observed no overrepresentation of Saharo-Arabian plants in the Moroccan flora (Chapter 6), Arabo-Muslim beliefs have shaped medicinal concepts in the Maghreb (Bellakhdar, 1997; Greenwood, 1981; Mateo Dieste, 2010; Merzouki et al., 2000). There is a perception that medicinal plant knowledge and local medicinal floras archaic, resulting from cumulative cultural transmission and long experimentation with the environment (Leonti et al., 2015; Salali et al., 2016) and that medicinal plants are healing treatments used for thousands of years in many cultures (Gewali, 2008; Harper, 2009; Touwaide & Appetiti, 2013), but this thesis provides evidence that medicinal plant use adapts rapidly to cultural and environmental change.

7.2.5 Inference of historical contribution of migrant peoples and migrant plants

In Chapter 6, I put forward the idea that selection of similar, familiar medicinal plants is not the prevailing adaptative strategy used by migrants faced with new floristic environments when they move into an already populated territory (Medeiros et al., 2012; Pieroni & Vandebroek, 2007). Although there is evidence of the continuous use of medicinal plants available in Saharo-Arabian and Mediterranean environments and replacement by congeneric species (Chapter 6), cultivation and import of species by migrants may have had a bigger impact in the Moroccan medicinal flora than selection of congenerics present in both environments. In Morocco, the culturally and genetically important Arab migration did not leave a footprint in the medicinal flora by overrepresentation of Saharan floristic elements. This contrasts with the observations by Moerman et al. (1999) and Leonti et al. (2003), possibly due to the fact that in Morocco, migrants moved into an already populated territory, and cross-cultural, horizontal knowledge transmission facilitated migrants' adaptation to the local flora. This contributes to the understanding of the adaptation of migrant populations to new environments (Medeiros et al., 2012; Pieroni & Vandebroek, 2007; van Andel et al., 2012) at deeper time scales, highlighting the importance of importation and cultivation of culturally important plants (Medeiros et al., 2012; Voeks, 1990; Volpato et al., 2009), which can contribute to the homogenisation of medicinal floras (Ellen & Puri, 2016).

The development of syncretic and pluralistic medicine is common across the world and throughout history when different medicinal knowledge systems are in touch (Bussmann et al., 2007; File & McLaws, 2015; Greenwood, 1981; Leslie, 1980; Mateo Dieste, 2010; Obermeyer, 2000; Prince et al., 2001; Salick et al., 2006; Soldati & Albuquerque, 2012; Stoner, 1986; Touwaide & Appetiti, 2013; van Andel & Westers, 2010) and it impacts local treatments by the incorporation of plants from different regions and cultures in local medicinal floras (Harris, 2010; Jernigan, 2012; Palmer, 2004), a process likely to be underpinned by perceptions of legitimacy and status (Teixidor-Toneu et al., 2017). Local healing systems in Morocco are syncretic (Bakker, 1992; Greenwood, 1981; Mateo Dieste, 2010), and so is the selection and use of medicinal plants. The Moroccan medicinal flora incorporates spices and traded Arabian and Asian products associated with status in the past, when only available to the high social strata (Van der Veen & Morales, 2015), and plants cited in religious texts (Chapter 3).

7.3 Pattern and process: cross-fertilisation of ethnographic and meta-analysis approaches

The research presented in this thesis benefits from cross-fertilisation between ethnographic and meta-analysis approaches in ethnobotany. Understanding of the cultural and medicinal context in which herbal remedies are used, and insight and observation of on-going processes of transmission of knowledge proved key to the interpretation of meta-analysis results. Furthermore, the evaluation of patterns of use from published data and through meta-analysis, allowed for the inference of processes of transmission at deeper timeframes and broader geographical scales.

Studies that integrate both qualitative and quantitative methods can be useful to address complex problems in ethobotany because they allow for understanding processes at different time and spatial scales (Albuquerque & Hanazaki, 2009). As in evolutionary biology, micro and macro ethnobiological approaches could be distinguished to refer to direct observation and inference from patterns, respectively (Ridley, 1997). This thesis applies both approaches. Direct observation of transmission of knowledge (Chapters 4 and 5) provided insights into the factors modulating change in local healing strategies and medicinal floras in Morocco, and processes of cross-cultural transmission were inferred from the interpretation of plant use patterns at broader spatial scales and deeper time frames (Chapter 6).

7.3.1 Developing methods where there are none: A new biogeographic approach

Ethnobotany is striving to develop quantitative methods to address hypothesis-driven questions (Albuquerque & Hanazaki, 2009; Phillips, 1996; Reyes-García et al., 2007; Tardío & Pardo-de-Santayana, 2008), which are often borrowed or inspired from the mother disciplines of botany and anthropology. Here I have drawn from concepts in biogeography and proposed a simple analytical tool exploring Generalised Linear Models to quantify overrepresentation of plants from specific biogeographical areas in a medicinal flora for the first time (Chapter 6). In order to have a better understanding of the impact of plant biogeography and human migrations on the assemblage of medicinal floras, these methods could be applied to other floras and cultural contexts. I propose a comparative study that uses the Moroccan case study as a start point, to investigate the impact of plant biogeography and human migration in different floristic environments and population histories.

7.3.2 Studying the evolution of medicinal floras: ways forward

The challenge of integrating information about cultural context with the multiple factors that can drive changes in medicinal floras may have delayed the development of theory-driven approaches. An unexplored alternative would approach the evolution of medicinal floras in a cultural evolutionary framework, using phylogenetic comparative methods to understand change of a wide range of cultural traits describing medicinal plant use (Mace & Pagel, 1994). Although evolutionary principles have underpinned biological research for over a century, they have only recently been applied to anthropology and the social sciences. Phylogenetic comparative methods, adapted from evolutionary biology, and the increasing availability of language phylogenies, are providing new insights into cultural change and evolution (Gray et al., 2007; Kirby et al., 2016; Mace & Pagel, 1994; Mace & Jorndan, 2011; Nunn, 2006; Watts et al., 2015, 2016). From the study of Iranian textiles (Matthews et al., 2011) to Polynesian canoes (Rogers & Ehrlich, 2008), evolutionary anthropologists are studying the evolution of material culture within a phylogenetic framework, an approach that also allows for the analysis of social and religious change (Matthews et al., 2016; Watts et al., 2015, 2016). Local medicine could be analysed in a similar manner; use of herbal remedies along with other aspects of local healing systems could be coded as cultural traits and phylogenetic methods could be used to explore traits' evolution. This would allow for the integration of aspects of the local illness explanatory model (*sensu* Kleinman, 1978) into quantitative analysis, as well as accounting for cultural histories at deep time scales. Ideas on health and illness, including aetiology beliefs, might be more resilient than the specific treatments themselves, especially across floristic boundaries.

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List of Appendices

Appendices are provided on digital format; an SD card is attached at the end of this thesis.