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Ethnobotanical survey of medicinal plants used by nomadic peoples in the Algerian steppe

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Abstract

Ethnopharmacological relevance

This study is the first ethnobotanical survey focusing on the herbal medicines traditionally used by the nomadic community of the Algerian steppe, identifying new medicinal plants and uses from one of the most characteristic indigenous populations in Algeria. Moreover, the study contributes to the understanding of transmission of medicinal plant knowledge in the Mediterranean basin.

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This work aims to document the phytotherapeutical knowledge and practice of the nomadic community of the Algerian steppe, and compare it with neighbouring sedentary populations and Mediterranean historical texts. Through this, the study strives to evaluate processes of transmission of knowledge among this population, for whom written sources have been largely unavailable.

Methods

Ethnobotanical surveys were carried out during two years (2015-2017). In total, 73 informants from nomadic populations were interviewed in several steppe regions including areas in the administrative departments of Tiaret, Saida, Naama, Djelfa and M'sila. Structured interviews about medicinal plant knowledge were combined with guided tours with the informants. Prior informed consent was always obtained. The surveys allowed for the collection of sociodemographic data and traditional knowledge about medicinal plants and their uses. Informant Consensus Factor (F_{IC}) was calculated to evaluate agreement among informants. Results were compared to existing literature to evaluate similarities between this nomadic medicinal flora, that of neighbouring communities and historical texts and identify new plant citations and uses.

Results

Among Algerian nomadic communities, herbal remedies are used mostly by women and elders, who are often illiterate. We identified 97 taxa of medicinal plants belonging to 42 botanical families, importantly Lamiaceae, Asteraceae and Apiaceae, like in neighbouring communities. The most common plant parts and method of preparation are also shared with neighbouring populations. New uses are described for 25 known medicinal taxa, and nine species with undocumented medicinal uses in recent literature have been reported. However, some of these have been reported in Mediterranean *materia medica*. In total, 60% of the medicinal plant diversity used by Algerian nomads are well-known plants of the Mediterranean ethnopharmacological heritage.

Conclusion

This study highlights the importance of traditional medicine for Algerian nomad communities. This indigenous population has specific knowledge about plants from their steppe environment, but also shares a pool of knowledge with sedentary Algerian populations and Mediterranean people as a whole. Our research shows that a common North African and Mediterranean ethnobotanical heritage exists.

Medicinal plants used by nomadic populations in the Algerian steppe

- 5 provinces
- 38 camps
- 73 informants
- 91 medicinal plants

Steppe

- Culturally important plants: *Mentha spicata* L., *Artemisia herba-alba* Asso., *Juniperus phoenicea* L.
- New uses for 25 known medicinal taxa
- 13 newly reported medicinal plants
- 60% of the plants reported in Mediterranean *materia medica*

Abbreviations

FI_C, Informant Consensus Factor; **GCPH**, General Census of Population and Housing; **HCDS**, The High Commission for the Development of the Steppe team; **ISE**, International Society of Ethnobiology; **NOH**, National Office of Statistics; **TPL**, The Plant List; **UR**, Use Reports.

Keywords: Algeria, herbal remedies, nomads, steppe, traditional medicine

1. Introduction

With more than 3139 species (Quézel and Santa, 1962-63), the Algerian flora is one of the richest of North Africa. Together with its biodiversity richness, Algeria has a long and rich herbal medical tradition (Farid, 2011; Scherrer et al., 2005 in Boughrara and Belgacem, 2016). In this country, phytotherapy is an integral part of local culture (Bouasla & Bouasla, 2017) that, to a great extent, has not been written down and continues to be transmitted orally between generations (Baba Aissa, 1991; Bouasla and Bouasla, 2017). Herbal medicine in Algeria stems from Arabic-Islamic medicine, which combines Prophetic with Galenic humoral medicine (Greenwood, 1981). It is practiced both by professional herbalists and healers based at urban centres, but also transmitted orally and practiced by the lay population. Since colonial times, biomedicine is also increasingly available and used in Algeria (WHO, 2015).

Phytotherapy in Algeria has been studied since the colonial period (before 1962), including some pioneering studies include Fourmet and Roque (1946). Ethnobotanical studies continued after the independence through the publication of guides and books (Aït Youssef, 2006; Baba Aissa, 1991; Beloued, 1998). Recently, several ethnobotanical research studies have been published with the aim of documenting Algeria's medicinal plant knowledge and use (Benarba et al., 2015; Bouasla and Bouasla, 2017; Boudjelal et al., 2013; Chermat and Gharzouli, 2015; Lakhdari et al., 2016; Meddour and Meddour, 2015; Miara et al., 2013; Ouelbani et al., 2016; Rebbas et al., 2012).

However, many geographical regions and ethnic communities in this country have still not been ethnobotanically explored due to the country's large surface and diversity. Of special interest is the knowledge of nomadic populations, found to maintain specific medicinal beliefs, knowledge, practices in North Africa.

Algerian nomadic communities are thought to have much knowledge and experience regarding medicinal plant use. Among Algerian indigenous communities, nomads practice constant displacement linked to livestock breeding practices. In total, 230 000 nomads are estimated to live in Algeria (NOH, 2008), including people from the two main nomadic communities: Tuareg populations in the Sahara, and Arabic-speaking nomads in the steppe highlands (Guillermou, 1990). These Arabic-speaking nomads live in the semi-arid steppe regions lying between the Algerian Tell Atlas and the Saharan Atlas. This biogeographic portion constitutes the high steppe plains of Algeria characterized by large areas of herbaceous and shrubby plants for pastoral grazing (Fig. 1). The steppe vegetation is dominated by *alfa* (*Stipa tenacissima* L.) occupying four million hectares, and *chih* (*Artemisia herba-alba* Asso) with three million hectares, followed by *sennagh* (*Lygeum spartum* L.) and *guettaf* (*Atriplex halimus* L.), which grow together in one to two million hectares. The rest is occupied by various vegetation associations (*Aristida pungens* Desf., *Thymelaea microphylla* Coss. & Durieu ex Meisn., *Retama raetam* (Forssk.) Webb, *Artemisia campestris* L., *Arthrophytum scoparium* (Pomel) Iljin ex Emb. & Maire and *Peganum harmala* L.; Nedjimi and Guit, 2012).

Nomadic steppe populations are pastoralist herders that practice both nomadism, which implies the displacement of the whole family, as well as transhumance, which concerns only the shepherd and his flock. Nomadism in the Algerian steppe highlands is based on a rational management of space and time through two essential movements: the *achaba* consists in taking the herds to the Tellian zones (Tell Atlas) during the three to four months of summer, and the *azzaba* is the movement of pastoralists and their livestock to the northern foothills of the Saharan Atlas during three months of winter (Nedjraoui, 2003). These livelihoods are adapted to arid environments and help maintain the production of ecosystems vulnerable to drought (Baumann, 2009). These particular movements have led these communities to acquire utilitarian knowledge about diverse steppe vegetation, notably the pre-forest formations of the Tell as well as the steppe and halophile vegetation of these regions.

These nomad communities often need to be self-sufficient for food as well as human and veterinary health care. No herbalists or professional healers are found among these communities, but lay people acquire knowledge on herbal medicine in informal ways throughout their life. In case of emergency, nomads take their sick to the closest public health centre or hospital, which may be several hours away from the camp. Nomadic communities also rely on plant diversity and

production as fodder for their herds, and their movements depend on fodder plant availability. This inextricable dependence to the vegetable world makes knowledge of plants and their uses crucial to the nomadic community's livelihoods. Currently, trends of sedentarisation have significantly reduced the number of nomads in Algeria (Belloum and Dekhil, 1993). In North Africa, it has been shown that this phenomenon involves the loss of ethnobotanical knowledge (Blanco and Carrière, 2016; Volpato & Waldstein, 2014). Thus, urgent action is needed to maintain biocultural diversity threatened with extinction if nomadic livelihoods disappear.

This study does not only strive to document medicinal plant diversity used by the nomadic Arab-speaking community of the Algerian steppe, but also to compare their knowledge to that of sedentarised communities and Mediterranean *materia medica*. Through this comparison, we identify new plants and medicinal uses, and we enquire about processes of transmission of knowledge about medicinal plants in nomadic communities. Leonti et al. (2009) observed that herbal practices in southern Italy were strikingly similar to Dioscorides *de materia medica*. In China, the distribution of medicinal plant books among rural populations resulted in medicinal plant knowledge in rural areas being strongly influenced by mainstream Chinese medicine (Weckerle et al., 2009). Leonti (2011) argued that written texts including historical *materia medica*, popular books on plant use, and other written sources, condition oral ethnobotanical knowledge and render ethnopharmacological practices more conservative. Nonetheless, when comparing herbal medicine across six Mediterranean countries, González-Tejero et al. (2008) did not find a common ethnobotanical heritage throughout the basin. In this study, we want to test if the medicinal flora of the Algerian steppe nomads is different to those of neighbouring sedentary populations, and to evaluate to what extent elements written in historical Mediterranean medical texts can be identified. We hypothesise that, due to their particular livelihoods, their high dependence on the steppe environment for plant resources, and high illiteracy rates, nomads' medicinal plants and uses will be specific to this community and different to those cited in historical texts. To the best of our knowledge, no study has been carried out so far about the herbal medicine of this community.

2. Material and Methods

2.1 Study area

With an estimated area of about 20 million hectares, the Algerian steppes constitute a geographical unit whose limits are defined by a bioclimatic criterion. They are located between the isohyets 400mm to the North and 100mm to the South, forming a 1000 km long ribbon over a width of 300 km in the west and in the centre, reduced to less than 150 km in the East (Halem, 1997). The steppes cover the area between the southern limit of the Tellian Atlas to the north, and that of the southern foothills of the Saharan Atlas to the south. The steppe corresponds to the Mediterranean

dry woodlands and steppe terrestrial ecoregion, part of the Mediterranean woodlands and forests priority ecoregions for biodiversity conservation (Olson et al., 2001; Olson and Dinerstein, 2002).

Administratively, this area it is distributed through 12 *wilayas* (provinces). Our research focused on the *wilayas* of Tiaret, Saida, Naama, Djelfa and M'sila, where nomads are known to live (Fig. 1).

Fig. 1. Administrative map of Algeria and political map of North Africa highlighting the localisation of Algeria. The provinces where this study was conducted have been highlighted in dark pink and the steppe area is mapped in yellow. Adapted from Wiki Commons.

2.2 Sampling method

The research was conducted during a period of two years, from spring 2015 to summer 2017. Finding nomad communities on the steppe routes was not an easy task because of their movements. The High Commission for the Development of the Steppe team (HCDS), equipped with appropriate vehicles and with knowledge of common locations and displacements of the nomads, provided invaluable support to find and access the camps of nomadic communities. The ISE code of ethics (ISE, 2008) was followed.

In total, we were able to study 38 camps and interview 73 individuals (56% women). These camps were found in different *wilaya*, often as far as 30 to 100km from urban areas as follows: Tiaret (11 camps, 26 individuals, 69% women), Saida (8 camps, 14 individuals, 43% women), Naama (6 camps, 11 individuals, 64% women), Djelfa (7 camps, 13 individuals, 54% women), M'sila (6 camps, 9 individuals, 33% women). The camps often consisted of a single family with 5 to 13 members. When approaching the inhabitants of the camps, explanations of the background and aim of the study were provided to the family head before starting the surveys. Then, we proceeded with a non-probabilistic sampling by convenience, interviewing subjects available during the study (Albuquerque et al., 2014). Only those who claimed to know the plants and their medicinal uses were interviewed. The agreement of the family heads as well as all interviewees was obtained orally.

2.3 Ethnobotanical surveys

Ethnobotanical interviews were combined with guided tours (Albuquerque et al., 2014). We were accompanied by the informants to the environment surrounding the camps, where they identified medicinal plants (providing vernacular names) and explained how they are used (including part or parts used, and mode of use). This technique allows validating vernacular names of inventoried plant species by identifying them directly (Albuquerque et al., 2014). This method was used with men and women who agreed to accompany us to several surrounding places including steppes, woodland, gardens or the market places (*souk*). Then, a structured interview was carried out with the informant (Albuquerque et al., 2014; Martin, 1995), which allowed the collection of sociodemographic data (gender, age, educational level) and in-depth documentation of plant

identities and their medicinal uses. Interviews were carried out in the nomads' mother tongue, Arabic language. All plant vernacular names were given in Arabic.

2.4 Botanical identification

All plants cited by our informants were collected. Some were acquired directly from the interviewees (often women keep quantities of plants both acquired in the souk or harvested near the camps) and others were harvested in the camps' surroundings. Herbarium specimens were mounted and identified using the following floras: Battandier and Trabut (1895), Maire (1959) and Quézel and Santa (1962-63). Identifications were updated concerning systematics, nomenclature and chorology using the index of the database of North Africa (Dobignard and Chatelain, 2010-13) and the Plant List (TPL, 2013). When discrepancies in taxonomy were found, accepted names by the Plant List (TPL, 2013) were used. Voucher specimens were coded and deposited in the herbarium of the Botanical Laboratory of the University of Tiaret (Tell Atlas, Central Algeria; see province in Fig. 1).

2.5 Data analysis

In order to describe the ethnobotanical data collected, data was first structured in Use Reports (UR; a citation of one plant use by one informant) and then information collected was synthesized for each plant species. Informant Consensus Factor (F_{IC}) was used as a descriptive ethnobotanical index to quantify the agreement among informants on how to treat different ailment categories. It is calculated with the following formula: $IFC = (N_{ur} - N_t) / (N_{ur} - 1)$, where N_{ur} refers to the total number of use reports for each ailment category and N_t is the number of taxa used in that category (Trotter and Logan, 1986). The diseases for which plants were used were classified into 24 emic ailment categories reflecting local ailment classifications, and have been reported with their vernacular names in Arabic as cited by informants.

To evaluate the overlap between the nomads' and others populations' medicinal floras, and to identify new medicinal plants and therapeutic uses, we compared fieldwork results to the existing body of literature. Overall plant diversity (accounting for families and species), the ways in which it is used, and the most common therapeutic applications were compared. First, we made use of the documents available in the university libraries of Tiaret, M'sila and Djelfa. Second, we conducted a literature search for books and articles using internet search tools in several scientific databases: DOAJ, Google Scholar, PubMed, Springer Science direct, and Scopus. We used several key words and combinations to make the research more comprehensive, including: Algeria, medicinal plants, Morocco, Tunisia, Mediterranean, ethnobotany, steppe, and nomads. Literature sources used can be found in Supplementary File 2. Staub et al. (2016) and De Vos (2010) were used to compare our

3. Results and discussion

Nomadic populations in the Algerian steppe harvest medicinal plants during their displacements between camps and from around the camps, and acquire other species in the *souk*. They keep these medicinal plants dry to be used when necessary. Ninety-seven medicinal species were identified in our survey (Supplementary File 1), including 94 plant and three fungi species.

3.1 Informants' sociodemographic profile

One hundred individuals were approached in total, but 27 did not wish to participate in the study claiming to not know about medicinal plants and their uses. They were not interviewed. Of these, 24 were young men and only three were women. Among the 73 nomads interviewed, women account for 56% (41 individuals), while men account for 43% (32 individuals). All informants were lay practitioners, since there are no professional herbalists among nomadic populations: professional herbalists are often bound to specific locations, which is incompatible with a nomadic lifestyle.

The calculated average values of the number of species mentioned by each sex shows that women cite the double number of species (20 species on average) than men (10 species on average). This is an indication that women are more familiar with medicinal plant knowledge and use. This can be explained by the women's role in providing the household meals, often plant-based recipes, and also in caring for the health their children and other family members (Howard, 2003; Voeks, 2007). Other studies conducted in neighbouring countries such as Morocco also show that it is women who have lay in-depth knowledge and practices related to traditional medicine by plants (Eddouks et al., 2017), despite men dominating the public and professional spheres of herbal therapy in North Africa. Boudjelal et al (2013) reported that in the M'sila area men dominate the practice of traditional medicine, but this is due to the nature of the surveys that have only considered herbalists and not lay practitioners.

Concerning the age of the participants in the survey, 70% (51 individuals) of the interviewees were between 46-65 years old. Older people (over 65) represent 21% (15 individuals). Young people (between 26-45 years) represent only 8% (6 individuals) of the interviewees, while only one interviewee was less than 25 years old. All 27 people approached who claimed not to know about medicinal plants were younger than 25 years old. These proportions are indicative of generational

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differences in knowledge about medicinal plants. Bouasla and Bouasla (2017) emphasize that older people have more knowledge due to their experience accumulated with age. This seems to be generalized in the Mediterranean countries where the average age of people practicing traditional phytotherapy is high, often exceeding 50 years (González-Tejero et al., 2008).

The majority of the nomads interviewed were illiterate (78%). People with a primary or secondary education level represent only 19% of the sample, while those with a university degree represent only 3%. This can be explained by the lifestyle of this community that hampers schooling of children because of their permanent movements (Guillermou, 1990). In some cases, children go to primary or middle school, in the school closest to the camp, and are fully engaged in the practice of pastoralism outside school hours. In Morocco, the illiteracy rate among the nomad population is 81.9% according to government statistics (GCPH, 2014); unfortunately, no such data are available for Algeria.

3.2 Medicinal species used by the Algerian steppe nomads

3.2.1 Botanical diversity

In total, the interviewees cited 97 species of medicinal interest, which are used by members of the community in their daily lives (Supplementary File 1). These plants belong to 42 botanical families, with over a third of the taxa belonging to Lamiaceae (18%), Asteraceae (15%) and Apiaceae (11%). Several studies published for Algeria report similar proportions regarding the dominance of these three families: Boudjelal et al. (2013), Benarba et al. (2015), Ouelbani et al. (2016) and Bouasla and Bouasla (2017). The abundance of these three families has also been observed in studies conducted in Mediterranean countries including Morocco (Teixidor-Toneu et al., 2016a), Turkey (Özdemir and Alpınar, 2015), Spain (Rigat et al., 2015) and Italy (Vitalini et al., 2013). These families are the most represented in the flora of Algeria (Asteraceae 557 taxa, Lamiaceae, 183 taxa, and Apiaceae, 170 taxa) (Dobignard and Chatelain, 2010-13), as well as the Mediterranean flora overall (Quézel and Médail, 2003). Phytochemically, the predominance of Lamiaceae, Asteraceae and Apiaceae may be justified by their organoleptic properties, which are clues to the high content of phenolic and flavonoid compounds responsible for antioxidant activity (Miliauskas et al., 2004; Khled Khoudja et al., 2014; Maulidiani et al., 2014). Other well-represented families are Fabaceae, Amaranthaceae and Brassicaceae with a percentage of 8%, 6% and 5% respectively. The remaining 36 families represent 37% of the total. These proportions do not differentiate the Algerian steppe nomads from neighbouring or other Mediterranean sedentary populations.

3.2.2 Most frequently cited taxa

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The most frequently cited medicinal species by nomads are: *Mentha spicata* L. (62 citations), *Artemisia herba-alba* (60 citations) and *Juniperus phoenicea* L. (46 citations). These plants are commonly used and uses among nomadic populations are also known amongst other populations. Other species also have high citation numbers are: *Artemisia campestris* (42 citations), *Rosmarinus officinalis* L. (40 citations), *Peganum harmala* and *Allium sativum* L. (32 citations each) and *Teucrium polium* L. with 30 citations (Supplementary File 1).

The aerial parts of *Mentha spicata*, locally called *nanaa*, is used in infusion or decoction for its to treat pains, diarrhoea and spasms properties. These properties have been confirmed by several studies (see for example, Souza 2013). The plant is also used for treating common colds, and in cases of extreme flatus. Moreover, this plant is characterized by strong antibacterial activity of its essential oils, hence used to treat infections (Carlier-Loy, 2015). *Nanaa* has been documented in the Algerian steppe regions especially the region of Hodna to treat high blood pressure (Hendel et al., 2012; Sarri et al., 2012). It has been quoted as sedative, disinfectant, astringent, antispasmodic, pain killer for teeth, emmenagogue, anthelmintic, carminative, stomachic, calm nerves and cooling (Meddour and Meddour-Sahar, 2015; Sarri et al., 2012, 2014). *Mentha spicata* is also known in Cyprus for treating the digestive and respiratory system diseases (Gonzales-Terejo et al., 2008).

Nomads use the whole plant of *chih* (*Artemisia herba-alba*) to treat several digestive problems. This seems supported by several published studies on phytochemical properties of this plant. Marrif et al (1995) have shown that the aqueous extracts of this plant increase the time of gastrointestinal transit and have suggested that this property may help to expel worms. Other authors such as (Khlifi et al., 2013, Yashphe et al., 1987) speak of an anti-inflammatory and antispasmodic activity of this plant. In other parts of Algeria, this plant has also been reported to treat digestive system ailments (González-Tejero et al., 2008; Boudjelal et al., 2013), but it is also used for respiratory system diseases and cancer (Ouelbani et al., 2016). Other indications of use of this plant are to treat diabetes (Bouasla and Bouasla, 2017; Mohamed et al, 2010), intestinal bloating and intestinal parasites (Benarba et al., 2015; Chermat and Gharzouli, 2015). This plant is also known in neighbouring countries for these virtues especially in Tunisia and Morocco to treat diabetes, bronchitis, diarrhoea, high blood pressure, headaches and other ailments (Marrif et al., 1995; Said et al., 2002; Tahraoui et al., 2007; Teixidor-Toneu et al., 2016b) and in Spain for caring some respiratory diseases (Calvo et al., 2011).

Juniperus phoenicea is called *araar* by the nomads, who use its leaves in decoction for different diseases including ulcers, intoxication, inflammation and other stomach disorders (nausea, diarrhoea). This is corroborated by several studies have shown antibacterial activity of this plant including: Ait Ouazzou et al (2012), Angioni et al. (2003) and Derwich et al. (2010). Nomadic populations also use it to treat lung diseases and kidney problems. This plant is widely used in the

Algeria to treat digestive disorders, high blood pressure, inflammations and eczema (Boudjelal et al., 2013). It is also recommended to treat respiratory, urinary or genital infections and gastric ulcers (Benasla and Benasla, 2017). In the Mediterranean basin, this plant is used in Cyprus for kidney and skin diseases and in Egypt for digestive ailments (González-Tejero et al., 2008).

3.2.3 Source of the plants used

Of the 97 medicinal taxa cited, 58 plants (60%) are collected from wild in the steppe. The rest (39 plants, 40%) are bought from herbalists in the *souk* of villages nearby the nomad camps (See Supplementary File 1 for origin of each plant species). Due to their nomadic lifestyle, the nomads do not cultivate plants for medicinal or other purposes. This contrasts with sedentary populations who often also use cultivated plants for medicinal purposes (see for example, Teixidor-Toneu et al., 2016b; Bouasla and Bouasla, 2017). Some of the species that are often cultivated can be found in the *souk* (e.g., *Mentha spicata* or *Allium sativum*), but others may not be available at all to nomads. Overall, nomads seem to rely on a slightly higher proportion of wild plant species than sedentary neighbouring populations: in the northeast Algeria, 51% of the medicinal plants used are sourced from the wild (Bouasla and Bouasla, 2017).

3.3 Therapeutic applications

Therapeutic applications reflect the emic classification system of the nomads. Sometimes, nomads use vernacular terms to refer to ailments diagnosed in hospitals such as cancer or diabetes. Our survey shows that 20% of the species are indicated to heal gastrointestinal diseases. Several authors conducting regional ethnobotanical surveys in Algeria (Benarba et al., 2015; Bouasla and Bouasla, 2017; Miara et al., 2013) reported that the majority of their species are indicated for the treatment of digestive diseases. The same observations were also highlighted by Fakchich and Elachouri (2014) and Eddouks et al. (2017) in Morocco. This category of diseases was mentioned most often by interviewees: it accumulates the highest number of citations ($N_{ur} = 385$) and highest number of taxa used ($N_t = 50$; Table 1), which results in the observed high F_{IC} value. Most of the published literature consulted report maximum agreement between informants for digestive system diseases (Benarba et al., 2015; Bouasla and Bouasla, 2017; Eddouks et al., 2017; Ouelbani et al., 2016). Respiratory diseases seem to be the second most important group of ailments in North Africa (for example, Benarba et al., 2015; Bouasla and Bouasla, 2017; Eddouks et al., 2017). Here, influenza and common cold are the second most commonly cited ailments treated with medicinal plants, as in neighbouring areas (Fakchich and Elachouri, 2014). This discrepancy is due to classification differences: nomads distinguish common cold and the flu (*berd* and *rih*, respectively) from lung and chest infections (called *riya* and *sdar*), which are often grouped together under “Respiratory diseases”.

Reproductive and sexual problems have the highest F_{IC} value ($F_{IC} = 0.92$) (Table 1). These diseases are essentially treated by two species of *terfess* (*Tirmania pinoyi* (Maire) Malençon and *Terfezia leptoderma* Tul. & C. Tul), which are also highly valuable edible mushrooms in the steppe region. There is also a high agreement on using *Silybum marianum* (L.) Gaertn. to treat liver diseases ($F_{IC} = 0.88$), a plant known for its hepatoprotective activity (Flora et al., 1998). In other parts of North Africa less agreement is observed in treating reproductive ailments because a much higher diversity of plants is used (e.g., Benarba et al., 2015; Bouasla and Bouasla, 2017; Fakchich and Elachouri, 2014). Liver problems are coded in various ways, which hampers comparability.

Table 1. Number of Use Reports (N_{ur}), species (N_t) and values for the Informant Consensus Factor (F_{IC}) per ailment category, ordered from higher to lower F_{IC} values. In brackets, vernacular names of illnesses in Arabic as used by informants given in italics and the terms' literal translations).

Ailment category	N_{ur}	N_t	F_{IC}
Sexual-reproductive (<i>jehd</i> "power", <i>lookm</i> "infertility")	41	4	0,92
Liver (<i>kebda</i> "liver", <i>bousafir</i> "jaundice")	52	7	0,88
Gastro-intestinal (<i>maada</i> "stomach", <i>mssarine</i> "intestine")	385	50	0,87
Influenza, common cold (<i>rih</i> "wind", <i>berd</i> "cold")	82	11	0,87
Respiratory (<i>riya</i> "lung", <i>sdar</i> "chest")	43	11	0,76
Cancer (<i>mard chine</i> "the bad illness")	14	4	0,76
Hair (<i>chaar</i> "hair")	13	4	0,75
Pains (<i>wjaa</i> , <i>dor</i> "pain")	68	19	0,73
Urinary (<i>boul</i> "urine", <i>bouala</i> "urinary tract", <i>mathana</i> "bladder")	35	10	0,73
Mouth (<i>fom</i> "mouth", <i>lessnan</i> "teeth")	24	7	0,73
General health (<i>saha</i> "health")	22	7	0,71
Skin (<i>jeld</i> "skin")	42	13	0,70
Heart (<i>galb</i> "heart")	48	15	0,70
Anaemia (<i>fqrдем</i> "weak blood")	37	12	0,69
Wounds (<i>jrah</i> "injury")	14	5	0,69
Haemorrhoids (<i>bwasser</i> "haemorrhoids")	16	6	0,66
Throat, nose and ears (<i>guerzi</i> "throat", <i>nif</i> "nose", <i>wednin</i> "ears")	7	3	0,66
Endocrine (<i>mard dakhlan</i> "inner disease", <i>skar</i> "diabetes")	24	9	0,65
Kidney (<i>klawi</i> "kidneys")	17	7	0,62
Neurological (<i>kanta</i> "hopelessness", <i>zaaf</i> "nervousness")	13	6	0,58
Infection and inflammation (<i>khmaj</i> "infection", <i>nefk</i> "inflammation")	15	7	0,57
Musculoskeletal (<i>laadam</i> "bones")	33	18	0,42
Fever (<i>hemma</i> "fever")	6	4	0,40
Gynaecological (<i>welada</i> "birth", <i>dem</i> "(women's) blood")	10	8	0,22

3.4 The parts used and mode of preparation

Nomad herbal medicine practices do not seem to differ from those of neighbouring communities in terms of the most common plant parts used and method of preparation. Leaves are the plant part most commonly used as herbal remedies (29%). Unspecified aerial parts are also often used (17%), as well as fruits and seeds (12 and 11% respectively). The predominance of leaf use in traditional remedies has been observed in several studies in Algeria (Benarba et al., 2015; Bouasla and

Bouasla, 2017; Boughrara and Belgacem, 2016; Ouelbani et al., 2016) and in other countries in Africa, Asia and Europe: Asiimwe et al. (2013) in Uganda, Parada et al. (2009) in Spain, Adnan et al. (2014) and Sher et al. (2015) in Pakistan, Tuttolomondo et al. (2014) in Italy and Guzel et al. (2015) in Turkey. Decoction is the most common way to prepare herbal remedies (36%), but infusions and oral ingestion of powdered dry plants are also used (28 and 21% respectively; Fig. 4). Several studies in Algeria and neighbouring countries show similar results (Benitez et al., 2010; Boudjelal et al., 2013; Fakchich and Elachouri, 2014; Hammiche and Maiza, 2006; Sargin et al., 2015; Sarri et al., 2014).

3.5 New reports for medicinal plants and uses

The results from the ethnobotanical survey with nomadic communities in the Algerian steppe were compared with available literature about medicinal plant use in Algeria and neighbouring countries to identify new data concerning medicinal plants and their uses for this region (Supplementary File 1).

Medicinal uses for 25 plants were observed in Algeria for the first time and seem unique to the nomads of the Algerian steppe (Table 2; Supplementary File 1). Moreover, we report nine medicinal taxa not documented in recent bibliography of medicinal plant use in Algeria and the Mediterranean, despite some of them having been described in historical Mediterranean *materia medica* or with congeners being used in similar ways: *Anthemis arvensis* L., *Bunium bulbocastanum* L., *Echium humile* subsp. *pycnanthum* (Pomel) Greuter & Burdet, *Genista quadriflora* Munby, *Pallenis hierichuntica* (Michon) Greuter, *Rosmarinus eriocalyx* Jord. & Fourr., *Terfezia leptoderma*, *Thymus munbyanus* Boiss. & Reut., and its subspecies *Thymus munbyanus* subsp. *ciliates* (Desf.) Greuter & Burdet.

Table 2. Previously undocumented uses for medicinal plants of the Algerian nomadic communities.

Medicinal taxa	Previously undocumented uses
<i>Allium cepa</i> L.	Constipation, headache, and hair loss.
<i>Anthemis arvensis</i> L.	Stomach problems, painkiller.
<i>Asparagus horridus</i> L.	Wounds.
<i>Atriplex hortensis</i> L.	Cholesterol, obesity, breast cancer, problems of the uterus, and malfunctioning of the thyroid gland.
<i>Beta vulgaris</i> L.	Soothing.
<i>Brassica rapa</i> L.	Cough.
<i>Bunium bulbocastanum</i> L.	Flatulence and intestinal worms.
<i>Cicer arietinum</i> L.	Anaemia.
<i>Citrullus colocynthis</i> (L.) Schrad.	Haemorrhoids.
<i>Echium humile</i> subsp. <i>pycnanthum</i> (Pomel) Greuter & Burdet	Digestive ailments.
<i>Eruca vesicaria</i> (L.) Cav.	Diuretic, appetizer. Gastro-intestinal problems.

<i>Genista quadriflora</i> Munby	Skin problems.
<i>Hibiscus sabdariffa</i> L.	Anaemia.
<i>Lawsonia inermis</i> L.	Rheumatism.
<i>Morus alba</i> L.	Diabetes.
<i>Pallenis hierichuntica</i> (Michon) Greuter	Stomach pain.
<i>Petroselinum crispum</i> (Mill.) Fuss	Increasing breast milk production.
<i>Pistacia lentiscus</i> L.	Bronchitis, weak breathing, diarrhoea.
<i>Rosmarinus eriocalyx</i> Jord. & Fourr.	Influenza, colon pain.
<i>Senna alexandrina</i> Mill.	Constipation.
<i>Spinacia oleracea</i> L.	Increasing breast milk production.
<i>Terfezia leptoderma</i> Tul. & C. Tul	Digestive and sexual problems.
<i>Thymus munbyanus</i> Boiss. & Reut.	Cough and endocrine gland diseases.
<i>Thymus wilddenowii</i> Boiss.	Digestive problems.
<i>Tirmania pinoyi</i> (Maire) Malençon	Sexual problems.

Several of these species are characteristic of the Algerian steppe ecosystem (Quézel and Santa, 1962-63), including *Echium humile* subsp. *pycnanthum*, *Pallenis hierichuntica*, *Genista quadriflora*, *Terfezia leptoderma*, *Tirmania pinoyi*, *Asparagus horridus*, *Thymus wilddenowii* and the two taxa of *Thymus munbyanus*. On the chorological level, the taxa *Thymus munbyanus*, *Thymus munbyanus* subsp. *ciliatus* and *Genista quadriflora* are endemic of Algeria-Morocco. This explains that they have not been documented as medicinal in other Mediterranean countries.

To the best of our knowledge, only 13% of the taxa cited by nomads had not been previously reported in other studies. In fact, 60% of the taxa (n=58) have been identified at species level in the Matthioli *materia medica* (1568) or other historical texts (De Vos, 2010; Staub et al., 2016) (Supplementary Material 1). Although the comparative work on medicinal plant uses across the Mediterranean by González-Tejero et al. (2008) concludes that there is no common ethnobotanical heritage throughout the Mediterranean basin, our results point otherwise. Regional differences do exist, as observed here by the citation of previously undocumented plants characteristic of the Algerian steppe environment. However, we argue that despite the conclusions of González-Tejero et al (2008) and despite the fact that no written texts are used by nomads and these populations have unlikely encountered herbals to guide their medicinal plant knowledge, a common heritage is shared by diverse populations living around the Mediterranean. This results suggest that the medicinal plants documented since historical times continue to be used, even in the absence of direct knowledge transmission through texts (Leonti, 2011). A literate medical tradition has persisted in North Africa since medieval times though universities (Tacquin, 1917) and manuscripts have always been used and present (Bellakhdar, 1997), though not accessed by most of the population until recently. However, herbalists, with whom nomads are in touch when shopping for specific plant products, often make use of such herbals and might link nomadic populations and the Mediterranean ethnopharmacological heritage.

4. Conclusion

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This study is the first attempt to document the phytotherapeutic practices of the nomadic community in the Algerian steppe. These nomads are indigenous populations living in constant contact with nature, and use plants in their environment, as well as traded species, to treat various diseases and health problems. Rich and valuable new information was gathered in study: some medicinal plant uses are particular to the Algerian steppe and have been documented for the first time as use by the nomadic populations. Many of the most used plants (*Mentha spicata*, *Artemisia herba-alba*, *Juniperus phoenicea*, *Artemisia campestris*, *Teucrium polium*) are natural plants of the steppe well known by the nomads with which they share steppe environments. Several plants previously not documented as medicinal are endemic and characteristic of this ecosystem (*Thymus munbyanus*, *Thymus munbyanus* subsp. *ciliatus* and *Genista quadriflora*). However, an important proportion of the medicinal plants used by nomads is shared with sedentarised Algerian communities and neighbouring North African peoples. Nomads use plants from the same families that are common among neighbouring communities in similar ways: the most common plant parts and modes of preparation are shared, as well as the most important ailments treated. Unlike sedentary communities, nomads do not cultivate medicinal plants but they acquire some of the commonly cultivated species in local *souks*. Importantly, a high percentage of plants used by nomads are part of the Mediterranean ethnopharmacological tradition documented in historical texts. Despite of their characteristic lifestyle, their isolation and characteristics illiteracy, these populations have likely exchanged knowledge with their neighbours for centuries. Contact with herbalists is likely to have an important impact for the transmission of regional and historically documented medicinal plant knowledge to these communities.

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Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

The contributions of the respective authors are as follows: M. D. Miara (miara14130@yahoo.fr) designed the study, contributed to the ethnobotanical survey, plant identification, data analysis and

wrote the manuscript; H. Bendif (bendif_hamdi@yahoo.fr) contributed to the ethnobotanical survey; M. Ait Hammou (mohamedaitammou@gmail.com) contributed to the botanical identification; Irene Teixidor-Toneu (i.teixidor-toneu@reading.ac.uk) contributed to data analysis and writing the manuscript. All authors read and approved the manuscript.

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