FLORISTIC AND ETHNOMEDICINAL STUDY OF THE FLORA OF THE BAINEM PERI-URBAN FOREST (NORTHERN ALGERIA)

ABLA, S.[1*] – ZERMANE, N.[2] – ZANNDOUCHE, O.[3]

[1]*Laboratory of Materials and Environmental Sciences, Department of Natural and Life Sciences, Faculty of Sciences, University of Algiers 1, Benyoucef Benkhedda, 02 Rue Didouche Mourad 16000, Algiers, Algeria*

[2]*Laboratory of Living Resources of Economic Interest in Algeria, REVIECO, Department of Natural and Life Sciences, Faculty of Sciences, University of Algiers 1, Benyoucef Benkhedda, 02 Rue Didouche Mourad 16000, Algiers, Algeria*

[3]*Forest Research National Institute (INRF), Arboretum of Bainem, BP 37 Chéraga 16014, Algiers, Algeria*

**Corresponding author*
e-mail: s.abla@univ-alger.dz

(Received 30th Aug 2025; accepted 24th Nov 2025)

Abstract. Since ancient times, medicinal plants have been used in virtually all cultures for therapeutic purposes. They are commonly utilized by local populations as traditional remedies. In this work, we highlight the diversity of the flora in the peri-urban forest of Bainem in northern Algeria, focusing on vegetation with medicinal value. It is worth noting that no previous studies have been conducted to adequately document and promote ethnomedicinal knowledge about the flora of this forest. Plants are under intense pressure due to overexploitation and unsustainable harvesting methods. We recorded 421 plant species belonging to 65 families, of which 346 species from 8 families had medicinal interest. Among these families, Asteraceae and Fabaceae were the most prevalent. Analysis of the results regarding medicinal species usage showed that most of these species are primarily used for skin conditions (28%) and inflammatory disorders (17%). These pathologies are mainly treated using the foliage (62%), which is the most commonly used plant organ, and through infusions (33%) and decoctions (27%), which represent the dominant preparation methods employed by the local population in the study area.
Keywords: *ethnoflora, medicinal plants, inventory, Baïnem, Algeria*

Introduction

Peri-urban forests are located within or on the outskirts of urbanized areas; they are protected and largely excluded from economic activities. Their protection is prioritized for their social, recreational, and aesthetic roles, as well as their ecological functions (Monot, 2017). These areas are also places where various plants, such as medicinal and ornamental species, are harvested.

The preservation of biodiversity in urban environments is considered a major environmental challenge. Its importance and protection have become increasingly significant environmental requirement at both local and international levels (Clergeau, 2007; Aronson and al., 2014). Humans have a long-established relationship with plants to meet various needs (Ezebilo and Mattsson, 2010).

Knowledge of medicinal plants develops through practices and beliefs that are passed down from generation to generation, thanks to a cultural transmission based on interactions between humans and their natural environment (Pirker and al., 2012).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_765784

The flora of urban environments is found in landscapes that have been heavily modified by human activity and are also highly fragmented (McKinney, 2009). For many years, medicinal plants have been recognized as an important source of natural compounds that can be used to treat and prevent a wide range of diseases (Bencheikh and al., 2021).

Plants were used to soothe pain and heal wounds (Grunwald and Jänicke, 2006). Medicinal plants and similar products derived from local medicinal plants and herbs have garnered increasing global interest in recent years (Qasim and al., 2017). Despite advances in pharmacology, medicinal plants continue to be widely used in certain countries around the world, particularly in developing countries (Tabuti and al., 2003).

The richness and diversity of the flora in Algeria make it a genuine phytogenetic reservoir, housing approximately 4300 species and subspecies of vascular plants (Dobignard et Chatelain, 2010-2013). It includes a wide variety of species classified according to their degree of rarity: 289 fairly rare species, 647 rare species, 640 very rare species, 35 extremely rare species, and 168 endemic species (FAO, 2012).

Algeria is one of the Mediterranean countries that exhibits exceptional ecological diversity. It includes various biogeographical zones and has biological resources of great interest. Among these biogeographical zones is the Algiers coastal subsector, which includes the peri-urban forest of Bainem.

This area has public domain status, and hence it is subject to forest regulations, and is managed by the General Directorate of Forests under the supervision of the Ministry of Agriculture and Rural Development. This area represents an important reserve of floral diversity, characterized by numerous plants with therapeutic and aromatic properties.

Nevertheless, this forest is experiencing significant degradation due to pollution, intense human pressure, repeated wildfires, overgrazing, and the indiscriminate uprooting of aromatic and medicinal plants by individuals (herbalists, florists, etc.).

Some populations are involved in the illegal extraction of wood fuel (logging, charcoal production, collecting dead wood). Additionally, urbanization on the outskirts seems to be taking its toll on this forest. Medicinal plants are also under significant harvesting pressure from visitors.

Today in Algeria, interest in herbal medicine is such that the trade in medicinal plants has become a source of income. However, the analysis of the Algerian medicinal literature shows that the data regarding medicinal plants is very fragmented and scattered, and the know-how is currently held by only a few individuals.

Medicinal plants are a valuable resource for humanity, especially for disadvantaged communities in developing countries to ensure their primary healthcare and livelihoods (Salhi et al., 2010).

Like other peri-urban forests, the Bainem forest remains the most important green space in the capital Algiers. It is home to a highly diverse biodiversity that includes threatened species such as *Onopordum algeriense* (Munby) Pomel (Djelid et al., 2020), as well as medicinal plants used to treat various diseases. The proximity of this forest to several residences increases the risk of its anthropization, leading to a constant decline in its plant diversity.

The population living around or near the forest cannot refrain from entering it to illegally harvest various natural plant resources.

In order to enhance the floral heritage of this peri-urban forest and to highlight plants with medicinal value by determining their therapeutic uses, as well as their biological, morphological, and phytogeographical characteristics, a floristic inventory has been

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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conducted based on a comprehensive list of existing plants focusing on vegetation with medicinal interest for better conservation, improved valorization, and sustainable use of its natural environments.

The objective of this study was first, to compile a floristic inventory of the Bainem forest, highlighting the diversity of medicinal plants present, and second, to conduct and analyze a series of ethnobotanical surveys. These surveys aimed to identify the medicinal plants used locally, gather as much information as possible on the traditional therapeutic practices of the population, and examine the links between plant species and the various pathologies treated.

Materials and methods

The present research was conducted in Algeria in the peri-urban forest of Bainem, located 15 km west of Algiers, in a coastal position less than 1 kilometer from the Mediterranean Sea.

It covers an area of 504 hectares, with elevations ranging from 80 to 302 meters, and has the following geographic coordinates: 36.788341° to 36.805497° North Latitude; 2.949164° to 2.986751° East Longitude (*Fig. 1*). Geologically, the terrain is diverse featuring metamorphic rocks (schists, mica schists, gneiss) (ISL-BRGM, 2006).

It represents the largest natural green space in the city of Algiers. The bioclimate is subhumid with a warm variant.

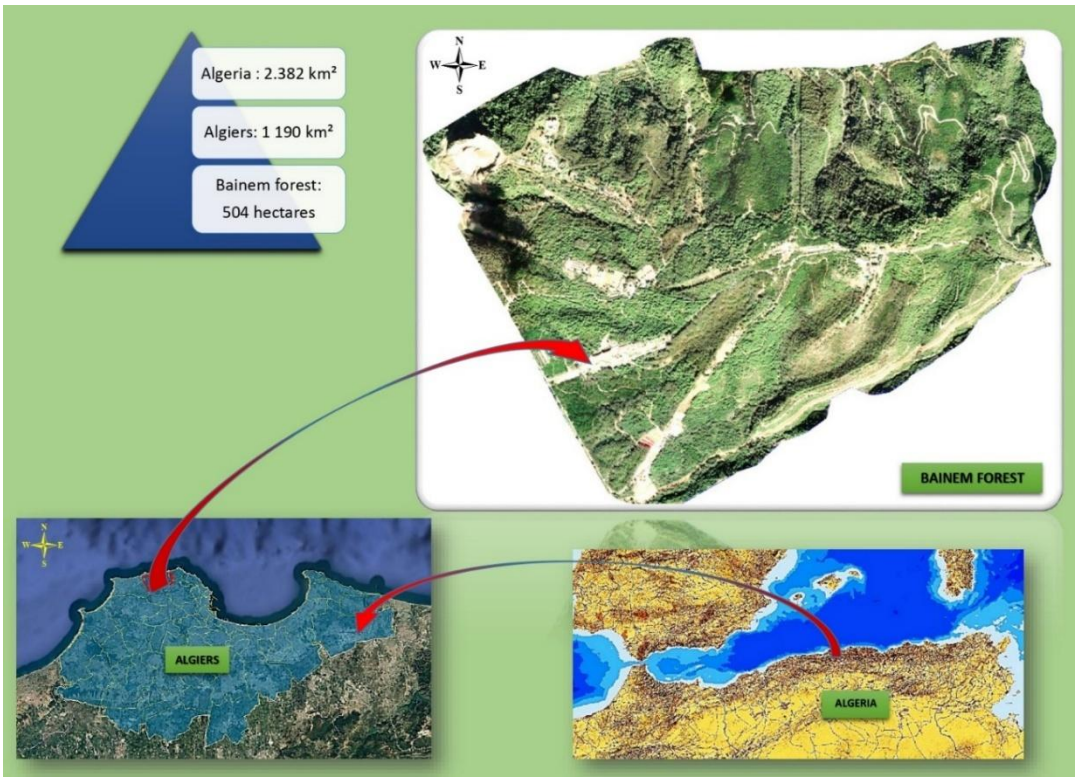

Figure 1. *Geographic location of the peri-urban forest of Bainem (Northern Algeria)*

In the case of our study, we opted for a subjective sampling method which involves selecting areas that appear particularly homogeneous and representative of the whole

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(Gounot, 1969). Thus, the methodological approach adopted to carry out this work involves 55 phytosociological surveys (*Fig. 2*) that were conducted during the optimal growing season (i.e., spring) of the year 2023 in the peri-urban forest of Bainem, taking into account the ecological diversity of this area.

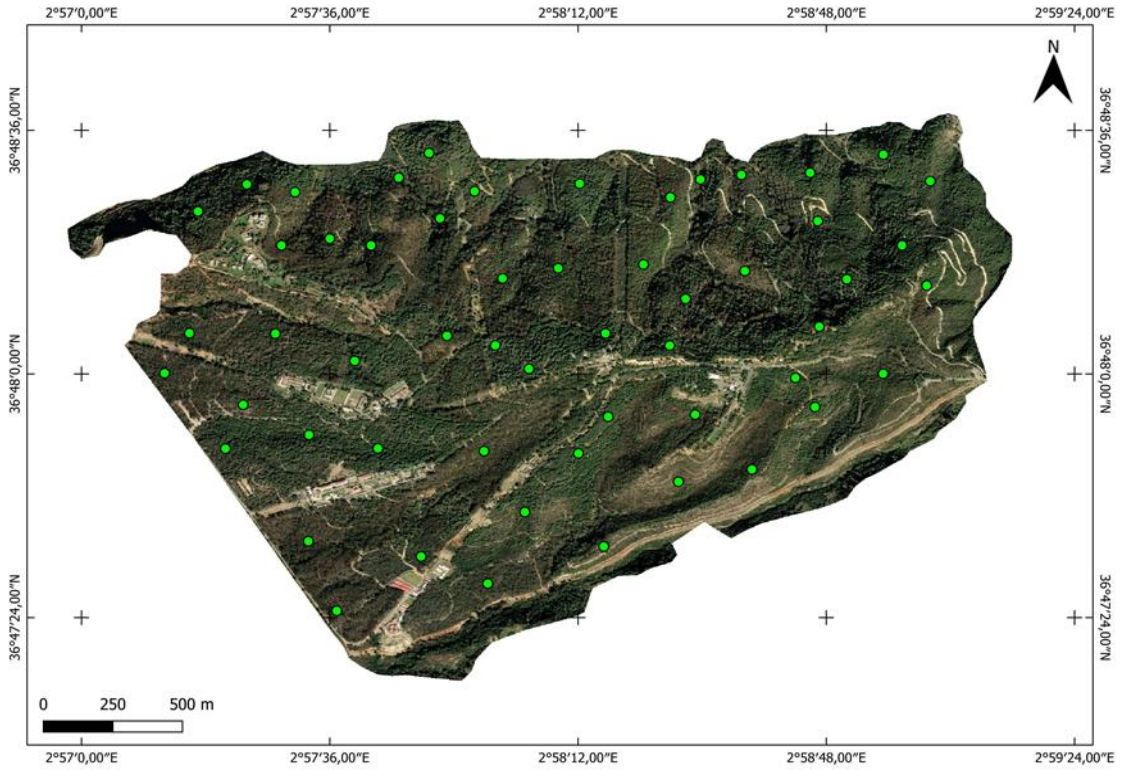

Figure 2. *Map showing the location of phytoecological surveys [green spots] in the peri-urban forest of Bainem (northern Algeria)*

The area of each phytosociological relevé was 100 m². This is the smallest area required for most species to be represented (Lemée, 1967).

Common species were recognized in the field, while those we could not identify (unknown and/or doubtful taxa) were carefully collected for laboratory identification. The species were identified using the flora of Quézel et Santa (1962-1963).

The nomenclature was updated using the synonym index of Dobignard et Chatelain (2010-2013) and the North African Plant Database (APD, 2021). For all inventoried species, the morphological, biological, and phytogeographical types were defined.

The biological and chorological types were defined based on the literature consulted (Quézel et Santa, 1962-63), as well as our own field observations. Herbarium specimens from the National Institute for Forest Research, INRF, herbarium were also used for biological types determination.

The survey on the traditional use of medicinal plants was conducted among local populations as well as visitors to the peri-urban forest of Bainem through face-to-face interviews. The questions were designed to be simple and accessible to everyone (30 min per interviewed person or respondent). Additionally, interviews were conducted in other locations, such as the National Institute of Forest Research located on the northern slope of the Bainem forest, and kiosks run by former foresters who worked in the forest.

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In certain situations, we organized group interviews, which led to discussions and debates about the different uses of the species. A total of 100 people were interviewed, regardless of age and gender, at various intellectual levels, who informed us about the local therapeutic and traditional application methods.

Regardless of the situation, the cultural information associated with a species has been supplemented by directly identifying plants in their natural environment or by using herbariums and photos that we provided to the interviewees. These were subjected to an open interview providing all information related to medicinal plants in French or the local Arabic dialect. Individual interviews identified the medicinal plants used, the different parts utilized, the targeted pathologies, and the methods of preparation and administration of the medicinal recipes. All the species mentioned were recorded by their common names.

Ethnomedicinal information obtained was entered into a raw data table using Microsoft® Excel 2023, which allows for the analysis and processing of information in the form of tables and graphs. This information pertains to the following aspects: the local medicinal uses attributed to each plant, the parts and vegetative organs used, the methods of preparation, the forms of administration, and the targeted pathologies.

Results and discussion

Total flora analysis

At the end of the floristic inventory conducted in the peri-urban forest of Bainem, 421 species belonging to 245 genera and 65 botanical families were recorded.

The most common genera are, in decreasing order of importance (percentage relative to the total flora and by family, respectively): *Eucalyptus* spp. (5.94%; 96.1%), *Trifolium* spp. (2.4%; 20%), *Allium* spp. (1.90%; 100%), *Centaurea* spp. (1.7%; 10.4%), *Acacia* spp. (1.4%; 12%), *Cistus* spp. (1.4%; 66.7%) and *Erodium* spp. (1.4%; 54.5%).

Floristic analysis of the 421 species reveals that 6 botanical families account for just over half (52%) of the recorded species.

The most represented are the Asteraceae with 67 species, accounting for approximately 16%. This is the largest family of flowering plants in Algeria, with over 408 species and 109 genera (Quézel et Santa, 1962–1963), followed by the Fabaceae with 50 species, (i.e., 12%), the Poaceae with 39 species (i.e., 9%), the Myrtaceae with 26 species, (i.e., 6%), the Lamiaceae with 19 species (i.e., 5%), and the Apiaceae with 16 species, that is 4% (*Fig. 3*). The remaining botanical families consist of only one or two species.

In the current study, the families Asteraceae, Fabaceae, and Poaceae are well represented. These families are predominantly found in the Algerian flora (Quézel et Santa, 1962-1963). They hold the top position in terms of species and genus richness and are among the most important families on the planet (Masharabu et al., 2010).

Biological types

The biological spectrum of the total flora of the peri-urban forest of Bainem is typical of the Mediterranean bioclimatic environment, revealing the predominance of Hemicryptophytes with 141 species (33.5%) over other life forms (*Fig. 4*), followed by Therophytes with 117 species (27.8%), while Phanerophytes rank third with 96 species (22.8%). In contrast, geophytes and chamaephytes are poorly represented, with 34 and 33 species, accounting for 8.1% and 7.8%, respectively, of the analyzed flora. Among the phanerophytes, there are a few representatives of nanophanerophytes and woody vines.

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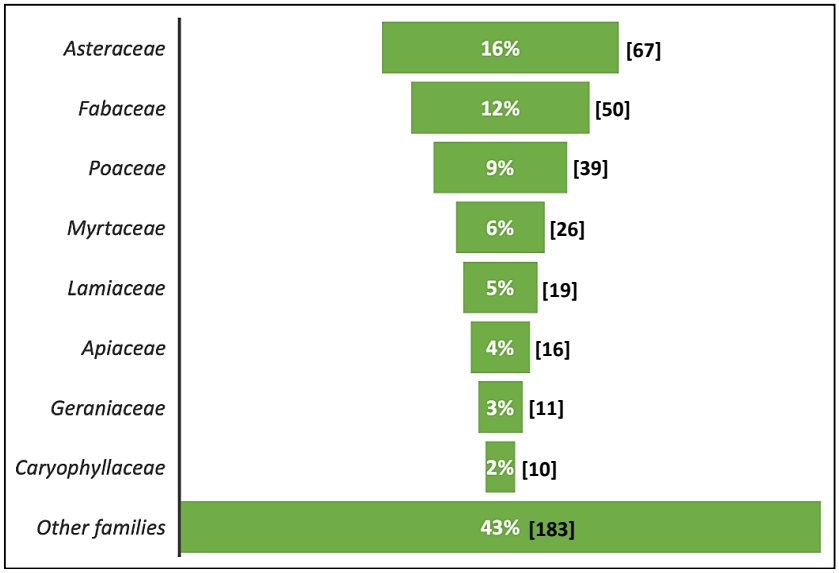

Figure 3. *Most represented botanical families in the total flora of the peri-urban forest of Bainem (Northern Algeria). The numbers into brackets indicate the number of species per family*

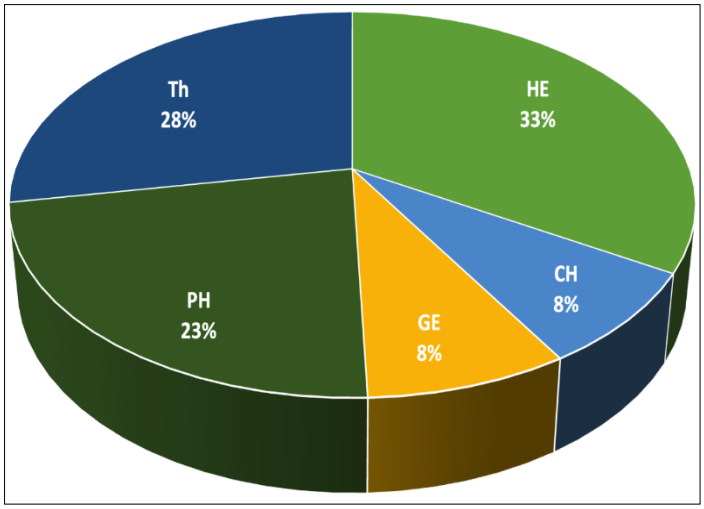

Figure 4. *Biological spectrum of the flora recorded in the peri-urban forest of Bainem (Northern Algeria). Th: Therophytes; HE: Hemicryptophytes; PH: Phanerophytes; GE: Geophytes; CH: Chamaephytes*

Regarding the proportions of biological types in the inventory, Hemicryptophytes rank in the top position. The abundance of Hemicryptophytes in the Maghreb countries is due to the presence of organic matter and humidity (Barbero et al., 2001).

Moreover, it appears that rainfall and low light levels contribute to the development of Hemicryptophytes (Bouchibane et al., 2017).

According to Hart (1977) in Verlaque et al. (2001), the success of these biennials is based on a resource optimization strategy, with certain adjustments made according to local conditions. This allows them to achieve a fruiting rate four to five times higher than that of other herbaceous plants.

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Therophytes also hold an important position, accounting for 28% of the other biological types; the percentage of therophytes in Mediterranean plant communities is high, estimated at between 25 and 50% (Barbero, 1989).

Repeated fires, environmental overexploitation, and significant anthropogenic activities observed during our field surveys promote the development and emergence of this biological type. Therophily is seen as a method of adaptation to unfavorable conditions (Daget, 1980).

Although Phanerophytes display a limited specific diversity, they can sometimes exert dominance through their canopy cover, and thereby significantly contribute to the formation of a characteristic floristic assemblage in forest environments (Lecompte-Barbet, 1975).

Finally, the Chamephytes and Geophytes account for only 8%. Some researchers, such as Aouadj et al. (2020a, b), suggest that the low proportion of Geophyte plants can be explained by their low germination rate.

Geophytes primarily reproduce vegetatively and prefer minimally disturbed soils. This biological type thrives in open habitats, particularly scrublands and mountain grasslands.

The hamaephytes are poorly represented, accounting for only 7.1% of the studied flora. The low number of these plants could indicate good health of the forest and pre-forest formations (Miara et al., 2017).

The net biological spectrum of the study area is as follows: Hemicryptophytes > Therophytes > Phanerophytes > Geophytes > Chamaephytes.

Phytogeographic analysis

The floristic analysis shows the presence of several phytocoric units (*Fig. 5*), with the Mediterranean element dominating, comprising 214 species (i.e., 51%) of the total flora. This situation is common to most natural ecosystems in Algeria (Quézel, 1964, 2002) and the Mediterranean basin (Quézel et Barbero, 1990; Quézel et Medail, 2003), followed by cosmopolitan species with 43 species (i.e., 10%). Australian (Aust.) and European (Eur.) elements are each represented by 32 species (i.e., 8%). Asian and Eurasian elements are poorly represented (i.e., 1% and 2%, respectively) with 26 species, and the rate of endemism is 6% of the total flora (*Table 1*).

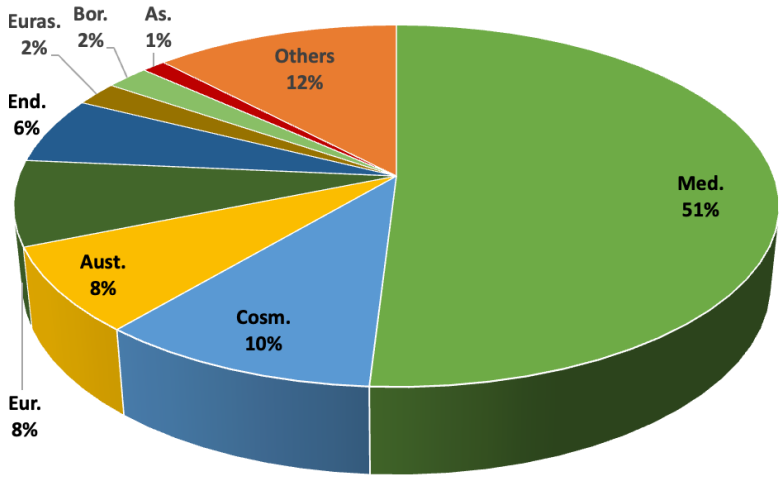

Figure 5. *Chorological spectrum of the peri-urban forest of Bainem (Northern Algeria). Med.: Mediterranean; Cosm.: Cosmopolitan; Aust.: Australian; Eur.: European; End.: Endemism; Euras.: Eurasian; Bor.: Boreal; As.: Asia*

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Table 1. *Endemic species among the flora of the periurban forest of Bainem (Northern Algeria)*

Species	Family	Endemism
Allium rotundum L.	Amaryllidaceae	Med. End.
Allium sphaerocephalum L. subsp. *Spharocephalum*	Amaryllidaceae	Med. End.
Allium subhirsutum L. subsp. *Subhisutum*	Amaryllidaceae	Med. End.
Onopordum algeriense (Munby) Pomel	Asteraceae	N. Afr. End
Plagius maghrebinus Vogt & Greuter	Asteraceae	End. Alg. - Tun. - Mar.
Plagius grandis (L.) Alavi & Heywood	Asteraceae	End. Alg. - Tun.
Pilosella pseudopilosella (Ten.) Soják	Asteraceae	End. Alg. - Mar.
Helminthotheca glomerata (Pomel) Greuter = Picris duriaei Emb. & Maire	Asteraceae	End.
Borago officinalis L.	Boraginaceae	N. Afr. End
Campanula alata Desf.	Campanulaceae	End. Alg. - Tun.
Silene pomelii Batt.	Caryophyllaceae	End. Alg. - Mar.
Cupressus dupreziana A. Camus	Cupressaceae	End.
Tetraclinis articulata (Vahl) Mast.	Cupressaceae	End. Alg. - Tun. - Mar.
Erophaca baetica (L.) Boiss. Subsp. *Baetica*	Fabaceae	End.
Genista tricuspidata Desf.	Fabaceae	End.
Quercus afares Pomel.	Fagaceae	End. Alg. - Tun.
Erodium battandieranum Rouy	Geraniaceae	End.
Geranium atlanticum Boiss.	Geraniaceae	N. Afr. End
Calamintha menthifolia Host	Lamiaceae	Med. End.
Thymus numidicus Poir.	Lamiaceae	End. Alg. - Tun.
Linum corymbiferum Desf.	Linaceae	End.
Phelipanche aegyptiaca (Pers.) Pomel = *Orobanche aegyptiaca Pers.*	Orobanchaceae	N. Afr. End
Linaria pinifolia (Poir.) Thell.	Plantaginaceae	Med. End.
Festuca atlantica Duval-Jouve ex. Clauson	Poaceae	End. Alg. - Mar.
Cyclamen africanum Boiss. & Reut.	Primulaceae	N. Afr. End
Galium tunetanum Lam.	Rubiaceae	N. Afr. End

End. = Endemic; Med. End. = Mediterranean endemic; N. Afr. End = North African Endemic; Alg. = Algeria; Mar. = Morocco; Tun. = Tunisia

Analysis of medicinal flora

The studied flora reveals a significant medicinal richness. Out of a total of 421 species, 346 are known for their therapeutic properties, representing 82% of the overall flora. Furthermore, a notable concentration of this medicinal flora is found within 8 botanical families, which together encompass 187 species, representing 54% of the 346 recorded medicinal plants (*Fig. 6*).

The ethnobotanical surveys conducted in the peri-urban forest of Bainem identified 89 species used by the local population as medicinal plants, which represent 26% of the 346 medicinal plants recorded (*Table 2*). These species are distributed among 45 genera and 27 families. The diversity of medicinal species collected underscores the social and economic value, as well as the medicinal plant potential that this peri-urban forest represents, being the only authentic remnant of forest in the Algiers region, intended for urban populations.

The parts of medicinal plants used by the local population

Every part of the plant has therapeutic properties. Thus, medicinal plants can be used in their entirety or in part (leaf, flower, root, fruit, etc.).

Analysis of the use of medicinal plant parts shows that 4 parts are the most frequently cited (*Fig. 7*).

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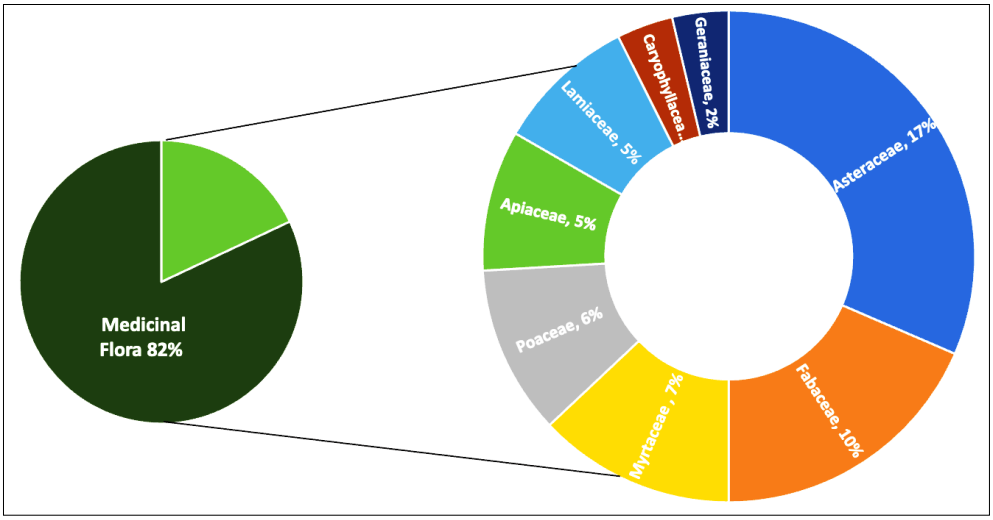

Figure 6. *Most represented botanical families in the medicinal flora of the peri-urban forest of Bainem (Northern Algeria)*

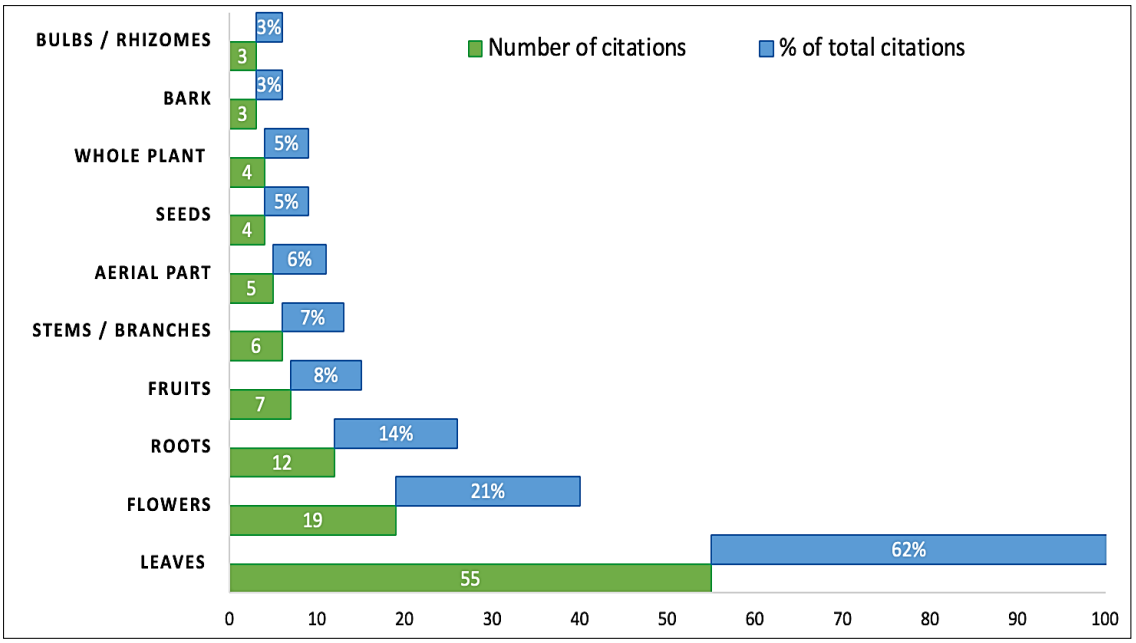

Figure 7. *Parts of medicinal plants used by the local population of the peri-urban forest of Bainem (Northern Algeria)*

Among these parts, the ranking in increasing order of importance indicates that out of 89 listed species, 55 citations pertain to leaves, accounting for 62% of the total citations, 19 citations refer to flowers, 12 citations to roots, and 7 citations to fruits. The other organs have fewer than 7 citations each. These organs are the stems/branches (6 citations), the whole plant (4 citations), the aerial part (5 citations), the seeds (4 citations), the bark and the bulbs (3 citations for each). As mentioned, the leaves are the most utilized vegetative organ. The ease and speed of harvesting (Bitsindou, 1986) may be the reason for the high rate of leaf usage by the population living near the edge of the peri-urban

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forest of Bainem. Flowers hold the second position with a rate of 21%, while roots and fruits contribute 14% and 8%, respectively. This greater use of the leaves of medicinal plants compared to other organs confirms the findings of Salhi et al. (2010); Tahri et al. (2012); Mosaddegh and al. (2016), and has also been reported in other ethnobotanical studies in the Maghreb region (Chermat and Gharzouli, 2015; Boutabia et al., 2011; Jdaidi et Hasnaoui, 2016; Benkhnigue et al., 2011).

According to Nasution and al. (2018), this widespread use of leaves can also be explained by the availability and ease of harvesting the leaves.

This widespread use of leaves can also be explained by the concentration of active compounds they contain. Although leaves represente the most commonly used organ, we noticed during our field visits that users tend to uproot the entire plant instead of focusing only on the desired part (i.e., the leaves). According to Cunningham (1996), there is a clear relationship between the part of the plant harvested and the effects of its exploitation on the plant survival.

Hence, the method of harvest may seriously compromise the sustainability of medicinal species, especially bulbous plants. It is important to note that leaves are the site of photosynthesis and sometimes the storage of secondary metabolites responsible for the plant's biological properties (Bigendako-polygenis et Lejoly, 1990).

On the other hand, other parts, such as seeds, bark, stems, and rhizomes or bulbs, are represented by less than 7%. This indicates a low reliance by the local population on these vegetative organs that are critical for the sustainability of the species.

Parts of medicinal plants most commonly used by the local population by family

The analysis of the use of medicinal plants parts by family shows that in 7 of the 8 most represented families (*Fig. 8*), leaves are the most frequently used (40 to 100%), followed by flowers (in 5 of the 8 families, 15 to 40%), roots (in 3 of the 8 families, 14 to 50%), and then aerial parts (in 3 of the 8 families, 10 to 20%). It is the Fabaceae family that has the highest number of uses (5 plant parts are used) in the study area. The importance of this family is confirmed by Zerbo et al. (2011) in Burkina Faso.

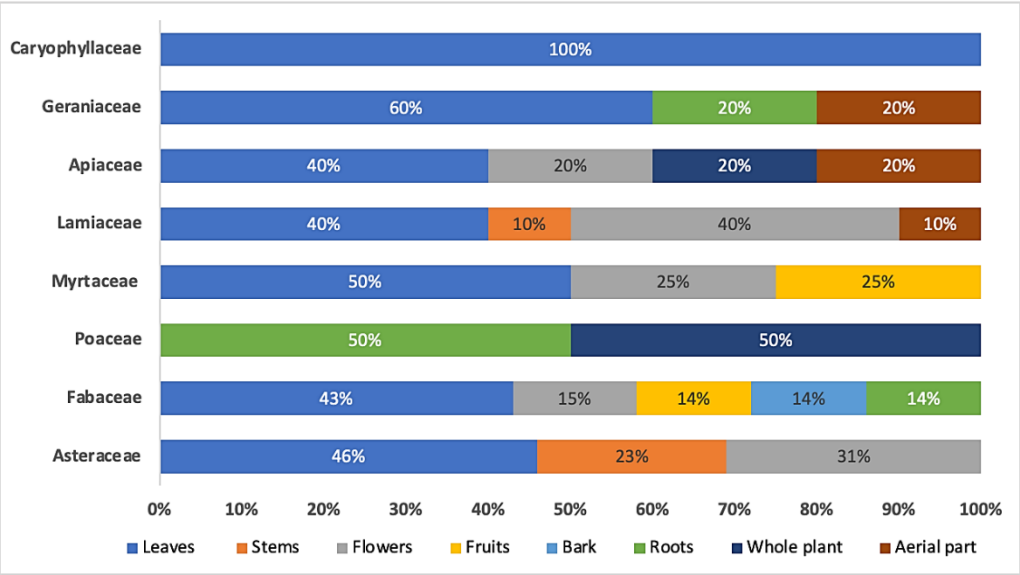

Figure 8. *Medicinal plant parts, by major families, most commonly used by the local population in the peri-urban forest of Bainem (Northern Algeria)*

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The popularity of this family can be explained by the wide range of bioactive compounds it contains (Kyaw Tun and al., 2006).

The Fabaceae family is characterized by significant concentrations of tannins and alkaloids, as well as the presence of isoflavonoids, which are recognized for their estrogenic properties. This family is followed by the Apiaceae and Lamiaceae (4 plant parts used for each), then by the Asteraceae, Myrtaceae, and Geraniaceae (3 plant parts used for each), the Poaceae (2 plant parts used), and Caryophyllaceae (1 plant part used).

Targeted pathologies

Regarding the main targeted pathologies, skin conditions and wounds rank first with 28% of citations, followed by inflammatory disorders and associated pain (17%), respiratory disorders and infections (16%), digestive disorders (15%), while other disorders account for less than 10% (*Fig. 9*). The details of the reported pathology categories are recorded in *Table A1* in the *Appendix*.

In addition, the comparative examination of the therapeutic uses reported locally and those described in the literature revealed that some species used by the local population have new therapeutic uses compared to the existing scientific literature. This is the case of *Foeniculum vulgare* (fennel), which is used in our study area for the treatment of rheumatism (*Table 2*), while it is used elsewhere for the treatment of respiratory and gynecological problems (Rather et al., 2016). A second example concerns *Marrubium vulgare* (white horehound), used in our study area for the treatment of skin irritation. In contrast, it is traditionally used in Europe to treat respiratory diseases, including chronic bronchitis, coughs, asthma and colds (Rodríguez Villanueva and Martín Esteban, 2016). The ethnopharmacological use of *Acanthus mollis* in our study area is also unprecedented. Used by the local population of the Bainem Forest for healing burns and scars, it is traditionally employed in the Mediterranean and Southern Europe to soothe the digestive and urinary mucous membranes, as well as to treat gastrointestinal diseases, ulcers and even certain types of tumors (Özenver et al., 2021).

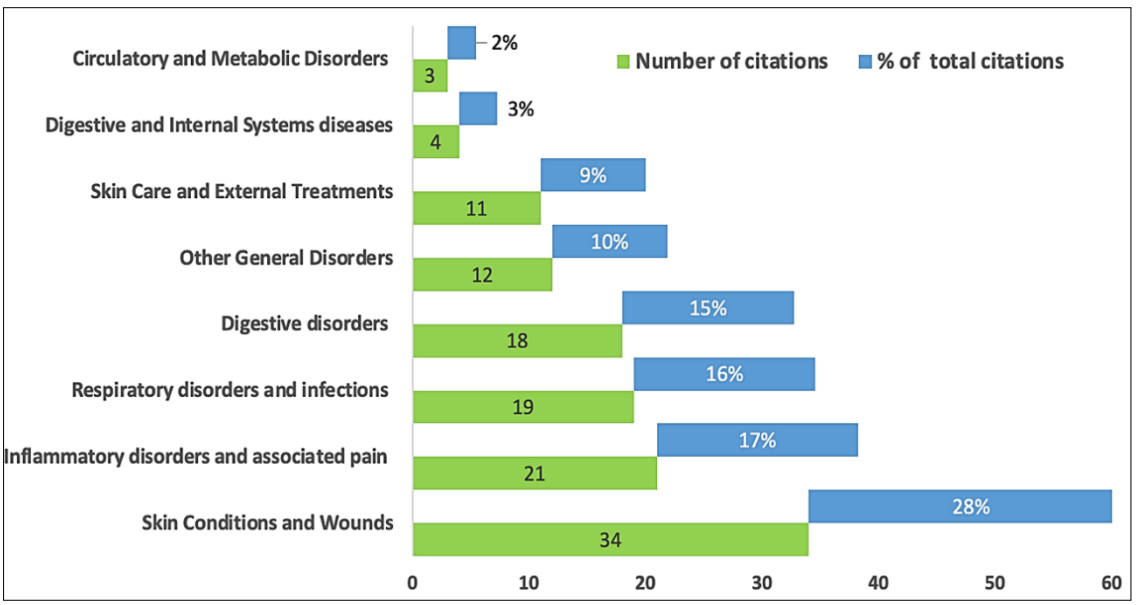

Figure 9. *Pathologies targeted by the local population using the medicinal flora of the peri-urban forest of Bainem (Northern Algeria)*

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Table 2. *Medicinal plants used by the local population in traditional therapy in the peri-urban forest of Bainem (Northern Algeria)*

Species	Family	Biological type	Parts used by the local population	Targeted pathology	Preparation method/traditional use
Acanthus mollis L.	Acanthaceae	He	Leaves	Burns/scars	Poultice
Viburnum tinus L. subsp. tinus	Adoxaceae	Ch	Leaves	Constipation	Decoction/infusion
Achyranthes aspera var. sicula	Amaranthaceae	Th	Leaves/seeds/roots	Cough	Decoction
Beta vulgaris L.	Amaranthaceae	He	Leaves	Wounds	Poultice
Allium roseum L.	Amaryllidaceae	Ge	Leaves/bulbs	Digestive issues	Decoction/powder
Allium triquetrum L.	Amaryllidaceae	He	Bulbs	Dewormer/antihypertensive	Decoction
Pistacia lentiscus L.	Anacardiaceae	Ph	Leaves/branches	Antiseptic	Infusion
Ferula communis L.	Apiaceae	He	Leaves	Rheumatism	Poultice
Prasium majus L.	Apiaceae	He	Leaves/flowers	Gastrointestinal	Infusion
Daucus carota L.	Apiaceae	He	Whole plant	Digestive issues	Infusion
Foeniculum Vulgare Mill. var. vulgare	Apiaceae	Ch	Whole plant without the roots	Rheumatism	Plant material sprayed between two cloths, on a part of the body
Nerium oleander L.	Apocynaceae	Ph	Leaves/flowers	External skin infections/dartre/scabies/insect bites	Local application of latex/aqueous maceration
Ilex aquifolium L.	Aquifoliaceae	Ph	Leaves	Rheumatism	Infusion
Ruscus aculeatus L.	Asparagaceae	Ch	Roots	Hemorrhoids	Herbal tea
Ruscus hypophyllum L.	Asparagaceae	Ch	Roots	Hemorrhoids	Herbal tea
Asphodelus ramosus L. = Asphodelus microcarpus Viv.	Asphodelaceae	Ge	Roots	Abscesses/otitis	Local application
Atractylis cancellata L.	Asteraceae	Th	Leaves/stems	Skin conditions	Decoction/poultice
Scolymus hispanicus L.	Asteraceae	He	Stems	Intestines	Couscous/ raw
Urospermum dalechampii (L.) F.W. Schmidt	Asteraceae	He	Leaves	Digestion	Raw
Anacyclus clavatus (Desf.) Pers.	Asteraceae	Th	Leaves/stems	Gastric problems/hemorrhoids	Couscous
Andryala integrifolia L.	Asteraceae	Th	Flowers	Diarrhea	Decoction/infusion
Bellis sylvestris Cyrillo	Asteraceae	Th	Flowers	Eczema	Infusion
Calendula arvensis (Vaill.) L.	Asteraceae	Th	Flowers	Antiseptic/anti-inflammatory/healing	Infusion
Dittrichia viscosa subsp. viscosa (L.)Greuter	Asteraceae	Ch	Leaves	Wounds/pain	Mash and apply to wound/put sprayed plant material between two cloths, on a part of the body
Pallenis spinosa (L.) Cass.	Asteraceae	He	Flowering plant	Colds	Herbs (tea)
Taraxacum officinale F.H.Wigg.	Asteraceae	He	Leaves	Appetite	Decoction
Pulicaria odora (L.)Rchb. = Inula odora L.	Asteraceae	He	Leaves	Stomach pains	Decoction of leaves in olive oil

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Borago officinalis L.	Boraginaceae	Th	Leaves/flowers/stems	Emollient	Poultice/infusion
Sinapis arvensis L.	Brassicaceae	Th	Leaves/seeds	Abscesses	Poultice
Sinapis alba L.	Brassicaceae	Th	Seeds	Skin rashes	Poultice
Paronychia argentea Lam.	Caryophyllaceae	He	Leaves	Diarrhea	Decoction
Cistus monspeliensis L.	Cistaceae	Ph	Leaves/flowers	Wounds	Poultice
Cistus albidus L.	Cistaceae	Ch	Leaves	Digestion	Infusion
Convolvulus arvensis L.	Convolvulaceae	He	Whole plant	Cough	Decoction
Tetraclinis articulata (Vahl) Mast.	Cupressaceae	Ph	Leaves	Stomach aches	Decoction
Dioscorea communis (L.) Caddick & Wilkin = Tamus communis L.	Dioscoreaceae	Nph	Roots/rhizomes	Anti-rheumatic	Poultice
Arbutus unedo L.	Ericaceae	Ph	Leaves/bark/roots/fruits	Anti-inflammatory/ antiseptic/astringent/diuretic/depurative	Decoction
Erica arborea L.	Ericaceae	Nph	Leaves/flowers	Anti-inflammatory	Infusion
Mercurialis annua L.	Euphorbiaceae	Th	Leaves	Constipation	Infusion
Ricinus communis L.	Euphorbiaceae	Ph	Leaves	Fever	Poultice
Albizia julibrissin (Willd.)Durazz.	Fabaceae	Ph	Flowers/bark	Bruises/firming/insomnia/insect bites/skin infections (boils and abscesses)	Decoction
Anthyllis vulneraria L	Fabaceae	He	Leaves	Skin rashes/wounds	Wound dressing
Ceratonia siliqua L.	Fabaceae	Ph	Fruits	Against vomiting/diarrhea	Decoction
Cytisus triflorus L'Herit = C.villosus Pourret	Fabaceae	Ph	Leaves	Wounds	Poultice
Ononis spinosa L.	Fabaceae	Ch	Roots	Eczema	Decoction
Trifolium arvense L.	Fabaceae	Th	Leaves	Diarrhea	Infusion
Quercus suber L.	Fagaceae	Ph	Leaves/bark	Diarrhea	Decoction/powder
Centaurium erythraea Rafn.	Gentianaceae	Th	Flowers	Indigestion	Infusion (tea)
Erodium cicutarium (L.) L'Hér	Geraniaceae	Th	Leaves/roots	Fever typhoid (fever)/wounds (racines)	Poultice/infusion
Geranium purpureum Vill.	Geraniaceae	Th	Aerial part	Diarrhea	Infusion
Erodium moschatum (L.)L'Hér.	Geraniaceae	Th	Leaves	Rheumatism	The leaves soaked in bath water
Geranium robertianum L.	Geraniaceae	He	Leaves	Sore throats/mouth ulcers	Fresh leaves chewed to relieve sore throats and mouth sores
Hypericum androsaemum L.	Hypericaceae	Ch	Leaves	Wounds	Poultice
Ajuga iva (L.) Schreb	Lamiaceae	Ch	Leaves/flowers/stems	Diabetes	Maceration (several days)
Lavandula stoechas L.	Lamiaceae	Ch	Flowers	Flu/bronchitis/stomach pains	Decoction
Marrubium vulgare L.	Lamiaceae	He	Leaves/flowers	Cutaneous-mucosal irritation	Essential oils/infusion
Mentha pulegium L.	Lamiaceae	Ch	Aerial part	Flu/bronchitis/cough/abdominal pain	Decoction/infusion
Rosmarinus officinalis L.	Lamiaceae	Ch	Leaves	Headaches/stomach aches/rheumatism	Infusion

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Salvia verbenaca (L.)Briq.	Lamiaceae	He	Leaves/flowers	Wounds/abscesses	Poultice
Linum usitatissimum subsp.angustifolium = L. bienne L.	Linaceae	Th	Seeds	Cough	Infusion
Malva sylvestris L.	Malvaceae	Th	Leaves flowers/roots	Back pain/bronchitis	Decoction/infusion
Malva parviflora L.	Malvaceae	Th	Leaves	Wounds	Poultice
Morus alba L. = Morus alba var. latifolia Bureau.	Moraceae	Ph	Roots	Cough	Infusion
Eucalyptus globulus Labill.	Myrtaceae	Ph	Leaves	Fever/flu	Encens
Myrtus communis L.	Myrtaceae	Ph	Leaves/flowers/fruits	Hemorrhoids/respiratory conditions	Fumigation/infusion
Fraxinus angustifolia Vahl.	Oleaceae	Ph	Leaves	Astringent	Decoction/infusion
Olea europaea var.sylvestris L.	Oleaceae	Ph	Leaves/fruits	Diabetes	Decoction/infusion
Phillyrea angustifolia L.	Oleaceae	Ph	Leaves	Headaches	Poultice
Phillyrea latifolia L.	Oleaceae	Ph	Leaves	Fever	Decoction
Phillyrea media L.	Oleaceae	Ph	Whole plant	Mouthwash	Infusion
Antirrhinum majus L.	Plantaginaceae	He	Leaves flowers	Ulcers	Poultice
Linaria pinifolia (Poir.) Thell.	Plantaginaceae	He	Leaves	Digestion problems	Decoction
Plantago coronopus L.	Plantaginaceae	He	Leaves	Insect bites/wounds	Poultice
Anthoxanthum odoratum L.	Poaceae	He	Whole plant	Rheumatism	Poultice
Cynodon dactylon (L.)Pers.	Poaceae	Ge	Roots	Rheumatism	Decoction
Lysimachia arvensis (L.) U. Manns et Anderb. = Anagallis arvensis L.	Primulaceae	Th	Aerial part	Wounds/rheumatism	Poultice/infusion
Adiantum capillus-veneris L.	Pteridaceae	Ge	Leaves (Foliage)	Cough/bee stings	Infusion/poultice
Pteridium aquilinum (L.)Kuhn	Pteridaceae	Ge	Leaves	Wounds	Poultice
Clematis cirrhosa L.	Ranunculaceae	Ph	Leaves	Rheumatism	Poultice
Clematis flammula L.	Ranunculaceae	Ph	Leaves	Arthritis	Infusion
Rhamnus alaternus L.	Rhamnaceae	Ph	Leaves	Digestive issues	Infusion
Crataegus monogyna Jacq.	Rosaceae	Ph	Leaves/fruits	Insomnia	Decoction/infusion
Crataegus oxyacantha L.	Rosaceae	Ph	Leaves/flowers	Diarrhea	Infusion
Rubus ulmifolius Schott.	Rosaceae	Ph	Leaves	Astringent (cicatrization)	Decoction
Rubia peregrina L.	Rubiaceae	He	Roots	Jaundice	Decoction
Ruta chalepensis L.	Rutaceae	He	Leaves/Fruits	Stomach aches/respiratory system disorders	Decoction
Smilax aspera L.	Smilacaceae	Ph	Fruits	Scabies	Ripe fruits are squeezed and applied to the skin
Daphne gnidium L.	Thymelaeaceae	Ph	Leaves	Rheumatism	Poultice
Urtica dioica L.	Urticaceae	Ge	Leaves	Anti-inflammatory	Poultice/infusion

He: Hemicryptophytes, Ge: Geophytes, Ch: Chamephytes, Th: Therophytes, Ph: Phanerophytes

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Targeted pathologies by family

The analysis of targeted pathologies by family shows that digestive disorders are the most frequently targeted conditions (in 5 out of 7 families, with citation rates ranging from 6% to 19%), followed by respiratory disorders and infections (in 4 out of 7 families, with citation rates ranging from 9% to 46%), then skin conditions and inflammatory disorders (in 3 out of 7 families each, with citation rates ranging from 5% to 47% and 17% to 33%, respectively). Skin care as well as circulatory and metabolic disorders are each represented by 2 families with citation rates of 25% to 50% and 50%, respectively.

The details of the frequencies of the pathologies targeted by the main families are represented in *Figure 10*.

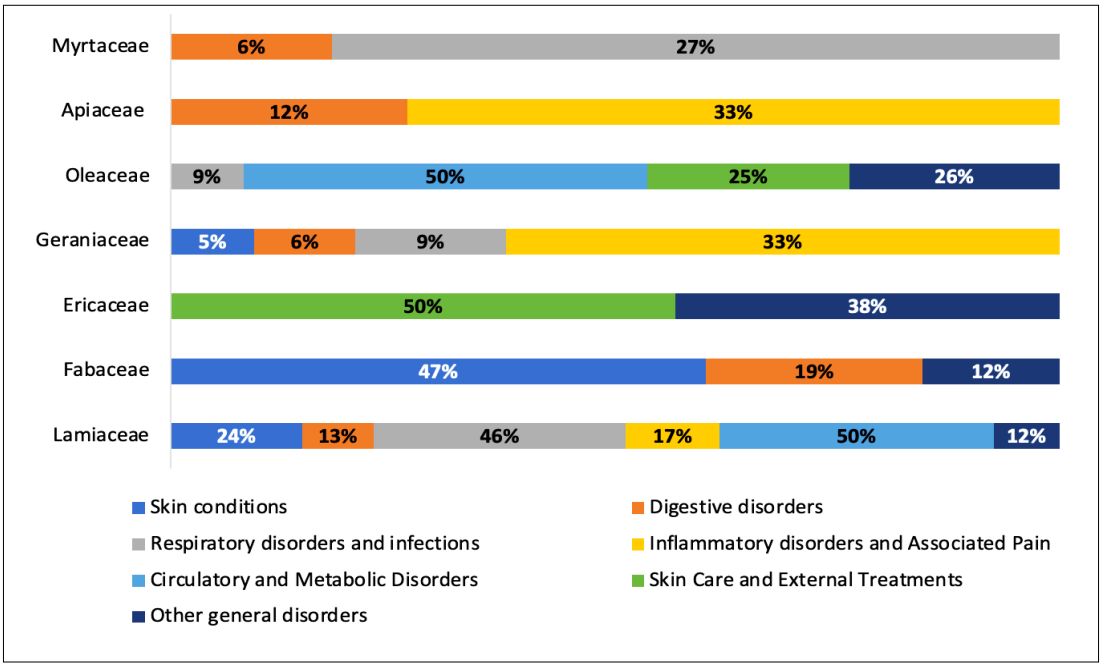

Figure 10. *Frequencies of the pathologies targeted by the main families of medicinal plants used by the local population of the peri-urban forest of Bainem (Northern Algeria)*

Methods of preparation and application

To address the various diseases and symptoms encountered in the study area, 12 main methods of drug preparation were identified during our survey.

The administration of remedies can be done either internally (decoction, infusion, or maceration) or externally (poultice, compress, ointment, herbal bath, etc.). Users are constantly looking for the easiest way to prepare and apply phytomedicines. Plants prepared as infusions (33%), decoctions (27%), and poultices (24%) are the most commonly used methods of preparation by the local population of the peri-urban forest of Bainem. This reflects the ease of their preparation; these results are consistent with those from Morocco (Benkhnigue et al., 2011; Rhattas et al., 2016). Furthermore, decoction offers the possibility of extracting a maximum of active principles while reducing or eliminating the toxic effects of certain preparations (Salhi et al., 2010). Other methods of preparation and application, such as chewing, fumigation, and steam treatment, maceration, etc. are less commonly used (*Fig. 11*).

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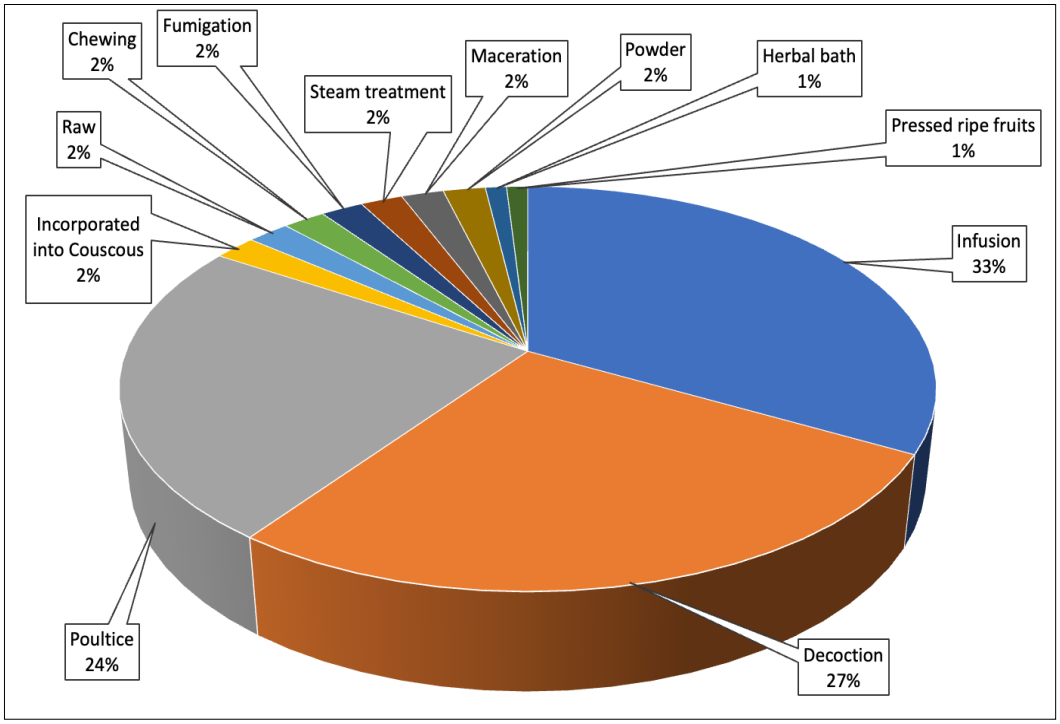

Figure 11. *Relative importance of preparation methods of medicinal plants used by the local population of the peri-urban forest of Bainem (Northern Algeria)*

As previously mentioned, decoctions and infusions are the most common methods of preparation, especially for leaves, flowers and roots. Poultices are also widely used for external applications, especially for the treatment of skin conditions (wounds, burns, abscesses, skin rashes, etc.). In addition to these conventional methods, several remarkable and localized practices have been documented. This includes plant parts (leaves, stems) rolled with couscous, reflecting the integration of medicinal plants into the most widespread popular dishes. Also noteworthy is the chewing of fresh leaves to soothe throat pains and mouth ulcers, a method that ensures direct contact of the bioactive compounds with the affected mucosa. The chewing of plant matter and its direct application to wounds is also mentioned, as is the case with the chewing of *Dittrichia viscosa* leaves. This method of preparation and application suggests a possible role of saliva in the activation and local absorption of bioactive compounds. Another singular technique is the application of powdered or crushed plant material, placed between two tissues and applied to body parts, illustrating an original transdermal approach within the ethnomedicinal knowledge of the local population.

Conclusion

The present study reveals an extreme diversity of medicinal species of the peri-urban forest of Bainem in Northern Algeria, which is linked to its biological richness. Unfortunately, their overexploitation without sustainability goals may lead to their disappearance.

The information gathered from the floristic surveys conducted in this peri-urban forest revealed the occurrence of 421 plant species, distributed across 65 families and 245

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DOI: http://dx.doi.org/10.15666/aeer/2401_765784

genera, of which 346 species belonging to 8 families had medicinal value, with a clear dominance of the Asteraceae family.

From an ethnobotanical and pharmacological perspective, the foliage is the most commonly used part, and infusion is the most practiced galenic form. Similarly, among all the diseases treated, skin conditions and wounds are the most frequently mentioned ailments. Furthermore, this study allowed a better understanding of traditional practices used by the population of the peri-urban forest of Bainem.

The richness of this traditional knowledge is evident through the results obtained. It remains essential however, to extend such investigation to other peri-urban forests across the country in order to preserve this valuable cultural heritage through the most comprehensive monograph possible. It is also important to experimentally validate the reported remedies using rigorous scientific protocols.

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DOI: http://dx.doi.org/10.15666/aeer/2401_765784

APPENDIX

Table A1. *Targeted pathologies and use of medicinal plants from the peri-urban forest of Bainem, as reported by the local population*

Categories of targeted pathologies	Details
Skin conditions and wounds	Burns; scars; wounds; eczema; scabies; insect bites; abscesses; eczema; rashes; bruises; firming; astringent
Inflammatory disorders and associated pain	Rheumatism; pain (in general, including back and abdominal pain); anti-inflammatory; anti-rheumatic; arthritis
Respiratory disorders and infections	Cough; colds; flu; bronchitis; respiratory conditions; fever; typhoid fever
Digestive disorders	Constipation; diarrhea; indigestion; stomach aches; vomiting; ulcers; appetite disorders
Skin care and external treatments	Antiseptic; emollient (skin softener); mouthwash (for oral infections)
Digestive and internal systems diseases	Hemorrhoids; jaundice; intestinal disorders
Circulatory and metabolic disorders	Diabetes; high blood pressure
Other general disorders	Insomnia; headaches; various pains

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